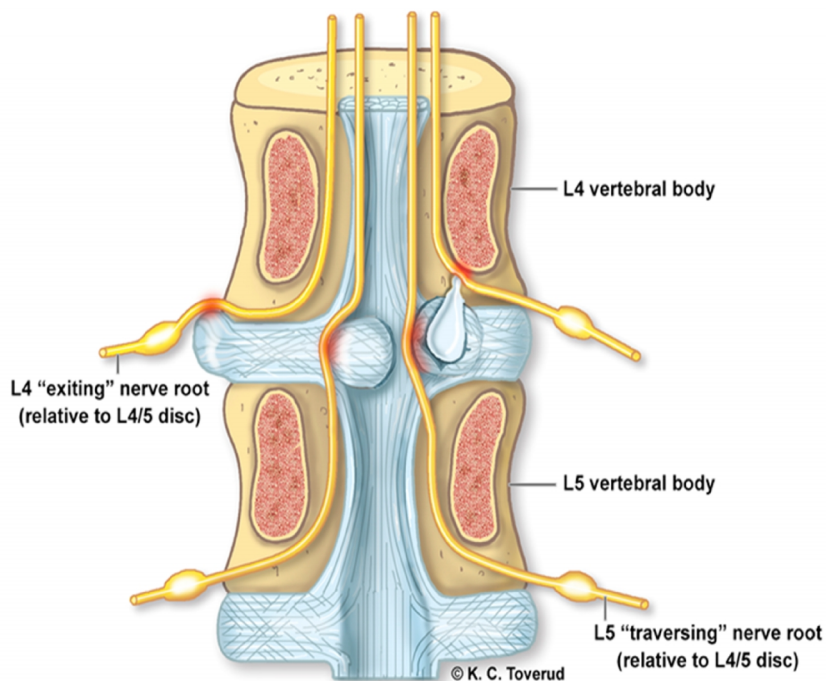


Lumbosacral radiculopathy managed in multidisciplinary back clinics

Diagnostic accuracy, prognostic factors and efficacy of epidural injection therapy.

A thesis for the degree of Philosophiae Doctor – 12 July 2015

Trond Iversen



CONTENTS

1. Acknowledgements	7
2. Norwegian abstract – Norsk sammendrag	9
3. List of papers	11
3.1 Paper I.....	11
3.2 Paper II.....	11
3.3 Paper III	11
4. Abbreviations.....	13
5. What is the thesis about?.....	15
6. Introduction.....	17
6.1 Prevalence, incidence and risk factors.....	17
6.2 Costs	19
6.3 Definition of spinal pain	20
6.4 Clinical presentation.....	21
6.5 Pathophysiology of pain.....	23
6.6 Imaging.....	23
6.7 Treatment	24
6.8 Recurrent pain, disability and cost-effectiveness.....	25
6.9 The physiology of pain and the pharmacology of steroids.....	26
6.10 Anatomy of the lumbosacral spine	27
6.11 Technical aspects of giving epidural injections	29
6.12 Need for further research	31
6.13 Evidence-based medicine	32
7. Research questions.....	35
7.1 Paper I.....	35
7.2 Paper II.....	35
7.3 Paper III	35
8. Aims of each paper.....	37
8.1 Paper I.....	37
8.2 Paper II.....	37
8.3 Paper III	38

9. Study design	39
9.1 Paper I.....	39
9.2 Paper II.....	39
9.3 Paper III	39
10. Material and methods	41
10.1 Referrals and eligibility	41
10.2 Inclusion criteria	41
10.3 Exclusion criteria.....	41
10.4 Study population	42
10.5 Clinical examination.....	44
10.6 Imaging.....	44
10.7 Randomization	45
10.8 Data collection.....	46
10.9 Follow-up.....	46
10.10 Outcome measures.....	47
10.11 Statistical analysis	48
10.11.1 Paper I.....	48
10.11.2 Paper II	49
10.11.3 Paper III.....	49
10.12 Intervention and blinding.....	49
10.13 Placebo and sham procedure	51
10.14 Ethics	52
11. Main Results.....	53
11.1 Paper I.....	53
11.2 Paper II	53
11.3 Paper III.....	54
12. Discussion of the research questions	55
12.1 Paper I.....	55
12.2 Paper II	57
12.3 Paper III.....	62
12.3.1 Is there a between-group difference when epidural steroid injections are compared with placebo injections?	64

12.3.2 Do epidural placebo injections constitute a treatment in comparison with sham injections?.....	70
12.3.3 Are there differences in effect size between epidural steroid injections and sham injections?.....	72
12.3.4 Do epidural steroid injections have a surgery-sparing effect?	73
12.3.5 Is there evidence to support the use of epidural steroid injections?	76
13. Limitations.....	79
13.1 Paper I.....	79
13.2 Paper II	80
13.3 Paper III.....	80
14. New areas of research.....	83
14.1 Modic changes	83
14.2 Pro-inflammatory interleukins.....	84
14.3 Tumour necrosis factor alfa	86
14.4 Pain neurobiology and glial activation.....	87
15. Translating evidence-based clinical guidelines for epidural steroid injections into practice – current recommendations.....	89
15.1 Same trials, different conclusions in clinical guidelines	89
15.2 Guidelines for epidural steroid injections in the Nordic countries	92
15.3 Implementation and change of practice	92
16. Main conclusions.....	95
16.1 Paper I.....	95
16.2 Paper II	95
16.3 Paper III.....	95
17. Reference list.....	97
Appendices.....	113

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2. NORWEGIAN ABSTRACT – NORSK SAMMENDRAG

I perioden 2005–2010 ble det ved fem norske sykehus utført en randomisert kontrollert studie over effekten av epidurale steroidinjeksjoner i behandlingen av kronisk (> 12-ukers varighet) isjias. Det ble til sammen undersøkt 461 pasienter i aldersgruppen 18–60 år for deltagelse i studien; 116 av disse ble etter grundig forundersøkelse inkludert og randomisert til tre ulike behandlingsgrupper.

Alle pasientene fikk utført magnetic resonance imaging (MRI) eller computer tomography (CT) av korsryggen for å kartlegge tilstedeværelsen av skiveprolaps med eventuell avklemming av spinal nerverot, og det ble det tatt opp en grundig sykehistorie og utført en standardisert nevrologisk undersøkelse for å kartlegge hvilken nerverot i korsryggen som mest sannsynlig forårsaket pasientens isjias. Alle pasientene fylte ut validerte spørreskjema for å kartlegge grad av smerter i rygg og ben (visual analogue scale), livskvalitet (the European quality of life (EuroQol) measure, EQ-5D) og ryggfunksjon (Oswestry Disability Index (ODI)). I tillegg ble en rekke psykososiale faktorer og pasientenes jobbstatus kartlagt.

Etter forundersøkelsen fikk en pasientgruppe to epidurale injeksjoner av en kombinasjon av steroider og saltvann (behandlingsgruppe); en gruppe fikk to epidurale injeksjoner med saltvann (placebogruppe) og en gruppe fikk to subkutane injeksjoner med saltvann (shamgruppe). Injeksjonene ble gitt med 2 ukers intervall av erfarne anestesileger.

Alle pasientene ble fulgt opp etter 6, 12 og 52 uker. Ved oppfølgingsundersøkelsene gjennomgikk alle nevrologisk undersøkelse og pasientene fylte ut spørreskjema for å kartlegge smerter, livskvalitet og ryggfunksjon.

Resultatene etter 52 uker viste at det ikke var noen forskjell mellom gruppene på bedring i smerter, livskvalitet og ryggfunksjon. Til sammen 15 pasienter ble ryggoperert i oppfølgingstiden, men det var ingen forskjell i antall opererte pasienter mellom gruppene. På basis av disse funnene ble det konkludert med at epidural steroidinjeksjon for å behandle isjias er uvirksom.

I studien ble det også undersøkt hvor presis den nevrologiske undersøkelsen er for å avklare hvilken nerverot som avklemmes av et skiveprolaps påvist på MRI eller CT. Vi fant at nytten av de ulike nevrologiske testene som brukes for å stille diagnosen isjias var lav.

I studien ønsket vi også å kartlegge hvilke faktorer som er viktig for å kunne si noe om forløpet (prognosen) til isjias. Vi fant at lav alder, høy utdanning, det å være i full jobb og det å ha lav frykt for at det å være i jobb skulle skade ryggen var gode indikatorer (prediktorer) for at isjiasplagene var bedre etter 52-ukers oppfølging.

3. LIST OF PAPERS

The following papers were produced during the course of this study. They are provided in Appendices 1 to 3.

3.1 Paper I

Iversen T, Solberg TK, Romner B, Wilsgaard T, Nygaard Ø, Waterloo K, Brox JI, Ingebrigtsen T (2013) Accuracy of physical examination for chronic lumbar radiculopathy. *BMC Musculoskelet Disord.* 2013 Jul 9;14:206. doi: 10.1186/1471-2474-14-206.

3.2 Paper II

Iversen T, Solberg TK, Wilsgaard T, Waterloo K, Brox JI, Ingebrigtsen T (2015) Outcome prediction in chronic unilateral lumbar radiculopathy: prospective cohort study. *BMC Musculoskeletal Disord.* 2015 Feb 7;16:17. doi: 10.1186/s12891-015-0474-9.

3.3 Paper III

Iversen T, Solberg TK, Romner B, Wilsgaard T, Twisk J, Anke A, Nygaard O, Hasvold T, Ingebrigtsen T (2011) Effect of caudal epidural steroid or saline injection in chronic lumbar radiculopathy: multicentre, blinded, randomised controlled trial. *BMJ* 2011 Sep 13;343:d5278. doi: 10.1136/bmj.d5278.

The papers will be referred to by their Roman numerals.

4. ABBREVIATIONS

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
APS	American Pain Society
ASIPP	American Society of Interventional Pain Physicians
AUC	Area under the curve
CI	Confidence interval
CMS	Centers for Medicare & Medicaid Services
CONSORT	Consolidated Standards of Reporting Trials
CT	Computer tomography
EuroQol	European quality of life
FABQ	Fear Avoidance Beliefs Questionnaire
FABQ-PA	Fear Avoidance Beliefs Questionnaire for physical activity
FABQ-W	Fear Avoidance Beliefs Questionnaire for work
FDA	Food and Drug Administration
IASP	International Association for the Study of Pain
LR	Likelihood ratio
MRI	Magnetic resonance imaging

NASS	North American Spine Society
NSAID	Non-steroidal anti-inflammatory drug
ODI	Oswestry Disability Index
OR	Odds ratio
PET	Positron emission tomography
PROM	Patient reported outcome measure
RCT	Randomized controlled trial
ROC	Receiver operating characteristic
SD	Standard deviation
SLR	Straight leg raise
STARD	STAndards for the Reporting of Diagnostic accuracy
TNFA	Tumour necrosis factor alfa
UNN	University Hospital of North Norway Tromsø
VAS	Visual analogue scale
WMD	Weighted mean difference

5. WHAT IS THE THESIS ABOUT?

This thesis deals with some of the key issues in evidence-based medicine, i.e. to provide knowledge about diagnostic accuracy, prognostic factors and treatment efficacy, which can be used in the clinical decision-making process for patients with lumbosacral radiculopathy. Scientific evidence for diagnostic workup and treatment recommendations are still lacking (1). Few areas of clinical medicine are therefore as controversial as the non-surgical management of patients with lumbosacral radiculopathy, and treatment recommendations are often made with much ambiguity.

It is hoped that the results presented in this thesis can be used in clinical guideline development, to improve health care for patients.

6. INTRODUCTION

Patients with degenerative disorders in the lumbosacral spine often have chronic low back pain and/or radiating leg pain, with or without neurological deficits. The consequences are disability, reduced quality of health and reduced working capability. In western societies, lumbar spine disorders account for higher costs resulting from disability and absenteeism from work than any other somatic disease category (2).

6.1 Prevalence, incidence and risk factors

The lifetime prevalence of low back pain in Norway is around 60–80%. Half of the population have suffered from low back pain during the past year, and approximately 40% in the past month. The yearly incidence of low back pain varies between 20 and 28% (3) and 70% can have relapses during the course of a year (2), but for the individual episode, the prognosis is good. The majority get better during the course of a few weeks. Variations in occurrence are associated with risk factors such as age, education, occupation, culture/ethnicity, lifestyle and psychosocial issues (4).

A specific cause can be found in only 10–15% of patients with low back pain and radiation pain to the leg; the causes include prolapse, spinal stenosis, and other underlying pathology such as rheumatic disease, infection, fractures or tumours. For the majority of the cases, our understanding of the pathophysiology, i.e. the cause of low back pain and lumbosacral radiculopathy is uncertain. Knowledge about risk factors is limited and conflicting (5-8).

Lifetime prevalence of lumbosacral radiculopathy due to a prolapsed disc is estimated to be 5.3% in men and 3.7% in women (9, 10). The annual prevalence of lumbosacral radiculopathy due to disc-related problems reported in the literature varies considerably ranging from 1.6% in the general population to 43% in selected working populations (10-12). A number of studies have estimated the annual incidence of lumbosacral radiculopathy to be 1–2% in the general population (13, 14). The variation in estimates is probably due to differences in the definition of symptoms and the interpretation of clinical and radiological findings (10, 15, 16).

There is a general belief that the course and prognosis of acute lumbosacral radiculopathy is favourable (17-21), but at 1 year up to 30% will still have significant symptoms, 20% will be out of work, and 5–15% will undergo surgery (21-26).

Two important risk factors associated with the occurrence of lumbosacral radiculopathy, and important predictors of pain and disability, are higher age and male gender (27, 28).

Lumbosacral radiculopathy is more common among persons over 40, and men show high prevalence rates of radicular syndromes. However, past the age of 40, the risk for women increases much faster than for men (28). In a study of lumbar intervertebral discs using magnetic resonance imaging (MRI), the prevalence of degenerative intervertebral discs was shown to increase linearly with age. The exact pathophysiological mechanism for the observed phenomenon is unclear. The underlying cause may be tissue weakening occurring primarily from genetic inheritance, ageing, nutritional compromise, and loading history (29).

Other known risk factors are: worrying and health anxiety, sick leave and fear avoidance about physical activity. Smoking also seems to increase the risk of disc disease, low back pain and lumbosacral radiculopathy. The hypothesis is that smoking may impair the blood supply to the vertebral endplate, thereby decreasing the nutrition of the intervertebral disc.

Many work-related factors are also relevant for the prognosis of lumbar radiculopathy, such as heavy physical work, static work posture, lifting and forceful movements, repetitive bending and whole-body vibration (30).

Identification of prognostic factors for persistent pain and disability is important for better understanding of the clinical course of lumbar radiculopathy and to assist clinical decision-making. There is, however, a lack of scientific evidence concerning which prognostic factors are most relevant to predict the course of the disease.

6.2 Costs

Every year there are around 2 million back-related consultations in Norway, constituting a major challenge in the daily workflow for doctors and physiotherapists (4). In primary care, musculoskeletal diseases represent the largest diagnostic group. Among the somatic conditions, back pain was the most important cause of sick leave and social benefit payments in Norway in 2010 (31).

The relative proportion of back pain as the cause of sick leave (>16 days) decreased from 17 to 11% in Norway in the period 1994 to 2008 (31). One possible explanation for the decline is that clinicians to a much greater extent emphasized that patients should maintain normal activity, and they recommended early return to work according to new

clinical guidelines. The decline is not unique to Norway, but is also registered in several other European countries, particularly in the UK (31). There is, however, in the same period observed a corresponding increase in sick leave for depression and mild psychological disorders (31).

6.3 Definition of spinal pain

Despite the efforts of the International Association for the Study of Pain (IASP) (32) to reach consensus about terminology and definitions, confusion still persists among clinicians about how to distinguish between back pain, referred pain, radicular pain, and radiculopathy.

Nociceptive back pain is evoked by noxious stimulation of structures in the lumbar spine but can also produce referred pain. Referred pain is provoked by noxious stimulation of nerve endings in the spine and is perceived in other regions that share the same segmental innervation. Referred pain is not caused by impingement of nerve roots and there are no neurological signs. Radicular pain is pain evoked by ectopic discharges emanating from a dorsal root or its ganglion. Neurological signs arise due to a conduction block corresponding to that spinal nerve or its root(s).

Radiculopathy is defined by objective neurological signs. Although radiculopathy and radicular pain commonly occur together, radiculopathy can occur in the absence of pain, and radicular pain can occur in the absence of radiculopathy (33).

In this thesis the focus is on chronic lumbosacral radiculopathy.

6.4 Clinical presentation

The most common clinical presentation of a lumbosacral radiculopathy is radicular leg pain below knee level with neurological deficits in the distribution of the lumbosacral nerves (10, 17). Radicular pain has a typical lancinating, shocking or electric quality travelling into the lower limb along a narrow band. In approximately 90% of cases, radiculopathy is caused by a prolapsed disc involving nerve root impingement (34, 35). Leg pain is often accompanied by both motor and sensory deficits, and back pain. The leg pain is typically more intense than the back pain. Numbness in the dermatome, a positive straight leg raise (SLR) test, and muscle weakness and reflex changes can be found (17, 36). Diminished reflexes occur as a result of either sensory or motor block. If this clinical syndrome is present for more than 12 weeks, it is defined as chronic lumbosacral radiculopathy (17, 37-39).

Systematic reviews of the diagnostic properties of clinical diagnostic tests for lumbosacral radiculopathy report variable accuracy, with low to moderate sensitivities for sensory deficits and impaired tendon reflexes (0.14 to 0.61) (40, 41) and motor weakness (0.27 to 0.62) (42, 43), and low to high sensitivities for the SLR test (0.35 to 0.81) (44). The ability of neurological testing procedures to detect a disc herniation is poor. Standardization of protocols for the neurological testing procedures would allow better evaluation of their sensitivity, specificity and reliability.

A recent Cochrane review confirmed poor performance of diagnostic tests to detect the presence of lumbosacral radiculopathy in 18 studies from specialized care (45). None of these studies discriminated between nerve root impingement and just the presence of a

disc herniation on the images they used as reference standard. This could be a major bias, since the prevalence of disc herniation in unselected populations without radiculopathy symptoms is high, and the presence of radicular pain is likely to be linked to radiological evidence of root impingement (46).

Vroomen (47) reported a strong inter-rater reliability for reduced muscle strength and sensory deficits (κ 0.57 to 0.82) in patients with lumbosacral radiculopathy and moderate agreement for reflex impairments (κ 0.42 to 0.53), whereas McCarthy (48) reported moderate inter-rater agreement for both reflexes and motor deficits (κ 0.41 to 0.56). Another study found strong to high agreement among doctors assessing sensibility to pain (κ 0.50 to 0.71) (49).

The clinical course of back pain and lumbosacral radiculopathy has been assessed in many cohort studies (50, 51). For low back pain and lumbosacral radiculopathy the course of the disease often follows a pattern of general improvement that starts rapidly and plateaus over time, independent of choice of treatment. It has been suggested that the mere participation in a study influences the course of symptoms (52, 53). This might be explained by benefits perceived by participants and assumed to be related to intensive assessment and monitoring. The so-called 'Hawthorne effect' is quoted as an example of how individuals change behaviour due to the attention they receive from researchers (54-56). This pattern of the clinical course of pain and disability entails a huge challenge to the researcher concerning interpretation of the outcome of treating lumbosacral radiculopathy.

6.5 Pathophysiology of pain

For centuries, the origin of pain in lumbosacral radiculopathy was believed to be an inflammation of the sciatic nerve (57). In 1934, Mixter and Barr recognized the mechanical origin of radiculopathy (58, 59), namely nerve root impingement by a herniated lumbar disc. Mixter and Ayers demonstrated in 1935 that radiculopathy can also occur without mechanical nerve root impingement (60). Later, several studies have shown a prevalence of disc herniation ranging from 20 to 76% among asymptomatic individuals (61, 62), and many patients with symptoms of radiculopathy have no radiological findings on MRI (17, 63, 64). Inflammation of the nerve root may therefore be an important factor for developing radiculopathy (65-67). A recent study using gadolinium-enhanced MRI (68) showed that annular disc tears may cause radiculopathy without any signs of nerve root impingement. Lauder (69) reported that in patients with radiculopathy confirmed by neurophysiological investigations, nearly 31% had no signs of weakness and up to 45% had no sensory deficits detected on clinical examination. Studies also demonstrate that in patients with severe lumbosacral radiculopathy, weakness may not be observed on examination, unless a large conduction block of the nerve root is present (70, 71). More than finding effective treatments for radiculopathy, research has revealed an increasingly complex pathophysiology of pain and new knowledge gaps over the years (33, 72).

6.6 Imaging

There is a weak correlation between the anatomical level of the disc herniation found on MRI and the clinical level that is suspected based on an examination of the patients.

Laupacis (73) argues that the increasing power of new technologies, such as computer tomography (CT) and MRI, has led to an inappropriate de-emphasis on clinical skills and a greater dependence on imaging.

Since the detection of abnormalities on physical examination may affect the decision to pursue epidural steroid injections, back surgery, or further diagnostic testing, bias in the physical examination may have substantial implications for the practice of spine care. High numbers of incidental findings on MRI (74, 75) may result in expectance bias among investigators and systematic errors in the results for the physical examination. Evidence suggests that sensory testing is most prone to bias due to prior knowledge of MRI results (76). The finding is consistent with observations that the potential for bias increases with increasing subjectivity in the interpretation of the clinical tests (77).

In a recent longitudinal cohort study of the associations between incident lumbar spine MRI findings and radiculopathy, only three MRI findings had large magnitude associations with symptoms and clinical findings. Annular fissures were associated with chronic low back pain, and patients with disc extrusions and nerve root impingement had a high incidence of radiculopathy (78, 79).

6.7 Treatment

Conservative treatment for radiculopathy is primarily aimed at pain reduction, using pure analgesics or non-steroidal anti-inflammatory drugs (NSAIDs), or more specific drugs against neuropathic pain (80-84). Other treatment options are steroid injections (20, 37), traction (85) and physiotherapy (86). Systematic reviews of conservative

interventions for lumbosacral radiculopathy have failed to identify an intervention that is superior to the others. However, large unbiased studies are scarce (87, 88).

Epidural steroid injections are increasingly applied (89), and this is the most widely used intervention for back pain and radiculopathy, with frequency doubling over the past 8 years (90). Unfortunately the clinical evidence supporting such treatment is insufficient (1) and use of steroids may have significant side effects. Surgery rates have also more than doubled over the past decade (91). There seems to be a consensus that surgery is indicated in carefully selected patients for lumbosacral radiculopathy in the presence of a herniated lumbar disc (34) with serious or progressive neurologic deficits and imaging demonstrating lumbar disc herniation at the nerve root level correlating with the patient's examination findings (19, 92).

There is, to date, no consensus about the right indication for epidural steroid injections.

6.8 Recurrent pain, disability and cost-effectiveness

Recurrent radicular pain after non-surgical treatment of acute lumbar disc herniation occurs in 25% of cases over 1 year. Recurrent back pain is more common, 43% (93).

Despite the increase in back pain interventions, disability rates continue to rise (94-96).

Epidural steroid injections have increased by more than 25% from 2000 to 2011 in the USA (97), representing a significant increase in costs for society and patients (98). In the UK, the use of therapeutic epidural injections increased by 49% from 2000 to 2010 (99).

6.9 The physiology of pain and the pharmacology of steroids

Exposed nuclear material is known to irritate the spinal nerve roots and probably also the sinuvertebral nerve endings (100). Inflammation makes nociceptors hyperexcitable by the release of pro-inflammatory mediators, resulting in a lowered firing threshold leading to a state called peripheral sensitization (101). Central sensitization results from longstanding changes in the properties of neurons; the pain is no longer coupled, as acute nociceptive pain is, to the presence, intensity or duration of particular peripheral stimuli. Central sensitization represents a major functional shift in the somatosensory system from high-threshold nociception to low-threshold pain hypersensitivity (102, 103).

Steroid injections gained wide popularity after Lievre in 1953 (104) reported improvement in 5 out of 20 patients with lumbosacral radiculopathy. The mechanisms of action and the local anti-inflammatory effect at the injection site have still not been fully elucidated and clinical effects are uncertain (105). The anti-inflammatory and pain reducing effect of steroids seems to be mediated via a steroid receptor complex in the cell nucleus inhibiting the formation of cyclo-oxygenase 2 (cox-2) enzymes, and thereby the prostaglandin synthesis resulting in reduced inflammation. Steroids also suppress the immunological response of lymphocytes, stimulate production of the anti-inflammatory mediator lipocortin and reduce inflammatory oedema around an affected nerve root (106).

6.10 Anatomy of the lumbosacral spine

The lumbar vertebrae consist of a body anteriorly, two pedicles that project posteriorly from the body, and two laminae that connect the pedicles, which together form the vertebral canal, which contains the spinal cord, spinal nerves, and epidural space. The spinal nerves exit the vertebral canal under the pedicles.

The five sacral vertebrae are fused forming the wedge-shaped sacrum. The fifth sacral vertebra is not fused posteriorly, giving rise to an opening known as the sacral hiatus. The hiatus can be identified by bony prominences on either side of it, the sacral cornua.

The epidural space is the space that lies between the spinal meninges and the bony structures and communicates with the paravertebral space through the intervertebral foramen (107). The epidural space is composed of a series of discontinuous compartments that can be opened by the volume of an injection (108). The compartments consist of a rich network of valveless veins, lymphatics and segmental arteries. The proximal parts of the nerve roots pass through the epidural space. The epidural fat appears to have clinically important effects on the pharmacology of epidural drug deposits (109, 110).

The dura mater is the outermost and thickest meningeal tissue and is composed of collagen and elastin fibres. It extends laterally along the spinal nerve roots and ends at approximately S2, where it fuses with the filum terminale. The inner edge of the dura mater is highly vascular and can be important for clearance from the epidural space (111).

The spinal cord gives rise to 31 pairs of spinal nerves, each composed of an anterior motor root and a posterior sensory root. The nerve roots are in turn composed of multiple rootlets. The portion of the spinal cord that gives rise to all of the rootlets of a single spinal nerve is called a cord segment. The skin area innervated by a given spinal nerve and its corresponding cord segment is called a dermatome. The intermediolateral grey matter of the T1 through L2 spinal cord segments contains the cell bodies of the preganglionic sympathetic neurons. These sympathetic neurons run with the corresponding spinal nerve to a point just beyond the intervertebral foramen where they exit to join the sympathetic chain ganglia. In the lumbar region the nerve roots are named for the vertebrae forming the cephalad half of the intervertebral foramen; for example, L4 emerges through an intervertebral foramen formed by L4 and L5. Those nerves that extend beyond the end of the spinal cord at L2 to their exit site are collectively known as the cauda equina (112).

The meningeal branches of the spinal nerves (also known as recurrent meningeal nerves, sinuvertebral nerves, or recurrent nerves of Luschka) are a number of small branches of the spinal nerve (Figure 1). They re-enter the intervertebral foramen, and innervate the annulus fibrosus of the intervertebral disc, the dura mater, facet joints and the ligaments of the spinal canal, carrying pain sensation. The ventral dura mater seems to contain a rich polysegmental innervation of both autonomic and nociceptor fibres (113), but the evidence for this is conflicting (114). The ventral dural nerves may extend up to eight segments, with a great amount of overlap between adjacent nerves. This may be the anatomical substrate for understanding extrasegmental, referred dural pain (115).

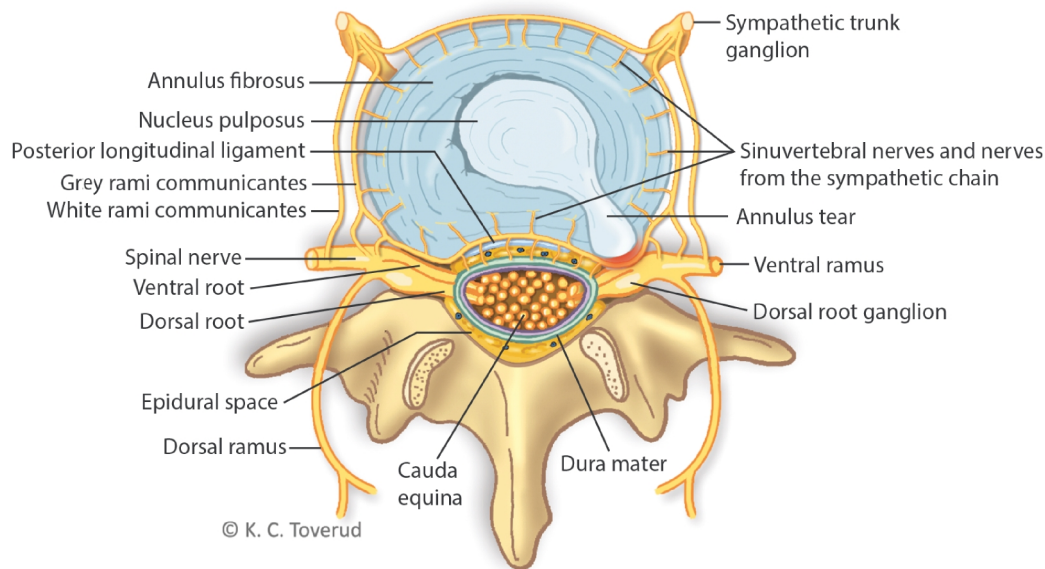


Figure 1. Anatomy of the lumbosacral spine.

6.11 Technical aspects of giving epidural injections

Epidural injections can be administered by three common methods – the transforaminal (perineural) (Figure 2), the interlaminar (Figure 2) and the caudal (Figure 3).

Caudal epidural injections are considered the safest and easiest method, with minimal risk of accidental dural puncture, even though relatively high volumes (10–30 ml) are required to reach the level where the pathology is situated. A caudal injection is placed through the sacral hiatus (located at S5 and occasionally S4). Ultrasound or fluoroscopic guidance is often used.

Interlaminar entry delivers the medication closer to the site of pathology and requires less volume (5–10 ml). It is performed by placing the needle between the spinous processes in the midline (or paramedian) traversing it through the ligamentum flavum using the resistance technique.

The transforaminal approach is considered even more targeted both with respect to pathology and pain generator (nerve ganglion), and an even smaller volume of injection is needed (2–5 ml). The transforaminal approach is a selective injection aimed at a specific level and is always done under fluoroscopic guidance. The foraminae are the small lateral openings between the vertebrae through which the nerve roots exit the spinal canal (116).

Caudal and interlaminar injection of steroids have been the main methods used, but more recently transforaminal epidural injections have gained increased popularity (117).

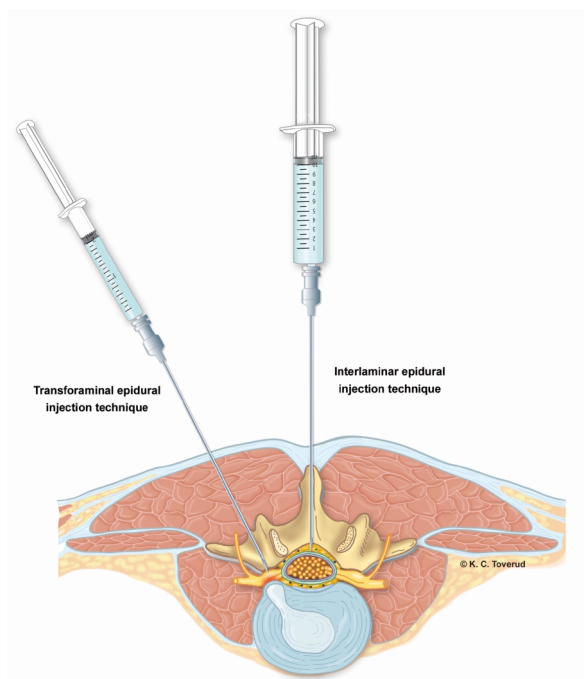


Figure 2. Interlaminar and transforaminal epidural injection techniques against a lateral herniated disc with nerve root displacement at level L4/5.

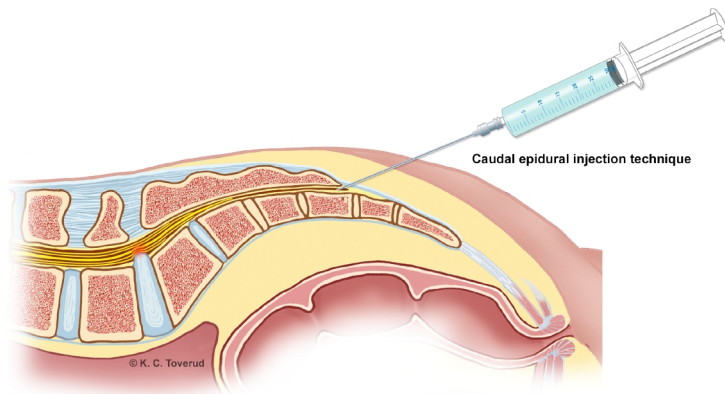


Figure 3. Caudal epidural injection technique against a disc herniation with nerve root displacement at level L5/S1.

6.12 Need for further research

Due to the significant increase in utilization of epidural steroid injections to treat lumbosacral radiculopathy in spite of lacking evidence for the efficacy of the method, further research is needed to clarify whether the method should be recommended or not. If the treatment can work, more research is needed to better refine selection criteria for epidural steroid injections, and to determine which approach, what dose, and how many injections are optimal (118).

A premise to select patients with suspected lumbosacral radiculopathy for either conservative or surgical treatment is correspondence between clinical and image findings. Further research is therefore needed to clarify the accuracy of the diagnostic tests to clarify the spinal level of lumbosacral radiculopathy due to disc herniation.

No specific predictors that can be used to modify the prognosis of lumbosacral radiculopathy have so far been identified. However, there is a strong association between elevated fear avoidance beliefs and chronic low back pain. Further research is needed to identify relevant predictors of the outcome of chronic lumbosacral radiculopathy. Information about risk factors and relevant predictors can be used for better selection of patients to avoid expensive and ineffective investigation and treatments and to inform patients about what benefit they can expect prior to treatment (shared decision-making).

6.13 Evidence-based medicine

According to Sackett, 'evidence-based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients' (127).

Incorporating the best evidence into clinical care requires a systematic approach in order to be manageable. The clinician must assess the patient and the problem to determine the pertinent issues, which may include a differential diagnosis, treatment decisions, or prognosis. From this evaluation the clinician must draw *a clear, answerable question to be pursued* from a range of appropriate sources. The quality of the evidence must be evaluated by its validity and reliability. Finally, the clinician must return to the patient and decide whether the evidence is applicable to the particular person at hand, appreciating their unique values and sociocultural setting.

The paramount objective in our research efforts has been to generate new knowledge to be used by clinicians in the evidence-based management of patients with lumbosacral radiculopathy.

7. RESEARCH QUESTIONS

7.1 Paper I

Are clinical tests accurate for the diagnosis and prediction of whether a lumbar nerve root is impinged or not by a disc herniation at a specific level in patients with chronic lumbosacral radiculopathy?

7.2 Paper II

Which prognostic factors predict persistent pain and disability in patients with chronic lumbar radiculopathy?

7.3 Paper III

Has treatment of chronic lumbosacral radiculopathy with caudal epidural injection of steroids or isotonic saline clinically important effects?

8. AIMS OF EACH PAPER

The aim of the thesis is to generate new knowledge in the research area of diagnostic accuracy, prediction and treatment efficacy of lumbosacral radiculopathy, so that the correct treatment can be given to the right patient more often. I will discuss the results presented in papers I, II and III in conjunction with the latest systematic reviews, meta-analyses and guidelines.

8.1 Paper I

The aims of this study were to investigate the association between findings at clinical examination and nerve root impingement, to evaluate the accuracy of clinical tests in a specialized care setting, and to see whether imaging clarifies the cause of clinically proven chronic lumbosacral radiculopathy. Patients were included when referred with symptoms of lumbar radiculopathy lasting more than 12 weeks and at least one positive clinical test. The tests were the SLR test, and tests for muscle strength, sensory loss, and reflex impairment.

8.2 Paper II

The aim of this study was to identify clinically relevant predictors of outcome of chronic lumbosacral radiculopathy at 52 weeks. We identified 15 clinically relevant baseline variables including demographic, psychosocial, clinical and imaging variables, and analysed them as predictors of outcome. The natural course of the disease was observed. Successful outcome at follow-up was set to ≤ 17.5 for visual analogue scale (VAS) leg pain, ≤ 22.5 for VAS back pain and ≤ 20 for the Oswestry Disability Index (ODI).

8.3 Paper III

The objective of the randomized controlled trial (RCT) was to evaluate the short- (6-week), intermediate- (12-week) and long-term (52-week) efficacy of caudal epidural steroid injections in the treatment of chronic (duration >12 weeks) lumbosacral radiculopathy. There were three intervention groups. Group 1 was given subcutaneous sham injections superficial to the sacral hiatus and not into the spinal canal, group 2 was given caudal epidural placebo injections of saline alone, and group 3 was given caudal epidural treatment injections of a combination of saline and triamcinolone acetonide. Each group received two injections over the course of 2 weeks. The primary outcome measure was the ODI, and the secondary outcome measures were the European quality of life (EuroQol) measure EQ-5D, VAS leg and back pain, and the Fear Avoidance Beliefs Questionnaire (FABQ).

9. STUDY DESIGN

9.1 Paper I

The aim of the STAndards for the Reporting of Diagnostic accuracy (STARD) studies initiative is to improve the accuracy and completeness of the reporting of studies of diagnostic accuracy by assessing potential for bias in the study (internal validity) and to evaluate its generalizability (external validity). The STARD statement consists of a checklist of 25 items and recommends the use of a flow diagram which describes the design of the study and the flow of patients (120, 121). We used the STARD guidelines in paper I.

9.2 Paper II

Cohort studies are a type of medical research used to establish links or associations between risk factors and health outcomes and are by definition prospective studies. The cohort is observed over a period to detect any changes in health in relation to predetermined risk factors or exposure(s). The cohort members are given questionnaires, and/or clinical examinations, and/or testing to determine exposure status. We used a cohort study design in paper II.

9.3 Paper III

The Consolidated Standards of Reporting Trials (CONSORT) statement is an evidence-based, minimum set of recommendations for reporting RCTs. It offers a standard way to prepare reports of trial findings, facilitating their complete and transparent reporting, and aiding their critical appraisal and interpretation. The CONSORT statement

comprises a 25-item checklist and a flow diagram. The checklist items focus on reporting how the trial was designed, analysed and interpreted; the flow diagram displays the progress of all participants through the trial (122). We used the CONSORT statement both in designing and reporting paper III.

10. MATERIAL AND METHODS

10.1 Referrals and eligibility

Patients with lumbosacral radiculopathy were referred from the catchment area (population 1,146,076) of the University Hospital of North Norway Tromsø (UNN), St Olavs University Hospital Trondheim, Levanger Hospital, Nordland Hospital Bodø, and Buskerud Hospital Drammen to the outpatient multidisciplinary back clinics at these five Norwegian hospitals. The general practitioners, neurosurgeons, orthopaedic surgeons, neurologists, manual physiotherapists, and chiropractors working in these areas were invited by letter to participate in the trial. Eligible patients between 20 and 60 years of age were consecutively assessed for inclusion. Written informed consent was obtained.

10.2 Inclusion criteria

The inclusion criteria were unilateral lumbosacral radiculopathy lasting for more than 12 weeks. The intensity of the leg pain, radiating from the back to below the knee, had to be comparable or worse than the back pain. There were no requests for a correspondence between demonstrated level of lumbosacral radiculopathy by clinical examination and findings on imaging.

10.3 Exclusion criteria

Patients presenting with a cauda-equina syndrome, severe paresis, severe pain, history of previous spinal injection or surgery, deformity, pregnancy, ongoing breastfeeding, warfarin therapy, ongoing treatment with NSAIDs not possible to cease, body mass

index >30, poorly controlled psychiatric conditions with possible secondary gains, or severe co-morbidity were excluded from the study. Patients with severe intraspinal pathology (large disc herniations occupying more than 50% of the spinal canal, spinal stenosis, tumours, bleeding, dural fistula, synovial cysts, or dysraphia) were excluded.

10.4 Study population

Between October 2005 and February 2009, 461 patients were assessed for inclusion. A total of 345 (74.8%) patients were excluded, and 116 (25.2%) patients with lumbar radiculopathy for more than 12 weeks were included in the study (Table 1).

Table 1. Study population.

Excluded patients (n = 345) at baseline	
Did not meet inclusion criteria, n (%)	97 (28.1)
Met exclusion criteria, n (%)	214 (62.0)
Declined to participate, n (%)	17 (4.9)
Substantial and rapid improvement after assessment, n (%)	17 (4.9)
Characteristics of the included patients (n = 116) at baseline	
<i>Sociodemographic variables</i>	
Age years, mean (SD)	42.0 (10.3)
Male gender, n (%)	68 (58.6)
Current smoker, n (%)	49 (42.2)
University or college education, n (%)	22 (19.0)
Working full-time, n (%)	43 (37.1)
<i>Low back pain/sciatica history</i>	
Low back pain weeks, mean (SD)	53.4 (110.0)
Leg pain weeks, mean (SD)	42.0 (99.0)
ODI score, mean (SD)	30.0 (13.2)
VAS score leg pain, mean (SD)	50.6 (24.7)
VAS score back pain, mean (SD)	47.6 (24.3)
EQ-5D, mean (SD)	0.51 (0.29)
FABQ-W, mean (SD)	12.8 (5.0)
FABQ-PA, mean (SD)	23.4 (10.2)
<i>Clinical examination</i>	
SLR <60°, n (%)	62 (53.4)
Muscle weakness, n (%)	94 (81.0)
Dermatomal sensory loss, n (%)	83 (71.6)
Reflex impairment, n (%)	55 (47.4)
Body mass index, mean (SD)	26.3 (3.8)
<i>Magnetic resonance or CT imaging</i>	
Concordance between nerve root impingement on MRI and clinical radiculopathy, n (%)	60 (51.7)
Disc herniation without nerve root impingement, n (%)	30 (25.9)
Normal or minor degenerative changes, n (%)	26 (22.4)
Modic type I and I/II, n (%)	66 (56.9)

Note: SD = standard deviation; FABQ-W = Fear Avoidance Beliefs Questionnaire for work; FABQ-PA = Fear Avoidance Beliefs Questionnaire for physical activity.

10.5 Clinical examination

The clinical examination followed a pre-prepared study procedure (Appendix 4) following the STARD initiative to decide whether the patient had a lumbosacral radiculopathy and to determine the most probable nerve root affected. The inclusion examination was done by trained neurologists or specialists in physical medicine and rehabilitation in cooperation with a physiotherapist.

10.6 Imaging

MRI in 109 (94.0%) patients or CT in 7 (6.0%) patients was performed. Experienced radiologists evaluated the images, and a written report from the radiologists was available for the clinicians to be able to exclude patients with severe intraspinal pathology obviously demanding surgery. All the MRI and CT scans were re-evaluated by two independent neuroradiologists using the Nordic Modic Classification (123) (Appendix 5). They were blinded regarding patient history and clinical findings. The locations of the disc herniation (Figures 4 and 5) were identified in the axial plane, and were categorized as being localized centrally or to the left or right in the spinal canal (124). In cases of disagreement, a consensus was reached emphasizing the conclusions of the most experienced neuroradiologist.



Figure 4. MRI longitudinal section showing normal disc, bulging degenerative disc and herniated disc.

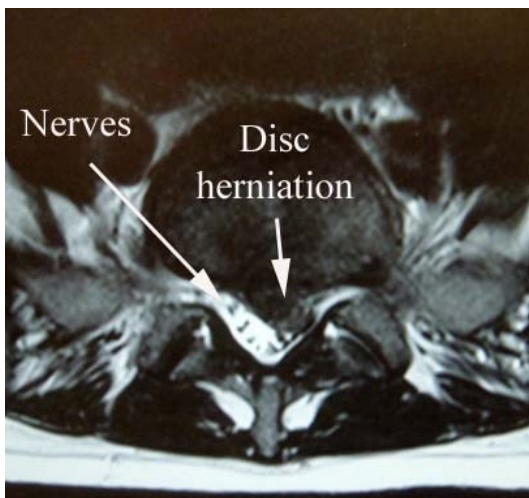


Figure 5. MRI transverse section showing herniated disc compressing the dura mater and nerve root.

10.7 Randomization

The randomization was done according to the CONSORT statement by the Clinical Research Centre at UNN. They used a computer generated block scheme for randomization, stratified according to intervention hospital.

10.8 Data collection

Each patient completed self-administered questionnaires, which were identical at baseline and follow-up (Appendix 6). The use of multidimensional patient reported outcome measures (PROMs) provides insight into how the impact of diseases and treatments are perceived by the patients. The PROMs in the study were the ODI, EQ-5D and FABQ (125). The questionnaires at baseline also contained questions about demographics, education, duration of pain, work status, medication, and lifestyle issues. Clinical signs of lumbosacral radiculopathy, need for physiotherapy or surgery during follow-up, patient perceived benefit of the intervention, and working capability were also monitored at each follow-up. A global question on a 4-point Likert scale was used to measure the benefit of the intervention at each follow-up (126).

10.9 Follow-up

All patients received standardized oral and written information about spine anatomy and function at baseline and follow-up. They were encouraged to engage in physical activity (127-130), and all patients received the brochure 'Worth knowing about bad backs. What experts agree on' (131). Patients using NSAIDs were told to cease this medication. The 6, 12 and 52-week follow-ups were conducted at the hospitals by a blinded physiotherapist and doctor. Use of physiotherapy was recorded during follow-up but was not routinely offered to the patients. During the study period, the need for surgical treatment among patients with increasing pain, or paresis, was evaluated by study-independent surgeons.

10.10 Outcome measures

The ODI was used as the primary outcome measure. The ODI questionnaire contains ten questions on limitations of activities to daily living. Each variable was rated on a 0–5 point scale, added up, and transferred into a percentage functional score ranging from 0 to 100 (0 = no disability) (132-134). Secondary outcome measures were evaluated by the EQ-5D, the VAS for low back pain and leg pain, and the FABQ. The EQ-5D measure is a generic and preference-weighted measure of health-related quality of life. It evaluates five dimensions: mobility, self-care, activities of daily life, pain, and anxiety and/or depression. For each dimension, the patient describes three possible levels of problems (no, mild to moderate, and severe). This descriptive system contains 243 combinations or index values for health states (135). We used the value set from the main survey of the EuroQol Group (136), which has been validated for patients with lumbar radiculopathy (137). Total score range is from –0.594 to 1, where 1 corresponds to perfect health and 0 to death. Negative values are considered to be worse than death (135). The intensity of leg pain and low back pain was indicated on a horizontal 100 mm VAS (0 = no pain) (137, 138). The FABQ is a questionnaire based on the Fear Avoidance Model of Exaggerated Pain Perception. The FABQ with the work (FABQ-W) and physical activity (FABQ-PA) subscales, measures patients' fear of pain and consequent avoidance of physical activity because of their fear. The questionnaire consists of 16 items, with each item scored from 0 to 6. The total possible score for the work subscale is 42 and for the physical activity subscale it is 24. Higher scores on the FABQ are indicative of greater fear and avoidance beliefs (38). The FABQ was used both as a continuous variable and was also dichotomized. We chose ≥ 34 as the cut-off for an elevated fear avoidance belief

for the FABQ-W (139) and ≥ 15 for the FABQ-PA (140). The FABQ subscale scores have been shown to have excellent test-retest reliability (intraclass correlation coefficient 0.77–0.90).

10.11 Statistical analysis

We calculated means and standard deviations (SDs) for continuous variables, and frequencies and proportions for categorical variables. Paired samples t-tests were used to test change scores between baseline and follow-up for patient reported outcomes. Analysis of variance (ANOVA) was used to compare mean differences between groups for continuous variables, and the Pearson chi-square test for categorical variables. All tests were two-sided using a significance level of 5%. All analyses were performed using the IBM SPSS Statistics software, versions 17, 19 and 22 (IBM Software, NY, USA), and in addition STATA 11.0 (Stata Corp®) was used for the mixed model analyses in paper III.

10.11.1 PAPER I

The prevalence of nerve root impingement based on the reference standard and the post-test probabilities for a positive and negative test were calculated. Diagnostic accuracy was quantified by calculating sensitivities, specificities, and positive and negative likelihood ratios (LRs), including 95% confidence intervals (CIs), for each clinical test. In a multivariable logistic regression model we included all index tests as independent variables. The estimated model was used to predict the probability of a positive MRI/CT for each patient. These probabilities were used to produce a receiver operating characteristic (ROC) curve and an estimate for the area under the curve (AUC).

10.11.2 PAPER II

We used univariable and stepwise backward (Wald) multivariable binary logistic regression to analyse associations between predictors and outcome measures.

Predictors with P value <0.20 from the univariable analysis were used in the multivariable analysis. In the analysis we adjusted for the baseline values. Odds ratios (ORs) with 95% CIs were calculated.

10.11.3 PAPER III

Linear mixed models were used to assess differences in time trends between the treatment groups for the primary and secondary outcome measures (141). We added time to the model as a categorical variable represented by dummy variables in order to analyse the differences between the groups at different time points. In all mixed model analyses, a crude adjustment was made for the baseline values of the particular outcome variable. In the secondary analysis, additional adjustments were performed for duration of back pain, duration of leg pain, and duration of sick leave prior to inclusion. The analyses for all outcome measures used all available data on an intention to treat basis.

10.12 Intervention and blinding

A standardized referral letter for the intervention contained information about the patient's cardiac and pulmonary status, medication and allergies but did not include information about back pain and radiculopathy (Appendix 6). There were three intervention groups (Appendix 7). Group 1 received subcutaneous sham injections of 2 ml 0.9% saline superficial to the sacral hiatus and not into the spinal canal. Group 2 received caudal epidural placebo injections of 30 mL 0.9% saline. Group 3 received

caudal epidural treatment injections of 40 mg triamcinolone acetonide in 29 mL 0.9% saline. All three intervention groups received two injections over the course of 2 weeks; the second injection was cancelled if spontaneous recovery had occurred between inclusion and the first intervention. An experienced anaesthesiologist gave the injections and followed a set procedure (142, 143) (Appendix 4). Anatomical landmarks were used to identify the sacral hiatus. In addition, use of an ultrasound machine (Honda Diagnostic Scanner HS-2000 Cine, Honda Electronics Co.) capable of examining musculoskeletal tissues with a 10 MHz real-time linear array ultrasound transducer increased the precision of the injections (144-146) (Appendix 4, Figure 6).

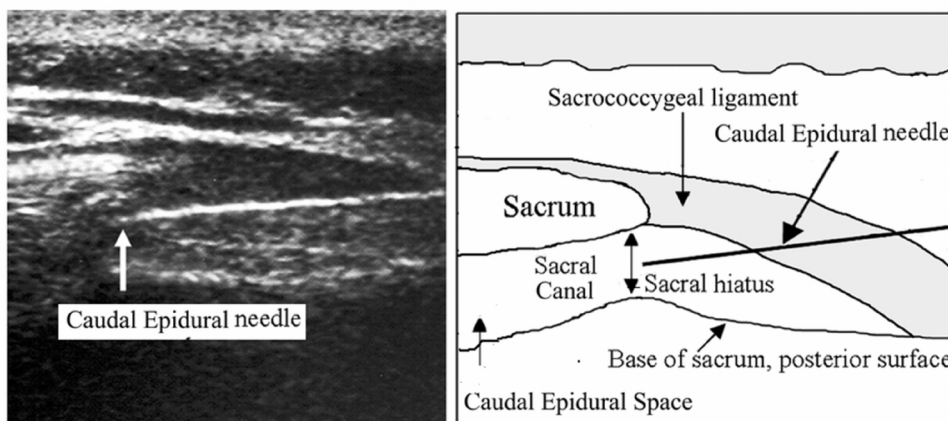


Figure 6. Ultrasound picture and diagram showing the epidural needle in the sacral hiatus entering the caudal epidural space (based on (145)).

We ensured that the patients, outcome assessors, and care providers were blinded during the study period; they were all unaware of the randomization and intervention given by the anaesthesiologists (Figure 7). The anaesthesiologists giving the injections were not blinded because inclusion of a subcutaneous sham group made this impossible (147). The injection products were concealed from the patients, and the

anaesthesiologists were instructed not to discuss the injection procedure or the products used with the patients.

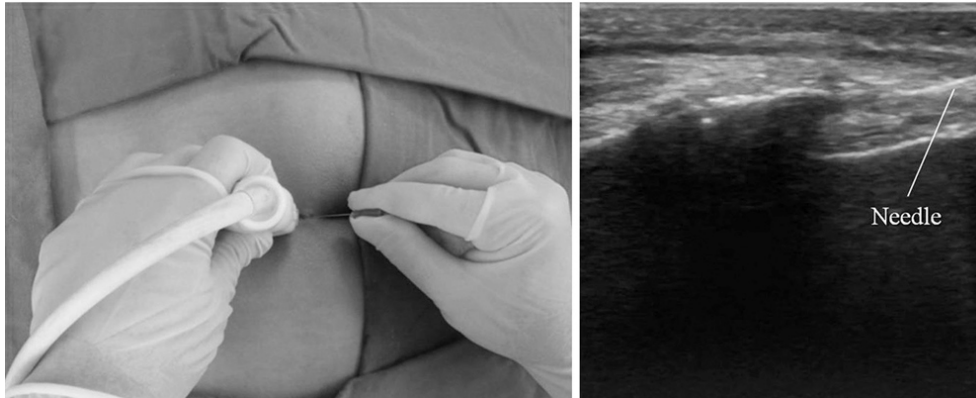


Figure 7. The caudal epidural injection technique with ultrasound guidance (145).

10.13 Placebo and sham procedure

We defined placebo intervention as administration of regular saline solution into the epidural space and sham intervention as administration of regular saline subcutaneously (148). In experimental studies, treatment is often compared with placebo or sham to determine whether or not treatment using an active medicine has any effect (149). In studies on the effect of epidural sacral injection, steroid treatment is often compared with placebo treatment using saline or local anaesthetic or with a sham injection. In some studies a positive effect has been recorded for epidural saline and local anaesthetic on its own. One possible interpretation of this could be that local anaesthetic results in a short-term suppression of pain transmission and that regular saline can have an effect via mechanisms other than purely pharmacological action, for example due to a volume or pressure effect. We wanted to clarify these mechanisms by comparing the effect of epidural injection of steroid (active treatment) and epidural

injection of regular saline (placebo injection) with non-epidural subcutaneous injection of regular saline (sham injection).

10.14 Ethics

The inclusion and randomization of patients with nerve root disease for epidural injection in a placebo and/or sham controlled study is associated with a number of ethical problems. The use of epidural injection is widespread and the procedure has been used both inside and outside hospitals to treat low back pain and radiculopathy. There is, however, no evidence that the method is effective. Since there is some uncertainty and lack of evidence associated with most methods for treating lower back pain and sciatica, testing the effect of epidural injection in a placebo and sham controlled study would be ethically defensible. Good patient information, informed consent, the principles of good clinical practice in clinical trials, the Declaration of Helsinki (150) and ethical approval are fundamental requirements followed in this study. Our study was registered in Current Controlled Trials with No 12574253 and the study protocol (Appendix 7) was approved by the ethics committee for Medical Research Region 5 Norway.

11. MAIN RESULTS

11.1 Paper I

We found a low correspondence between clinical findings and MRI proven disc herniation with relevant nerve root impingement. A correspondence was only present in 60 out of 116 patients (51.7%) in our study.

The diagnostic accuracy of individual index tests was low with no tests reaching positive LR >4.0 or negative LR <0.4 . The overall clinical evaluation was slightly more accurate, with a positive LR of 6.28 (95% CI 1.06–37.21) for L4, 1.74 (95% CI 1.04–2.93) for L5, and 1.29 (95% CI 0.97–1.72) for S1 nerve root impingement.

11.2 Paper II

At follow-up, 75 (64.7%) patients had reached a successful outcome with an ODI score ≤ 20 , 54 (46.6%) with a VAS leg pain score ≤ 17.5 , and 47 (40.5%) with a VAS back pain score ≤ 22.5 .

Lower age (OR 0.94 (CI 0.89–0.99) for each year increase in age) and FABQ-W ≥ 34 (OR 0.16 (CI 0.04–0.61)) were independent variables predicting a successful outcome on the ODI. Higher education (OR 5.77 (CI 1.46–22.87)) and working full-time (OR 2.70 (CI 1.02–7.18)) were statistically significant ($P < 0.05$) independent predictors of successful outcome (VAS score ≤ 17.5) on the measure of leg pain. Lower age predicted success on the ODI (OR 0.94 (95% CI 0.89 to 0.99) for each year) and less back pain (OR 0.94 (0.90 to 0.99)), while higher education (OR 5.77 (1.46 to 22.87)), working full-time (OR 2.70 (1.02 to 7.18)) and muscle weakness at baseline (OR 4.11 (1.24 to 13.61)) predicted less

leg pain, and reflex impairment at baseline predicted the contrary (OR 0.39 (0.15 to 0.97)).

11.3 Paper III

All groups improved following the interventions, but there were no statistical or clinical differences between the groups over time. The estimated change with 95% CI in the ODI from the adjusted baseline value for the sham group was -4.7 ($-0.6, -8.8$) at the 6-week follow-up, -11.4 ($-6.3, -14.5$) at the 12-week follow-up, and -14.3 ($-10.0, -18.7$) at the 52-week follow-up. The differences in outcome for the epidural saline intervention group compared to the sham intervention group were -0.5 ($-6.3, 5.4$) at the 6-week follow-up, 1.4 ($-4.5, 7.2$) at the 12-week follow-up, and -1.9 ($-8.0, 4.3$) at the 52-week follow-up. The differences in outcome for the epidural steroid intervention group compared to the sham intervention group were -2.9 ($-8.7, 3.0$) at the 6-week follow-up, 4.0 ($-1.9, 9.9$) at the 12-week follow-up, and 1.9 ($-4.2, 8.0$) at the 52-week follow-up. Analysis adjusted for duration of leg pain, back pain, and sick leave did not change this trend.

12. DISCUSSION OF THE RESEARCH QUESTIONS

12.1 Paper I

Are individual clinical tests accurate for the diagnosis and prediction of whether a lumbar nerve root is impinged or not by a disc herniation at a specific level in patients with chronic lumbosacral radiculopathy?

Our main finding in paper I was that individual clinical tests lack diagnostic accuracy for predicting whether a lumbar nerve root is impinged or not at a specific level in patients with chronic lumbosacral radiculopathy, when the specialist was unaware of the radiological findings.

In 2014, the North American Spine Society (NASS) published clinical guidelines for the diagnosis of lumbar disc herniation with lumbosacral radiculopathy (151). The work group consisted of multidisciplinary spine care specialists trained in the principles of evidence-based analysis. They recommended the usual clinical tests for muscle power, sensibility and the SLR test but not to use tendon reflexes for diagnosing lumbosacral radiculopathy. In patients with a history consistent with physical examination findings, MRI was recommended as an appropriate non-invasive diagnostic test to confirm the presence of lumbosacral disc herniation.

In a systematic review from 2013 (152), Nezari examined the diagnostic accuracy of the standard neurological examination in detecting disc herniation with suspected lumbosacral radiculopathy using MRI as a reference standard. This meta-analysis including 14 studies showed that all the clinical tests had low sensitivity, moderate

specificity, and limited diagnostic accuracy. The pooled sensitivity was low for sensory testing (0.32), motor testing (0.40) and reflex testing (0.25). The corresponding pooled specificity values were high, 0.72, 0.62 and 0.75, respectively. The pooled positive LR for all neurological examination components were low, ranging from 1.02 to 1.26. Nezari argues that insufficient standardization of the testing procedures, variation in use of reference standard, and the complexity of the pathology associated with disc herniation can explain the low diagnostic accuracy. He called for studies that evaluate the accuracy of the neurological tests to detect disc herniation at specific spine levels.

In paper I, on the accuracy of physical examination for chronic lumbar radiculopathy, we obtained identical findings concerning the sensitivity and specificity tests that Nezari found in his pooled analysis. We also addressed the issue of the accuracy of the tests at specific spine levels, which were low.

An MRI can with a high degree of precision show which level and side the herniated disc is localized and whether the nerve root is likely to be impinged. For a surgeon, a correspondence between clinical and MRI findings is crucial. In accordance with previous studies (151, 152) we found that this correspondence between clinical findings and the level and side of disc herniation with nerve root impingement on MRI was low, only 51.5% (paper I).

In 2014, Verwoerd (153) examined the diagnostic accuracy of patient reported symptoms and signs to detect lumbosacral nerve root impingement on MRI among 395 patients with lumbosacral radiculopathy. Age, gender, pain worse in leg than in back, subjective sensory loss, subjective muscle weakness, and more pain on

coughing/sneezing/straining were used as predictors. Verwoerd found poor accuracy for all predictors, with sensitivity values ranging from 0.53 to 0.89 and specificity values ranging from 0.18 to 0.59.

The diagnosis of lumbosacral radiculopathy is inaccurate. Information from history, clinical examination and imaging separately gives conflicting results. Clinical skills and practise improves the diagnostic accuracy, but further research is necessary to develop evidence-based knowledge to be able to select the most efficient diagnostic methods and to minimize dependency on imaging to reach a valid diagnosis.

12.2 Paper II

Which prognostic factors predict persistent pain and disability in patients with chronic lumbar radiculopathy?

In paper II, we identified that lower age and low FABQ-W predicted a better functional outcome and less back pain at the 52-week follow-up, while higher education and working full-time predicted less leg pain at the 52-week follow-up.

Most prognostic estimates of lumbosacral radiculopathy are based on individual studies examining a range of predictors measured and quantified differently. Results have therefore been difficult to reproduce in more comprehensive studies, but the prognosis seems generally to be most influenced by an individual's expectations and beliefs regarding pain and disability (154).

Fritz (139) found that a FABQ-W score >34 identified patients at risk of not returning to work 4 weeks after an incident of acute low back pain. In a prospective cohort study of

49 patients with lumbosacral radiculopathy treated with physiotherapy they found at long-term follow-up that the FABQ-PA score had improved by 4.5 points, from 20.5 at baseline (155). A clinically important change in beliefs has occurred, but a clinically relevant change value has, however, not yet been established (139). For patients treated with disc prosthesis, long duration of back pain and high FABQ-W score at baseline have been shown to significantly be associated with a worse outcome at the 2-year follow-up as assessed by the ODI (156). Cognitive behavioural therapy and graded exposure to physical activity can reduce back pain in patients with high fear avoidance measured by the FABQ (157-159). Recent studies also show that high fear avoidance can be reduced by cognitive intervention with the prospect of improved outcomes (160-163). This indicates that high fear avoidance is a modifiable risk factor that is clinically relevant.

Our findings are further partially consistent with the findings of a study by Suri (154), that being in full-time employment appears to predict a lower leg pain level. In a study of surgically and conservatively treated patients with lumbosacral radiculopathy due to disc herniation (164), most patients who were receiving workers' compensation had significantly worse outcome than patients not initially receiving workers' compensation.

In a systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery (165), den Boer found positive evidence that a lower level of education predicts an unfavourable outcome. This is in line with the findings of our paper II that higher education predicted less leg pain at 52-week follow-up. Research conducted among chronic pain patients demonstrates that a low social economic status is a risk factor for various chronic pain conditions. The specific nature of this

relationship is not entirely clear, and could be caused by various factors, such as physical work conditions, less access to health services, and/or less healthy behaviours.

Patient reported outcomes after conservative treatment of lumbosacral radiculopathy due to disc herniation are diverse. Many patients experience a spontaneous recovery, while others experience a more protracted course. Treatment failure after conservative treatment is often defined as lack of recovery or the need for subsequent surgery. Early identification of patients with a poor prognosis is important and can prevent initiation of ineffective conservative treatment and prolonged sick leave.

In a recently published systematic review of prognostic factors for non-surgically treated patients with lumbosacral radiculopathy (166), Verwoerd found that higher baseline leg pain intensity was the only independent predictor of treatment failure. However, in 2014, Suri was unable to reproduce this finding (154). This reflects a large problem in the research on prognostic factors, namely the inability to find risk factors that are clinically relevant and can be modified to improve treatment and prognosis of lumbosacral radiculopathy. As highlighted by Suri, focus has to be put on risk factors for unsuccessful outcomes, where the potential for improvements is greatest. Furthermore, identification of independent risk factors needs to be reproduced in subsequent studies to gain credibility in the scientific community. Suri defined four main groups of predictors of treatment failure – subsequent surgery, persistent leg pain, persistent disability, and patient reported lack of recovery (Table 2).

Table 2. Candidate predictors of treatment failure of conservative treatment for lumbosacral radiculopathy leading to subsequent surgery, persistent leg pain, persistent disability and patient reported lack of recovery (154).

Subsequent surgery	Persistent disability
High initial leg pain intensity	<i>High initial disability</i>
High initial disability	High initial back pain intensity
Long duration of symptoms	<i>Female gender</i>
<i>Prior low back pain</i>	Long duration of symptoms
<i>Positive SLR</i>	Current smoking
Positive crossed SLR	Medical comorbidities
Positive femoral stretch test	Prior low back pain
	Sick leave
	Herniated extruded disc
	Abnormal tendon reflexes
Persistent leg pain	Patient reported lack of recovery
High initial leg pain intensity	High age
High initial back pain intensity	<i>Female gender</i>
Female gender	Long duration of symptoms
Long duration of symptoms	Current smoking
Current smoking	Sick leave
Medical comorbidities	Positive SLR
<i>Sick leave</i>	Positive femoral stretch test
Muscle weakness	Foraminal disc herniation
Herniated extruded disc	<i>High initial disability</i>

Suri identified *prior low back pain* and *positive SLR* as predictors of subsequent surgery, *sick leave* for persistent leg pain, and *high initial disability* and *female gender* for persistent disability and patient reported lack of recovery.

Searching for an evidence-based answer to a common clinical question such as ‘What is the prognosis for recovery with conservative care for a 43-year-old man with lumbar disc herniation and lumbosacral radiculopathy?’, Emary (167) found only two relevant systematic reviews to base his answer to the patient on (50, 168). Unfortunately, both were unable to give an adequate answer to his question. However, two individual cohort studies by Suri (93, 169) made it possible for Emary to estimate a likely outcome for his patient, indicating a 72–90% chance of recovering from leg pain within 6 months, but with a 15–35% chance of recurrent leg pain within a year, regardless of type of conservative treatment chosen (87).

Reviews show that most previous studies suffer from methodological weaknesses, which may explain why no consistent predictors have been identified (166, 168). Appropriate methodology implies a careful cohort study design and use of multivariable analysis to determine adjusted and independent risk factors for different outcomes.

Identification of prognostic factors predicting persistent pain and disability is important for better understanding of the clinical course – information that can be provided to patients and physicians – and better decision-making in the treatment and guidance of patients with radiculopathy.

12.3 Paper III

Has treatment of chronic lumbosacral radiculopathy using caudal epidural injection of steroids or isotonic saline clinically important effects?

In paper III, 39 patients received caudal epidural injection of saline and 37 received caudal epidural injection of saline plus steroid. At both short- and long-term follow-up there was a significant within-group difference for both groups compared with the baseline values for pain and function, but there were no between-group differences.

Parr (116) and Manchikanti (170) have, in two systematic reviews on the effect of epidural steroid injection from 2012 and 2014 respectively, analysed four key RCTs of high methodological quality (171-176) treating lumbosacral radiculopathy. They compared these four studies with our study in paper III and found similar results.

In the included study by Dashfield in 2005 (171), 60 patients with an average 10-month history of sciatica were included. Patients were randomized into groups to receive either caudal epidural injection of steroids and local anaesthetic, or to receive targeted epidural local anaesthetic and steroid placement with a spinal endoscope. The follow-up period was 6 months. No significant differences were found between the groups for pain scores, but there were significant improvements within both groups compared with pretreatment values.

In the included study by Ackerman in 2007 (172), 90 patients with a prolapse in level L5/S1 and an average case history of 1 month were randomized to receive caudal epidural injection, interlaminar epidural injection or transforaminal injection of steroids and saline. The follow-up period was 6 months. Pain improved within all groups but was

significantly greater with the transforaminal approach. Improvements in disability scores were equal for the three groups. The reason why more patients specified pain freedom after the transforaminal epidural injection technique was attributed to the placement of the steroids in the ventral epidural space, theoretically providing a better anti-inflammatory effect compared with the two other injection techniques.

The third included study was conducted by Manchikanti. Preliminary results were published in 2008 (173), 1-year follow-up results in 2011 (174) and the 2-year follow-up results in 2012 (175). In this study, 120 patients were randomized to receive caudal epidural injection of steroids and local anaesthetic or only local anaesthetic. All patients had chronic lumbosacral radiculopathy and MRI-verified disc herniation with nerve root impingement. Both groups had significant improvement in pain and disability.

The fourth study, by Murakibhavi in 2011 (176), included 100 patients with chronic lumbosacral radiculopathy due to disc herniation. The patients were randomized to physiotherapy and pain killing medication or caudal epidural steroid injection in combination with saline and local anaesthetic. The patients were followed for 6 months. A within-group effect in the injection group was shown, but no between-group effect.

Parr (116) concludes that the evidence is considered good for short- and long-term relief of pain from treatment with epidural steroid injections and local anaesthetics injections. Manchikanti (170) concludes that the available evidence suggests that epidural steroid injections offer improvement in pain and function in well-selected patients with lumbar disc herniation.

These conclusions are only based on effects within the treatment groups. None of the studies have shown better results in the intervention groups compared to controls and none have shown any long-term effects. The conclusion from the systematic reviews by Parr and Manchikanti, that epidural steroid injections are an effective treatment for lumbosacral radiculopathy caused by disc herniation, is therefore likely to be flawed.

Our study, which concludes that epidural steroid injections are not efficacious, has been criticized for being methodologically weak, i.e. in design, selection criteria and inclusion criteria, and for not including injection of local anaesthetic. In the systematic reviews of Parr and Manchikanti, paper III therefore received only a moderate method score (3 on a scale from 0 to 8). However, another systematic review (177) gave it a strong method score of 7. This illustrates that scoring of methodological quality is not solely based on objective criteria, but also on subjective judgement.

When summarizing our results with those of the other four studies one can conclude that the patients improve regardless of injection technique and type of drug use, but that there are no between-group treatment effects when comparing epidural steroid injections with epidural local anaesthetic or saline injections.

12.3.1 IS THERE A BETWEEN-GROUP DIFFERENCE WHEN EPIDURAL STEROID INJECTIONS ARE COMPARED WITH PLACEBO INJECTIONS?

In 2013, Pinto published a systematic review to determine the efficacy of epidural steroid injections for lumbosacral radiculopathy compared with placebo epidural injections of saline or local anaesthetics (177) via the caudal, transforaminal and interlaminar route. For the caudal technique he compared our paper III with two other

similar studies (174, 178). Pinto argues that an important limitation for interpreting the results of many clinical trials is that the comparator is often another active drug of unknown effectiveness (local anaesthetics) rather than an inert epidural placebo injection of saline (177, 179-180). Manchikanti (170) argues that even an epidural injection of saline into the epidural space cannot be regarded as placebo, but an effective treatment to relieve pain and improve function. The physiological mechanisms involved for such a proposed effect are still unexplained, but studies indicate that epidural injection of saline alone may have a positive effect by diluting inflammatory cytokines or lysing of scar tissue (173, 181, 182).

In a study by Bush in 1991 (178), 23 patients were randomized into groups to receive caudal epidural injections of steroids and local anaesthetic or to receive caudal epidural injections of saline only used as placebo. At 1-year follow-up, both groups demonstrated a statistically significant reduction in pain score, but there were no differences in outcome between the treatment arms.

The second study was conducted by Manchikanti in 2011 (174). In this study, 120 patients with MRI-confirmed disc herniation with nerve root impingement were randomized into groups to receive caudal epidural injections of steroids and local anaesthetic or epidural injections of only local anaesthetic as a placebo. There was a significant improvement in pain and function in both groups.

A meta-analysis of the included studies for all injection techniques (lumbar, transforaminal and caudal) to estimate the short- and long-term efficacy showed

significant short-term effect favouring epidural steroids but non-significant results at long-term follow-up compared to placebo (177).

Table 3 shows the weighted mean difference (WMD) for short- and long-term efficacy for leg pain and disability for the caudal epidural steroid injections compared to placebo.

Table 3. Short- and long-term WMD for leg pain and disability for caudal epidural injections (177).

Author (Reference)	Steroids		Placebo		WMD (95% CI)
Leg Pain	Patients <i>n</i>	Mean Pain Score (SD)	Patients <i>n</i>	Mean Pain Score (SD)	
Short-term follow-up					
Bush (178)	12	-	11	-	
Iversen (Paper III)	37	37.6 (23.6)	35	42.4 (25.0)	
Manchikanti (174)	60	34.0 (17.0)	60	41.0 (18.0)	
Long-term follow-up					
Bush (178)	12	-	11	-	
Iversen (Paper III)	34	21.2 (23.6)	33	27.1 (25.0)	
Manchikanti (174)	60	35.0 (19.0)	60	41.0 (18.0)	
Disability					
		Mean Disability Score (SD)		Mean Disability Score (SD)	
Short-term follow-up					
Iversen (Paper III)	37	22.9 (12.1)	35	24.7 (14.3)	
Manchikanti (174)	60	27.2 (13.0)	60	33.0 (14.4)	
Long-term follow-up					
Iversen (Paper III)	34	18.8 (12.1)	33	14.1 (14.7)	
Manchikanti (174)	60	26.2 (14.0)	60	31.0 (15.5)	

The small effects observed in the review by Pinto were less than the proposed thresholds for minimal clinically important difference (177), which is in accordance with the conclusion in paper III. Table 4 shows the WMDs (95% CI) calculated by Pinto for the caudal epidural injection of steroids and placebo. Including all trials in the meta-analysis, the effect size (WMD (95% CI)) for leg pain at short-term follow-up was -6.2(-9.4 to -3.0) and -4.8(-10.2 to 0.7) at long-term follow-up. The respective values for disability were -3.1(-5.0 to -1.2) at short-term follow-up and -2.7(-6.8 to 1.3) at long-term follow-up. Negative values favoured the epidural corticosteroid group.

Pinto concludes that the low between-group effects for pain and disability were too small to be judged as clinically meaningful by patients and clinicians.

Table 4. Effect sizes for short- and long-term leg pain and disability for caudal epidural injections (177).

Study, Year (Reference)	Outcome Measure -ment Scale	Mean (SD or ± SE)* Data Extracted from the Published Report. Groups:		Mean (SD)* Data Converted to 0-100 Scale. Groups:		Steroid Group, n	Placebo Group, n	Mean Difference (95% CI)
		Steroid	Placebo	Steroid	Placebo			
Short-term follow-up for leg pain								
Bush (178)	VAS	NA‡	NA‡	NA‡	NA‡	12	11	-26.9 (-49.2 to -0.6)
Iversen (Paper III)	VAS	NA§	NA§	37.1 (24.2)	42.4 (25.0)	37	35	-4.7 (-15.9 to 6.5)
Manchikanti (174)	NRS	3.4 (1.7)	4.1 (1.8)	34.0 (17.0)	41.0 (18.0)	60	60	-7.0 (-13.3 to -0.7)
Long-term follow-up for leg pain								
Bush (178)	VAS	NA‡	NA‡	NA‡	NA‡	12	11	-13.0 (-42.3 to 16.3)
Iversen (Paper III)	VAS	NA§	NA§	21.2 (23.6)	27.1 (25.0)	34	33	-5.9 (-17.5 to 5.7)
Manchikanti (174)	NRS	3.5 (1.9)	4.1 (1.8)	35.0 (19.0)	41.0 (18.0)	60	60	-6.0 (-12.6 to 0.6)
Short-term follow-up for disability								
Iversen (Paper III)	ODI	NA§	NA§	22.9 (12.1)	24.7 (14.3)	37	35	-1.8 (-7.9 to 4.3)
Manchikanti (174)	ODI	13.6 (6.5)	16.5 (7.2)	27.2 (13.0)	33.0 (14.4)	60	60	-5.8 (-10.7 to -0.9)
Long-term follow-up for disability								
Iversen (Paper III)	ODI	NA§	NA§	18.8 (12.1)	14.1 (14.3)	34	33	4.7 (-1.6 to 11.0)
Manchikanti (174)	ODI	13.1 (7.0)	15.5 (7.74)	26.2 (14.0)	31.0 (15.5)	60	60	-4.8 (-10.1 to 0.5)

Note: NA = not applicable; NRS = numeric rating scale; SE = standard error.

* Positive mean values are post-intervention scores.

‡ Data for all patients were available in the published report; mean difference was calculated using analysis of covariance (ANCOVA) adjusted for baseline.

§ Mean was calculated from graphs.

|| SD calculated from the CI of the baseline data and sample size.

||| Authors report the ODI without multiplying the final score by a factor of 2.

12.3.2 DO EPIDURAL PLACEBO INJECTIONS CONSTITUTE A TREATMENT IN COMPARISON WITH SHAM INJECTIONS?

So far we have seen that epidural steroid injections, and epidural injections of saline or local anaesthetic could have some effects, but no significant differences in outcome between the treatment alternatives have been found. The effect of epidural steroid injections compared to epidural placebo injections (saline and local anaesthetic) has been found to be too small to be considered clinically relevant, but research has found that epidural injection of saline or local anaesthetic may be regarded as active treatment rather than a placebo.

In 2013, a review by Bicket therefore evaluated whether epidural steroid injections, or epidural injection of saline or local anaesthetic could have a treatment effect compared with sham injections (181).

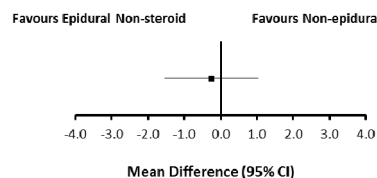
In our study in paper III, which was included in the review, a non-significant tendency favouring both epidural steroid injections (treatment) and saline injections (placebo) over subcutaneous saline injections (sham) was demonstrated using the caudal route. Table 5 shows these results in comparison with the other three studies using the caudal route from the systematic review of Bicket.

The main conclusion of Bicket from analyses based on 28 different studies including all administration routes (caudal, interlaminar and transforaminal) was no significant differences in pain reduction when comparing the epidural placebo injections with epidural steroid injections and sham injections. Both of these conclusions were entirely consistent with the findings in our study in paper III.

Table 5. Forest plots comparing pain score reduction versus injection for epidural steroid injections, epidural non-steroid (placebo) injections and non-epidural (sham) injections (181).

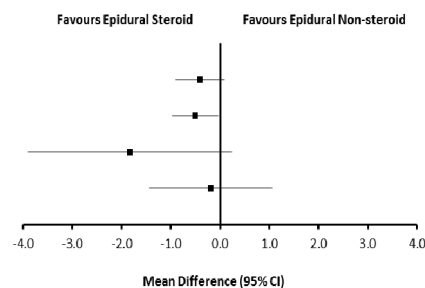
Direct comparison of epidural non-steroid (placebo) to non-epidural (sham) injections

Study	Epidural Non-steroid Injection			Non-epidural Injection		
	Mean	SD	Total	Mean	SD	Total
Iversen (Paper III)	-1.34	2.96	39	-1.09	2.89	40



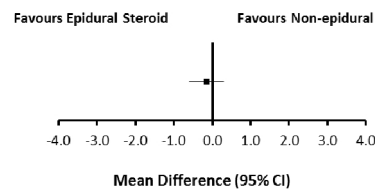
Direct comparison of epidural steroid to epidural non-steroid (placebo) injections

Study	Epidural Steroid Injection			Epidural Non-steroid Injection		
	Mean	SD	Total	Mean	SD	Total
Manchikanti (175)	-4.40	1.36	60	-4.00	1.42	60
Manchikanti (174)	-4.30	1.22	60	-3.80	1.40	60
Bush (178)	-2.25	1.95	12	-0.42	2.96	11
Iversen (Paper III)	-1.53	2.61	37	-1.34	2.96	39



Direct comparison of epidural steroid to non-epidural (sham) injections

Study	Epidural Steroid Injection			Non-epidural Injection		
	Mean	SD	Total	Mean	SD	Total
Iversen (Paper III)	-1.53	2.61	37	-1.09	2.89	40



12.3.3 ARE THERE DIFFERENCES IN EFFECT SIZE BETWEEN EPIDURAL STEROID INJECTIONS AND SHAM INJECTIONS?

In a systematic review and meta-analysis by Høltedahl from 2015 (183), paper III is evaluated along with three other key RCTs regarding the effect of epidural steroid injections compared with a sham procedure (184-186).

In this review, the effect size for both the active and the sham treatments were calculated. An effect size of 0.8 or more was assumed to be large, while an effect size of 0.5–0.8 was considered moderate (see Figure 8).

In the included study by Valat from 2003 (184), 85 patients with lumbosacral radiculopathy were randomized into groups to receive lumbar epidural steroid injections of 2 ml saline (defined as sham by Høltedahl). At 35-day follow-up, there was no difference in pain scores and disability scores between the groups: 48.3% in the steroid group and 47.6% in the sham group had experienced good recovery.

In a randomized study by Arden (185) from 2005, 228 patients with lumbosacral radiculopathy lasting less than 18 months received lumbar epidural steroid injections of 2 ml saline in the interspinous ligament. At 52-week follow-up there were no statistically significant differences in recovery of leg pain and disability between the groups.

In a study by Cohen (186) in 2012, 84 patients with lumbosacral radiculopathy with a history of less than 6 months were included. They were randomized to transforaminal epidural injection of steroids, the tumour necrosis factor alfa (TNFA) inhibitor etanercept, or saline (defined as sham by Høltedahl). All groups were given additional

local anaesthetic. The patients were followed for 12 weeks and no differences were found between the groups in reduction of leg pain or disability. Figure 8 shows the effect sizes (Cohen's d) calculated by Høltedahl for the four epidural steroid injection studies in comparison with the sham procedure. The effect size was calculated by subtracting the average score after treatment from the average score before treatment and dividing the result by the average of the SDs before and after treatment.

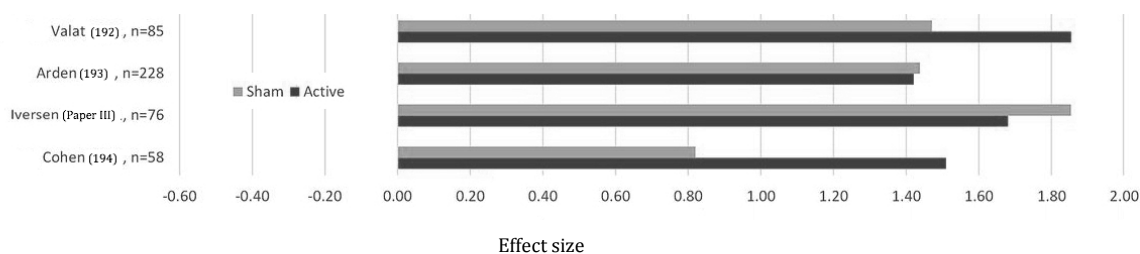


Figure 8. Effect sizes of epidural steroid injections (active treatment) and sham injections on the primary outcome pain and disability (183).

None of the studies showed a large difference in effect size between active treatment and sham groups on primary outcomes. Høltedahl concludes that 'a large part of the reported outcomes in the active treatment groups are due to placebo effects, statistical regression to the mean or the natural course of the condition' (183).

12.3.4 DO EPIDURAL STEROID INJECTIONS HAVE A SURGERY-SPARING EFFECT?

In paper III, referral to surgery was a secondary outcome measure. At 1 year, 1 out of 37 (2.7%) patients in the epidural steroid group had received surgery versus 14 out of 79 (17.7%) in the epidural saline (placebo) and subcutaneous saline (sham) groups.

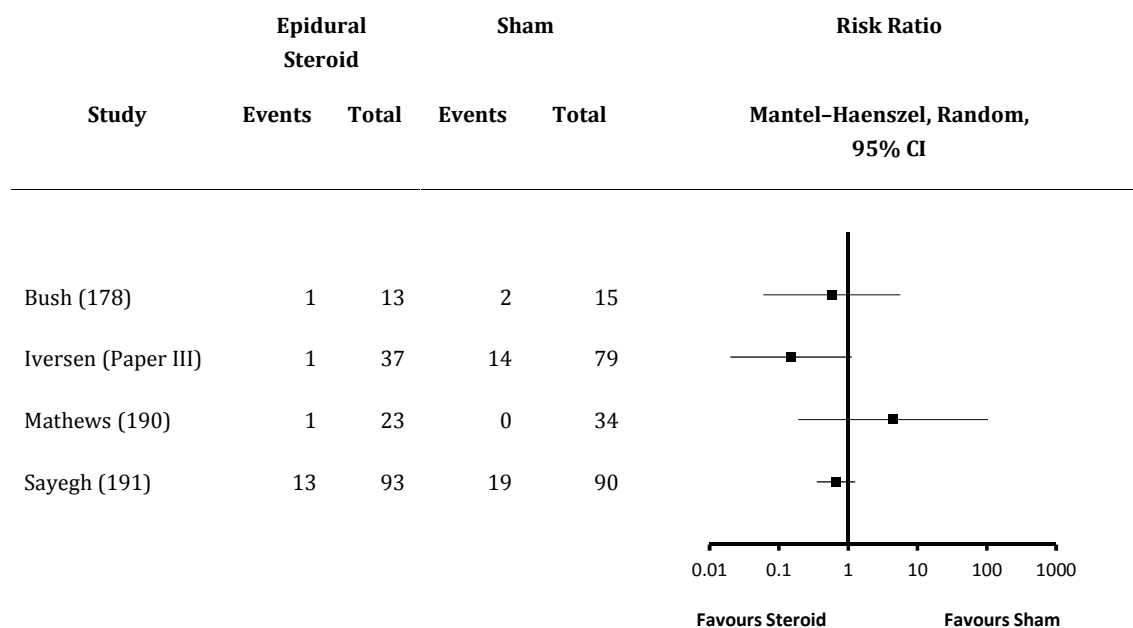
There is only one RCT available to date which has used surgery prevention as the primary outcome after epidural steroid injections (187, 188). This study from 2000 included 55 patients with indication for prolapse surgery and nerve root impingement confirmed on MRI. They were randomized into two equal groups which were given treatment with transforaminal injection of steroids plus local anaesthesia, or treatment with transforaminal injection of local anaesthetic alone. They found that 29% of patients in the steroid group had had surgery, versus 67% in the control group at 1-year follow-up, and very few further patients had to be operated up to the 5-year follow-up.

In studies where the surgery-sparing effect of epidural steroid injection is used as a secondary outcome measure, the results are more complex, and meta-analyses of the RCTs have failed to demonstrate a surgery-sparing effect (189).

In a systematic review of 21 studies from 2015 (189), Bicket investigated whether epidural steroid injections could be cost-effective by preventing costly spinal surgery. We are in this context interested to see what effect the caudal epidural injection technique has on this outcome measure. Our study in paper III is compared in the meta-analysis with three other RCTs (178, 190-191).

This meta-analysis showed no differences in surgery rates among patients treated with epidural steroid injections and the control groups. Table 6 shows the risk ratio for need of surgery for the individual studies applying the caudal epidural injection technique.

Table 6. Forest plot of the effect of caudal epidural steroid injections compared to sham injections on need for surgery in the long-term (≥ 1 year) outcome (189).



Risk ratio left of the midline favours caudal epidural steroid injection. Risk ratio right of the midline favours sham injection. If the horizontal lines (95% CI) touch the midline, the risk reduction for needing surgery is not statistically significant, i.e. it is comparable for the two treatment alternatives. To increase statistical power, Bicket merged the data from all the studies, but the overall surgery-sparing effect showed the same non-significant trend towards the benefit of epidural steroid injections, with 17.2% needing surgery in the steroid group versus 38.9% in the sham group. Given the previous discussion, the only surgery-sparing effect of epidural injections would be the natural course of lumbosacral radiculopathy, possibly modified by placebo (150).

12.3.5 IS THERE EVIDENCE TO SUPPORT THE USE OF EPIDURAL STEROID INJECTIONS?

In 2009, an expert group from the US Food and Drug Administration (FDA) (192) evaluated the safety and indications for epidural steroid injections after several reports about serious complications such as infections and nerve injury following interlaminar and transforaminal epidural steroid injections (193). The expert group developed 17 safeguard statements to prevent neurological complications, but despite this, further neurological complications were reported. In 2014, the FDA therefore announced that the use of epidural steroids was 'off-label' and not recommended (194).

In a detailed review of the effect mechanism of steroids on nerve root inflammation due to disc herniation, Balague concluded as early as 2012 (1) that steroid injection is neither clinically effective nor cost-effective, despite a strong biologically anti-inflammatory effect. In this context he refers to paper III. Balague claims that 'the proponents of epidural injection therapy always will find potential flaws in previous studies to justify starting new clinical trials and continuing this kind of treatment, despite safety concerns and striking scientific evidence against any benefits for the patients' (1).

Still there has been an increase in all injection procedures in the USA from the year 2000 to the year 2011 (see Figure 9) (195).

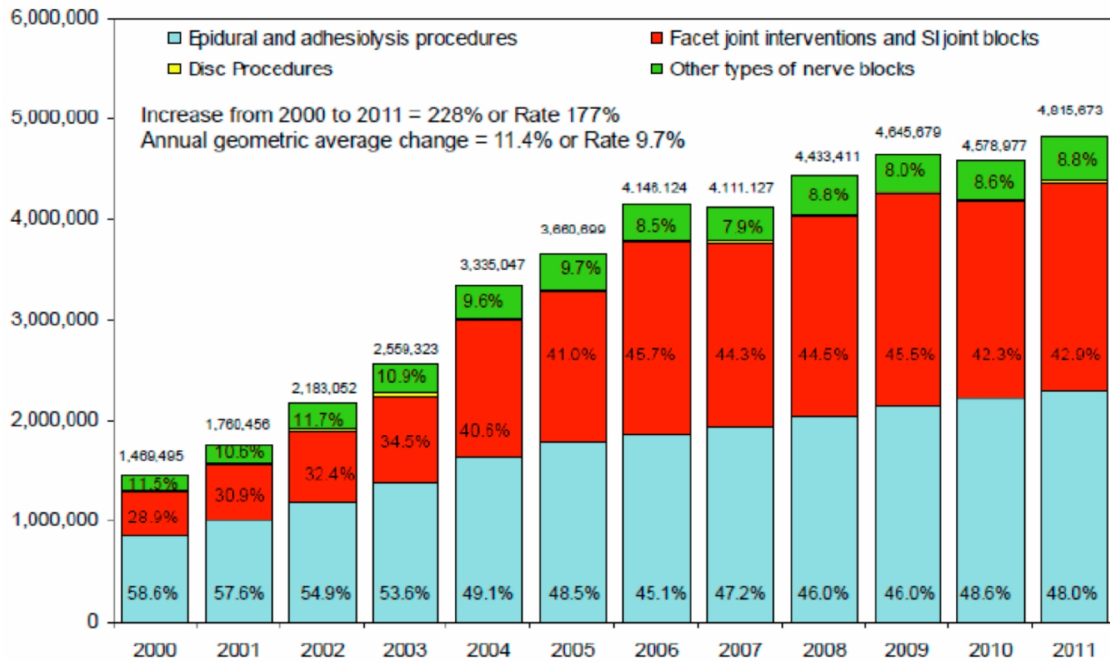


Figure 9. Distribution of procedural characteristics by type of procedures from 2000 to 2011 (195). SI = sacroiliaca.

The Centers for Medicare & Medicaid Services (CMS) proposed in 2013 cuts in reimbursements for epidural injections amounting to 49%. As a consequence (195), many pain management physicians will be struggling to keep their practice open and survive into the future despite high skills, and extensive and expensive training. On the other hand, time consuming and costly procedures, that are stressful and risky for the patients, can be spared.

13. LIMITATIONS

13.1 Paper I

The present study has weaknesses. We did not register inter-tester variability for the clinical tests and image interpretations. However, all clinicians were trained to perform the tests in a standardized manner, and agreement should thus be superior to that achieved between clinicians in daily practice. MRI was substituted with CT in 7 (6.0%) of the study subjects. A few cases of nerve root impingement may have been missed, but this is unlikely to have influenced the results significantly. Further, the duration of symptoms (average 42 weeks) was relatively long. Development of chronic centralized pain followed by regression of nerve root impingement may have occurred in some patients, and our results may not be generalizable to situations with shorter symptom duration.

Finally, it must be emphasized that the index tests work differently when applied in other settings. In unselected primary care populations, the proportion of false positives will be lower and the specificity of the tests higher. Accordingly, the tests may be useful in primary care to reduce the post-test likelihood of lumbar radiculopathy and thereby restrict unnecessary referrals for imaging and specialized care. On the other hand, when applied in a highly selected surgical patient population with shorter duration of symptoms and a large disc herniation obviously corresponding with the symptoms, the proportion of true positives will be high and the proportion of false positives low, resulting in high sensitivity and specificity. The results from the present study should

therefore not be generalized to unselected patient populations in primary care nor to even more selected surgical populations.

13.2 Paper II

Our study is limited by a relatively small number of patients, which precluded explorative analysis of the effect of different combinations of predictors. We chose to analyse 15 possible predictors, and thereby exceeded the generally accepted recommendation of a minimum of 10 events per tested predictor. In our multivariable analyses, only 5–8 predictors were included. It is a weakness that this approach entails a risk of type 1 error occurring.

Many previous prognostic studies of chronic radiculopathy have focused on patients encountered in primary care or at the surgical units. The present study deals with patients referred to outpatient multidisciplinary back clinics. Our results should not be generalized to surgical patient populations or to patients from unselected primary care.

13.3 Paper III

Our power calculation required inclusion of 41 patients in each group. Due to rapid improvement in 17 patients between inclusion and randomization we did not reach this goal. The study is therefore slightly underpowered, missing 4 patients in the epidural steroid group, 2 patients in the epidural saline group, and 1 in the sham group. The number of 41 patients in each group considered necessary to detect a 10-point between-group difference for the main outcome measure was not reached. On the other hand, the study showed no trend towards any group difference after 12 months. We therefore

consider it highly unlikely that a larger study population would have influenced the results.

The patients in our study had long-lasting symptoms of radiculopathy (26–57 weeks), and our results may be less relevant for patients with radiculopathy of shorter duration.

Low efficacy of the selected active substance, under-dosage of the substance, and a dilution effect of the steroid due to high injected volumes could have influenced the effect of the caudal epidural steroid injections in our study.

14. NEW AREAS OF RESEARCH

14.1 Modic changes

Are Modic changes clinically relevant MRI abnormalities, and is the presence of Modic changes an important predictor of outcome in lumbar disc herniation patients?

Modic marrow changes are common in disc herniation patients with a prevalence of 25–49% in patients with acute and chronic lumbosacral radiculopathy (196). In particular, Modic type I (197) but also Modic type II (198) have been linked to increased risk of pain, but how Modic changes affect recovery of pain is unclear (199).

In a systematic review in 2011 (200), it was not possible to draw firm conclusions regarding whether or not Modic changes were associated with treatment outcomes for low back pain.

In paper II, a total of 66 (56.9%) out of 116 patients had Modic type I and type I/II changes at baseline. They were not found to be significant predictors for outcome for either pain or disability. This may be due to lack of statistical power (type II error).

Further studies are needed to clarify the relevance of Modic changes for the prognosis of lumbosacral radiculopathy, and possible treatment options for this condition.

In 2014, Peterson (201) performed a cohort study of 346 patients with lumbosacral radiculopathy and MRI-confirmed disc herniation treated with transforaminal epidural steroid injections. Peterson's study found no association between the chance of Modic type I and II being present and reduction in pain after transforaminal epidural steroid injections. In a study in 2014 (202), 243 patients with lumbosacral radiculopathy were

followed for 1 year. There were no differences in VAS back pain or VAS leg pain scores at follow-up. The authors concluded that Modic type I changes delayed the recovery of lumbosacral radiculopathy, but the prognosis was still good.

In a 2-year follow-up study (203), there was found a significant positive association between decrease of Modic type I change at follow-up and improvement of low back pain and disability measured by the ODI.

To date, there is no evidence-based treatment for Modic changes. Two randomized trials have evaluated the efficacy of medication for low back pain due to Modic changes. In a Danish study (204), amoxicillin-clavulanate treatment for 3 months was effective compared to placebo among patients with Modic type I and verified disc herniation. In another study (205), zoledronic acid, a long-acting bisphosphonate, was effective in reducing the intensity of low back pain in the short term and in reducing the use of NSAIDs at 1-year follow-up among patients with chronic low back pain and Modic changes. Although these results are promising, the authors conclude that more research should be carried out to verify their results.

14.2 Pro-inflammatory interleukins

We showed in paper II that a high level of fear avoidance is an important predictor of more pain and poor function among patients with chronic lumbosacral radiculopathy. There may well be a connection between high fear avoidance, negative emotions and high levels of serum IL-6, which can intensify central sensitization and development of chronic pain.

Pedersen (206) investigated 127 patients with at least a 1-month case history and clinical findings indicating lumbosacral radiculopathy due to MRI-verified disc herniation. During follow-up, 46 patients were operated and 81 patients received cognitive therapy and physiotherapy. Serum levels of interleukin IL-6 and IL-8 were measured at inclusion and after 12 months and compared to leg pain. All the patients had a drop in serum level of IL-6 and IL-8 during the first 6 weeks. At 12 months there were statistically significant higher levels of IL-6 and IL-8 in patients with more VAS leg pain. The author concluded that high levels of interleukins may be associated with persistent pain either by local inflammatory processes or as part of a central pain sensitization. These findings are very interesting because they shed light on the complexity of the development and maintenance of radicular pain following disc herniation. Much of the treatment has been directed against the local inflammation or unblocking of the impinged nerve root by surgery. The understanding of how central sensitization and development of chronic pain are communicated through pro-inflammatory interleukins may open up new and more effective treatment strategies.

High levels of interleukins can be seen in chronic anxiety and depression. In 2015, Stellar (207) examined how positive emotions affect the level of pro-inflammatory cytokines (interleukin IL-6). The hypothesis was that high levels of interleukins can cause negative health effects through increased activity in the hypothalamic–pituitary–adrenal axis. Conversely, positive emotions could lower the serum levels of interleukins. Therefore, they examined a total of 223 students, measuring concentration of interleukin IL-6 and the extent of positive emotions (the latter by the use of questionnaires). A high score on positive emotions was associated with low values of IL-

6, but no causal relationship could be drawn. However, this study may be a step towards a biological understanding of the relationship between positive attitudes and good health.

In 2013, Miyamoto (208) investigated how negative emotions can predict high levels of interleukin IL-6. He included 1,044 patients in the USA and 382 patients in Japan. In the US population there was a significant relationship between negative emotions and high levels of serum IL-6, but not in the Japanese population. Miyamoto postulated that this may be related to cultural differences, and that negative emotions can be more accepted in Japan than in the USA.

If a biological explanation for the association between chronic pain and personality profile can be shown, new treatment strategies for chronic lumbosacral radiculopathy can be found. To investigate whether cognitive therapy or medication can lower the serum level of IL-6 to stimulate positive emotions and reduce pain, complex interventional studies have to be performed.

14.3 Tumour necrosis factor alfa

In 1993, Olmarker (209) was the first to show that the material from animal nucleus pulposus induces histological and neurophysiological changes in non-impinged spinal nerves. In 2000, Igarashi (210) showed that application of TNFA produced similar effects. In 2001, Olmarker (211) showed that TNFA inhibitor reversed inflammation and nerve conduction deficits induced by nucleus pulposus material. TNFA may therefore be an inflammatory factor involved in nerve swelling and neuropathic pain induced by a disc herniation.

The first studies of the effect of transforaminal epidural injection of TNFA inhibitor etanercept were carried out by Cohen in 2009 (147) and 2012 (186). In the first study, no dose–response relationship between etanercept and improvement of pain and disability was found. In the second study, Cohen found no difference in improvement of pain and disability between patients with lumbosacral radiculopathy randomized to transforaminal epidural injection of either a steroid or an etanercept.

In a systematic review from 2014 of the effect of treatment of lumbosacral radiculopathy with TNFA inhibitors, Wang (212) found that the TNFA inhibitor could reduce the risk of surgery at medium-term follow-up but neither provided additional pain relief nor improved function compared to placebo or steroids. He attributed the surgery-sparing effect of TNFA inhibitors to a possible neuroprotective effect, and concluded that the mechanisms underlying nociceptive and neuropathic pain still remain unclear (213). In a state-of-the-art review from 2014 (103) concerning the mechanisms and clinical implications of neuropathic pain, Cohen concluded that ‘there is a considerable overlap between neuropathic and nociceptive pain both concerning pathophysiological mechanisms and response to treatment, but that the affective component of chronic pain makes neuropathic pain notoriously refractory to treatment’.

14.4 Pain neurobiology and glial activation

The cytokines are thought to play an essential role in the pathogenesis of chronic pain, inducing central sensitization and enhancing pain conditions. In a study by Loggia in 2015 (214), 19 patients with chronic low back pain were compared with 25 healthy subjects to map levels of glial activation. The hypothesis was that chronic pain activates

microglia and astrocytes, causing neuro-inflammation in the central nervous system resulting in the production of pro-inflammatory cytokines (TNFA and the interleukins IL-1B and IL-6). The participants completed integrated positron emission tomography (PET)/MRI to assess signs of neuro-inflammation in key regions of the brain, and inflammatory cytokines from blood samples were analysed. Loggia found that glial activation was correlated with high levels of serum interleukin IL-6 in patients with chronic low back pain. He concluded that 'glial activation might be an early marker for the alterations that have been shown to occur in the brains of chronic pain patients and that this might allow early identification of individuals at risk of developing chronic pain'. More recent studies indicate that anti-inflammatory drugs that inhibit glial cells may be beneficial for chronic pain patients (215). This finding is interesting because it might help to explain the difference in treatment response we see in patients with acute and chronic lumbosacral radiculopathy. As we have seen, some patients can respond to local anti-inflammatory treatment with epidural steroid injections in the acute phase, but this effect seems to decrease as symptoms prolong and central sensitization occurs. If effective drugs that can reduce glial activation are found, one can hope that development of chronic lumbosacral radiculopathy can be prevented.

15. TRANSLATING EVIDENCE-BASED CLINICAL GUIDELINES FOR EPIDURAL STEROID INJECTIONS INTO PRACTICE – CURRENT RECOMMENDATIONS

15.1 Same trials, different conclusions in clinical guidelines

The first systematic review of the effect of caudal epidural steroid injections was performed by Kepes in 1985 (216). He concluded that there was no scientific basis for supporting the use of epidural steroid injections. However, in 1986, Benzon (217), utilizing the same studies, concluded that nerve root irritation may respond to epidural steroid injections.

In 1995, Watts and Koes published two systematic reviews of the effect of epidural steroid injection in the treatment of patients with lumbosacral radiculopathy due to disc herniation (218-219). Watts included 13 studies in his meta-analysis, while Koes included 12 studies. Nine of the studies were the same in the two meta-analyses, but the conclusions were different. Watts concluded that 'epidural administration of steroids is effective in management of lumbosacral radicular pain', while Koes concluded that 'the efficacy of epidural steroid injections has not yet been established'. Hopayian (220) therefore advised clinicians to read reviews critically.

In 2007, the American Academy of Neurology (221, 222) stated that epidural steroid injections could not be recommended to treat radiculopathy.

Manchikanti (223), on behalf of the American Society of Interventional Pain Physicians (ASIPP), presented a set of 'comprehensive evidence-based guidelines for interventional techniques in the management of chronic spinal pain' in 2009 and concluded that there is 'level I evidence for caudal epidural steroid injections in managing disc herniation'. In the same year, the American Pain Society (APS) published evidence-based clinical practice guidelines for interventional therapies for low back pain (224-225) and concluded that epidural steroid injection is moderately effective for short-term, but not long-term, symptom relief. Hence, different understanding and interpretation of study design was crucial in how the two pain groups came to different conclusions in the two sets of guidelines. Levin (226) claims that an active control trial intends to show that a new treatment is equivalent or superior to the standard treatment. He claimed that ASIPP drew incorrect conclusions by overestimating treatment effects in active control studies, assuming that the control groups had received known effective injection treatments. Levin claims that such an assumption cannot be made, because no accepted effective treatment of lumbosacral radiculopathy that new treatments can be compared with exists.

A review by Cohen in 2013 (227) showed that reviews performed by interventionists are approximately three times more likely to find that epidural steroid injections are effective compared with reviews conducted by non-interventionist physicians.

Chou (228) summarizes the discussion of clinical guidelines with different recommendations and claims that 'professional societies should support the training of members in systematic review and guideline development methodology'. Chou argues further that 'when the evidence is weak for an intervention and the trade-offs between

benefits and harms is close, the perspectives and values of the guideline development group tend to have a great effect on how the evidence is interpreted'. In response, Manchikanti argues (229) that 'knowing the tools of evidence-based practice methodology is necessary, but not sufficient, for delivering the highest quality patient care. The clinical guidelines panel must incorporate not only the methodologists, but also the clinicians who actually practice medicine and are experts in the technique being reviewed'.

In 2014, NASS provided updated evidence-based clinical guidelines for the diagnosis and treatment of lumbar disc herniation with radiculopathy (151). NASS summarizes the evidence for epidural steroid treatment in the following way: there is insufficient evidence to make a recommendation for the use of one injection approach over another (interlaminar, transforaminal, caudal). Transforaminal epidural steroid injection is recommended to provide short-term (2 to 4-week) pain relief, but there is insufficient evidence to make a recommendation for long-term (52-week) efficacy. Referring to two Finnish studies by Karppinen from 2001 (22, 230), NASS recommend transforaminal epidural steroid injections when there is a so-called 'contained disc herniation' but not when there is a 'disc extrusion'. When MRI proves a contained disc herniation, NASS refer to 'savings at 1 year of \$12,666 per responder', as opposed to an extruded disc herniation where the use of transforaminal epidural steroid injections can increase the rate of surgery.

15.2 Guidelines for epidural steroid injections in the Nordic countries

The Swedish, Norwegian and Danish national guidelines agree that the evidence for the use of epidural steroid injections for acute and chronic lumbosacral radiculopathy due to disc herniation is weak, level C (231-237). The Swedish guidelines do not give any specific advice about when injections can be tried, and the Norwegian and Danish guidelines give conflicting advice. In the Norwegian guidelines, it is recommended that epidural steroid injections can be tried while waiting for surgery, while the Danish guidelines recommend trying epidural steroid injections only in those patients with long-lasting symptoms where there is no indication for surgery.

15.3 Implementation and change of practice

In a follow-up study in 2005 (238) after presenting the Norwegian national guidelines for the diagnosis and treatment of acute low back pain, it was concluded that the guidelines may have contributed to better cooperation between different professions, that they were an important reference frame for education and communication, and that they made health workers more confident in their communication with the individual patient. The leader of the national spinal network claimed that the guidelines also may have contributed to a more realistic attitude towards back pain in the general population.

In May 2015, the Norwegian Knowledge Centre for the Health Services published a report on the effect of interventions for implementing clinical practice guidelines. They included 19 systematic reviews which addressed different guideline implementation

strategies. The transfer of research into clinical practice is a difficult and slow process, and even in the face of evidence it may be difficult to change long-held beliefs and practices (239).

16. MAIN CONCLUSIONS

16.1 Paper I

The accuracy of individual clinical index tests used to predict imaging findings of nerve root impingement in patients with chronic lumbar radiculopathy is low when applied in specialized care, but clinicians' overall evaluation improves diagnostic accuracy slightly. The tests are not very helpful in clarifying the cause of radicular pain, and are therefore inaccurate for guidance in the diagnostic workup of the patients. Further studies on diagnostic accuracy are needed.

16.2 Paper II

Lower age, higher education, working full-time and low fear avoidance beliefs each predict a better outcome of chronic unilateral lumbar radiculopathy. Specifically, lower age and low fear avoidance predict a better functional outcome and less back pain, while higher education and working full-time predict less leg pain. Fear avoidance may be a modifiable risk factor. These results should be validated in further studies before being used to inform patients.

16.3 Paper III

Treating chronic lumbar radiculopathy with either caudal epidural steroid injection or epidural saline cannot be recommended. Compared to a sham procedure, we found no evidence of any clinically important treatment effect of caudal epidural steroid or saline injections in patients with chronic lumbar radiculopathy.

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APPENDICES

Appendix 1 Paper I

Appendix 2 Paper II

Appendix 3 Paper III

Appendix 4 Investigator's brochure

Appendix 5 Template for radiological evaluation of magnetic resonance or CT images

Appendix 6 Form book

Appendix 7 Study protocol

Appendix 1 Paper I

RESEARCH ARTICLE

Open Access

Accuracy of physical examination for chronic lumbar radiculopathy

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Abstract

Background: Clinical examination of patients with chronic lumbar radiculopathy aims to clarify whether there is nerve root impingement. The aims of this study were to investigate the association between findings at clinical examination and nerve root impingement, to evaluate the accuracy of clinical index tests in a specialised care setting, and to see whether imaging clarifies the cause of chronic radicular pain.

Methods: A total of 116 patients referred with symptoms of lumbar radiculopathy lasting more than 12 weeks and at least one positive index test were included. The tests were the straight leg raising test, and tests for motor muscle strength, dermatome sensory loss, and reflex impairment. Magnetic resonance imaging (n = 109) or computer tomography (n = 7) were imaging reference standards. Images were analysed at the level of single nerve root(s), and nerve root impingement was classified as present or absent. Sensitivities, specificities, and positive and negative likelihood ratios (LR) for detection of nerve root impingement were calculated for each individual index test. An overall clinical evaluation, concluding on the level and side of the radiculopathy, was performed.

Results: The prevalence of disc herniation was 77.8%. The diagnostic accuracy of individual index tests was low with no tests reaching positive LR >4.0 or negative LR <0.4. The overall clinical evaluation was slightly more accurate, with a positive LR of 6.28 (95% CI 1.06–37.21) for L4, 1.74 (95% CI 1.04–2.93) for L5, and 1.29 (95% CI 0.97–1.72) for S1 nerve root impingement. An overall clinical evaluation, concluding on the level and side of the radiculopathy was also performed, and receiver operating characteristic (ROC) analysis with area under the curve (AUC) calculation for diagnostic accuracy of this evaluation was performed.

Conclusions: The accuracy of individual clinical index tests used to predict imaging findings of nerve root impingement in patients with chronic lumbar radiculopathy is low when applied in specialised care, but clinicians' overall evaluation improves diagnostic accuracy slightly. The tests are not very helpful in clarifying the cause of radicular pain, and are therefore inaccurate for guidance in the diagnostic workup of the patients. The study population was highly selected and therefore the results from this study should not be generalised to unselected patient populations in primary care nor to even more selected surgical populations.

Keywords: Sensitivity, Accuracy, Likelihood ratio, Lumbar radiculopathy, Physical examination

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Background

Lumbar radiculopathy is a common reason for physician consultations and imaging referrals [1-3]. Typical symptoms are radiating pain, often with numbness, paraesthesia, and/or muscle weakness [1,4]. Clinical examination aims to clarify whether there is mechanical impingement of a nerve root [5]. The most common clinical diagnostic tests are the straight leg raising test, and tests for tendon reflexes, motor weakness, and sensory deficits [6]. An inaccurate clinical diagnosis may lead to unnecessary imaging and healthcare expenditure, and additional concerns for patients [7-12].

The aim with imaging is to confirm or disprove a clinical suspicion, and to provide a roadmap for planning of surgical or other intervention procedures, if indicated. Mechanical nerve root impingements demonstrated with magnetic resonance imaging (MRI) or computer tomography (CT) is an accepted reference standard [13].

Systematic reviews on the diagnostic properties of clinical diagnostic tests for lumbar radiculopathy report variable accuracy, with sensitivities ranging from 0.14 to 0.61 for sensory deficits and impaired tendon reflexes [14,15], 0.27 to 0.62 for motor weakness [14,16], and 0.35 to 0.81 for the straight leg raising test [17]. Most studies report likelihood ratios (LRs) suggesting negligible differences between pre- and post-test probabilities for presence of nerve root impingement as the target condition, indicating limited value of the tests in clinical decision-making. A recent Cochrane review confirmed poor diagnostic performance of diagnostic tests in 18 studies from specialised care [13].

This review raised concern that none of the reported studies specifically discriminated between nerve root impingement and just the presence of a disc herniation when using imaging as a reference standard. This could be a major bias, since the prevalence of disc bulging or herniation in unselected populations without radiculopathy symptoms is high [18].

The aims of this study are to investigate the association between findings at clinical examination and nerve root impingement, to evaluate the accuracy of clinical index tests in a specialised care setting, and to see whether imaging clarifies the cause of chronic radicular pain.

Methods

Study participants

The study was performed as part of a multicentre randomised controlled trial on the treatment effect of caudal epidural injections [19]. Eligible patients with suspected chronic lumbar radiculopathy, aged between 20 and 60 years, referred to outpatient multidisciplinary back clinics of five Norwegian hospitals, were consecutively assessed for inclusion. All patients were referred

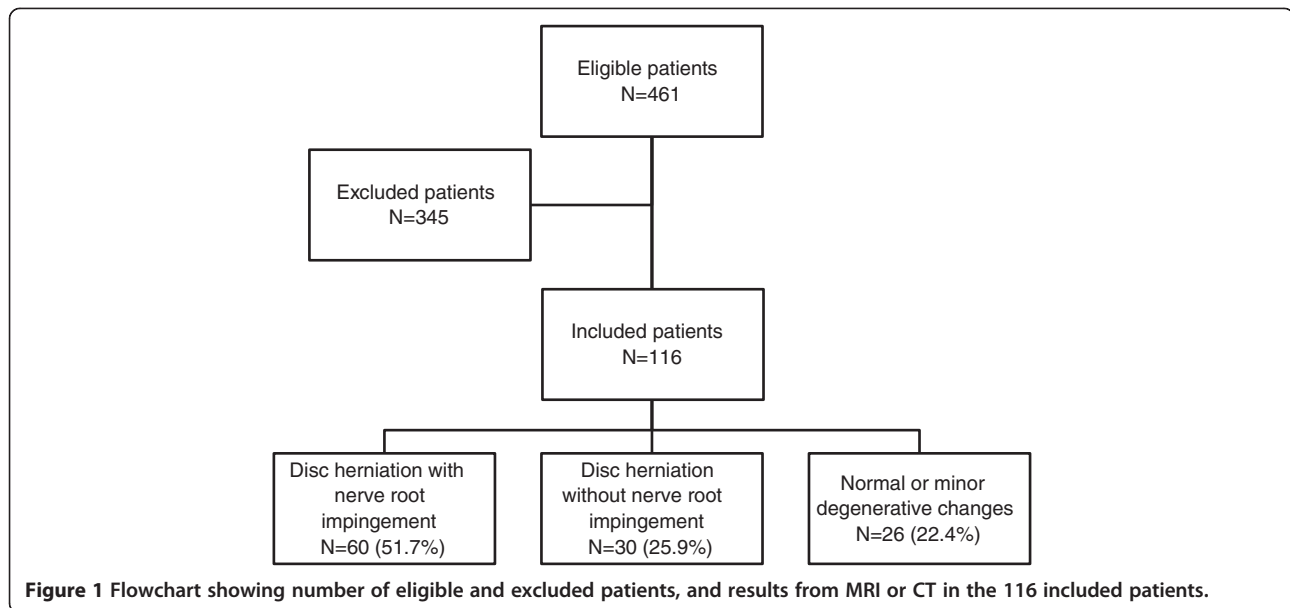
with a history suggesting chronic lumbar radiculopathy, and the clinical diagnosis was verified with at least one corresponding positive clinical test (index test) consistent with affection of a specific lumbar nerve root. These inclusion criteria ensured a homogenous patient population with clinically verified lumbar radiculopathy and a high pre-test probability of nerve root impingement. MRI or CT was used to specifically clarify whether the nerve root in question was impinged or not. The reference standard was set to be disc herniation causing impingement (compression and/or dislocation) of a spinal nerve root. Written informed consent was obtained, and the Regional Committee for Medical and Health Research Ethics in North Norway approved the study.

We assessed 461 patients with suspected lumbar radiculopathy for inclusion (Figure 1). 376 (81.6%) were referred from general practitioners, and 85 (18.4%) were internally referred in the participating hospitals. The inclusion criteria were unilateral lumbar radiculopathy lasting for more than 12 weeks and one or more positive index tests consistent with nerve root affection. The intensity of the leg pain, radiating from the back to below the knee, had to be comparable to or worse than the back pain. Whilst obtaining the patient's history, enquiries were made about the intensity of leg and low back pain on a visual analogue scale, the possible dermatome distribution of the pain, the presence of paraesthesia in the leg, whether the pain was aggravated by forward flexion or sitting, and whether there was any muscle weakness in the lower extremity.

We excluded 345 (74.8%) patients fulfilling predefined exclusion criteria according to the original randomised control trial [19]: 146 (42.3%) due to unspecific low back pain with referred leg pain, 105 (30.4%) due to radiculopathy improving during the last two weeks, 24 (7.0%) due to radiculopathy requiring referral to surgery, 16 (4.6%) because of earlier back surgery, 37 (10.7%) due to different medical conditions (pregnancy, breast feeding, use of anticlotting medication), and 17 (4.9%) because they declined to participate.

Physical examination

The physical examination was performed according to the recommendations given by the American Spinal Injury Association [20-22]. It consisted of the following index tests: the straight leg raising test, the femoral nerve stretch test, testing of muscle power in seven muscle groups on a five-point scale, dermatome sensory loss using light touch and pin prick classified on a three-point scale, and reflex impairment testing on a four-point scale. Each index test was dichotomised as being normal or abnormal according to the standard neurological classification. The straight leg raising test was considered abnormal when pain occurred before 60 degrees



passive elevation from horizontal, and the femoral nerve stretch test was considered positive when the patient experienced radiating pain [23].

Specialists in neurology or physical medicine and rehabilitation did the examination in cooperation with a physiotherapist. Prior to the study, they were trained to perform the tests in a standardised way.

Based on an overall evaluation of the patient history and results of all the index tests, a clinical decision was reached for each patient concerning the suspected level and side of nerve root affection [24-27]. The clinical decision for a nerve root involvement required a history of radicular pain accompanied by one or more corresponding positive index tests. The clinicians were blinded to the results of the imaging until this decision had been reached. To diagnose an L4 radiculopathy the clinician placed emphasis on the femoral nerve stretch test, the straight leg raise test, the knee reflex, sensory loss in the L4 dermatome and the muscle power for the ankle dorsiflexion. To diagnose an L5 radiculopathy the clinician focused on the straight leg raise test, sensory loss in the L5 dermatome, and the muscle power for the hip abduction, ankle dorsiflexion, ankle eversion, and the big toe extension. For an S1 radiculopathy the clinician emphasized the straight leg raise test, the ankle reflex, sensory loss in the S1 dermatome, and the muscle power for hip extension, knee flexion, ankle plantarflexion, and ankle eversion.

Imaging reference standard

MRI in 109 (94.0%) patients or CT in 7 (6.0%) patients was performed. Experienced radiologists evaluated the images, and a written report from the radiologists was available for the clinicians to be able to exclude patients

with severe intra-spinal pathology obviously demanding surgery [19,28].

All the MRI and CT scans were re-evaluated by two independent neuroradiologists using the Nordic Modic Classification [29]. They were blinded regarding patient history and clinical findings. The locations of the disc herniation were identified in the axial plane, and were categorised as being localised centrally or to the left or right in the spinal canal [30]. In cases of disagreement, a consensus was reached emphasising the most experienced.

Statistical analysis

We calculated means and standard deviations (SD) for continuous variables, and frequencies and proportions for categorical variables. The prevalence of nerve root impingement based on the reference standard and the post-test probabilities for a positive and negative test were calculated. Diagnostic accuracy was quantified by calculating sensitivities, specificities, and positive and negative likelihood ratios (LR), including 95% confidence intervals (CI), for each clinical test. In a multivariable logistic regression model we included all index tests as independent variables. The estimated model was used to predict the probability of a positive MRI/CT for each patient. These probabilities were used to produce a receiver operating characteristic (ROC) curve and an estimate for the area under the curve (AUC). All analyses were performed using the Statistical Package for the Social Sciences software (SPSS), version 19 (IBM Software, NY, USA).

Results

In total, 116 patients with unilateral chronic lumbar radiculopathy were included. Their clinical and demographic

characteristics are summarised in Table 1. Mean age was 42.0 (SD 10.3) years, 68 (58.6%) were males, and the mean duration of symptoms on inclusion was 42.0 (SD 99.0) weeks. Figure 1 shows the results of MRI or CT for the included patients. The overall prevalence of disc herniation at any of the studied lumbar levels (L2 to S1) was 77.8%.

Table 2 shows the frequencies of positive index tests, the overall clinical evaluation, and the imaging findings. Table 3 shows the diagnostic accuracies for the different index tests for detection of the level and side of the nerve root impingement. None of the individual tests were highly accurate, as both sensitivities and specificities were low with wide CIs. All positive LRs were ≤ 4.0 , and all negative LRs ≥ 0.4 .

Table 4 shows that the clinicians' overall evaluations using information from all relevant index tests to predict nerve root impingement were slightly more accurate than each of the individual index tests. ROC analysis of the diagnostic properties of the overall clinical evaluations showed AUCs of 0.95 (95% CI 0.90–1.00) for L4, 0.67 (95% CI 0.56–0.77) for L5, and 0.66 (95% CI 0.54–0.77) for S1 nerve root impingement.

Discussion

This study included patients with symptoms suggesting lumbar radiculopathy. Patients were recruited by screening and referral from general practitioners, and those with large disc herniation obviously requiring surgery were excluded. The sample emerging from these criteria is typical for the chronic radiculopathy population seen in specialised care. Results from the study are relevant for our understanding of diagnostic accuracy in the common clinical setting where specialists have access to imaging findings prior to the clinical examination, and often are challenged by having to evaluate which of

Table 1 Clinical and demographic characteristics of 116 patients with chronic lumbar radiculopathy

Characteristics	
Smoker	49 (42.2)
Body mass index (kg/m ²) Mean (SD)	26.3 (3.8)
Physically demanding work	58 (50.0)
Educational level	
Secondary school	94 (81.0)
College/University	24 (19.0)
Receiving sickness benefit	53 (45.7)
VAS Low back pain (0–100) Mean (SD)	47.6 (24.3)
VAS Leg pain (0–100) Mean (SD)	50.6 (24.7)
Time from referral to inclusion (weeks) Mean (SD)	6.4 (6.8)

Data are number (%) unless stated otherwise.

SD Standard Deviation.

VAS Visual Analogue Scale.

Table 2 Incidence of positive index and reference tests in painful leg*

Index test or reference test	Positive	Percent
Nerve stretch tests		
Femoral nerve stretch test	6	6.0
Straight leg raise test	62	53.4
Reflex tests		
Knee reflex	21	18.1
Ankle reflex	47	40.5
Sensory loss testing		
L3	4	3.4
L4	14	12.1
L5	31	26.7
S1	52	44.8
Motor strength/weakness		
Hip flexion (Iliopsoas L1,L2,L3)	13	11.2
Hip extension (Gluteus maximus L5,S1,S2)	14	12.1
Hip abduction (Gluteus medius L4,L5,S1)	9	7.7
Knee flexion (Hamstrings L5,S1,S2)	64	55.2
Knee extension (Quadriceps femoris L2,L3,L4)	1	0.9
Ankle dorsiflexion (Tibialis anterior L4,L5)	37	31.9
Ankle plantarflexion (Gastro-cnemius and Soleus S1,S2)	45	3.9
Ankle eversion (Peronei L5,S1)	80	6.9
Big toe extension (Extensor hallucis longus L5,S1)	25	21.5
Clinician suspected spinal nerve root impingement		
L3	1	0.9
L4	7	6.0
L5	37	31.9
S1	71	61.2
MRI or CT proven disc herniation with spinal nerve root impingement		
L3	0	0
L4	3	2.6
L5	30	25.9
S1	27	23.3
MRI or CT proven disc herniation without spinal nerve root impingement		
L3	0	0
L4	1	0.9
L5	12	10.3
S1	17	14.6
MRI or CT normal or with minor degenerative changes without spinal nerve root impingement		
All lumbar spinal levels	26	22.4

*Number of patients 116.

Table 3 Diagnostic accuracy of individual neurological tests

Predictor	L4 nerve root impingement				L5 nerve root impingement				S1 nerve root impingement			
	Sens	Spec	+LR	-LR	Sens	Spec	+LR	-LR	Sens	Spec	+LR	-LR
Femoral nerve stretch test	*	*	*	*	0.17 (0.07–0.33)	0.99 (0.94–1.00)	14.33 (1.74–117.80)	0.84 (0.72–0.99)	*	*	*	*
Straight leg raise test	*	*	*	*	0.53 (0.36–0.70)	0.47 (0.36–0.57)	1.00 (0.68–1.47)	1.00 (0.64–1.57)	0.63 (0.44–0.78)	0.49 (0.39–0.60)	1.24 (0.87–1.78)	0.75 (0.44–1.28)
Knee reflex	0.67 (0.21–0.94)	0.83 (0.75–0.89)	3.96 (1.61–9.74)	0.40 (0.08–1.99)	0.18 (0.08–0.37)	0.75 (0.63–0.84)	0.73 (0.30–1.79)	1.09 (0.87–1.37)	0.11 (0.04–0.28)	0.80 (0.70–0.87)	0.55 (0.18–1.72)	1.11 (0.94–1.32)
Ankle reflex	0.67 (0.21–0.94)	0.60 (0.51–0.69)	1.67 (0.73–3.84)	0.55 (0.11–2.76)	0.27 (0.14–0.44)	0.55 (0.44–0.65)	0.59 (0.31–1.11)	1.34 (1.00–1.79)	0.44 (0.27–0.639)	0.61 (0.50–0.70)	1.13 (0.69–1.85)	0.92 (0.63–1.33)
Sensory loss L4	0.33 (0.06–0.79)	0.88 (0.81–0.93)	2.90 (0.54–15.55)	0.75 (0.34–1.68)	0.20 (0.10–0.37)	0.91 (0.83–0.95)	2.15 (0.81–5.70)	0.88 (0.73–1.07)	0.11 (0.04–0.28)	0.88 (0.79–0.93)	0.90 (0.27–2.99)	1.01 (0.87–1.18)
Sensory loss L5	0.33 (0.06–0.79)	0.73 (0.65–0.81)	1.26 (0.25–6.40)	0.91 (0.40–2.03)	0.43 (0.27–0.61)	0.79 (0.69–0.86)	2.07 (1.16–3.70)	0.72 (0.51–1.00)	0.18 (0.08–0.37)	0.71 (0.61–0.79)	0.63 (0.27–1.49)	1.15 (0.92–1.44)
Sensory loss S1	*	*	*	*	0.33 (0.19–0.51)	0.51 (0.41–0.61)	0.68 (0.39–1.18)	1.30 (0.94–1.81)	0.44 (0.27–0.63)	0.55 (0.45–0.65)	0.99 (0.61–1.60)	1.01 (0.69–1.48)
Hip flexion	*	*	*	*	0.23 (0.12–0.41)	0.93 (0.86–0.97)	3.34 (1.22–9.16)	0.82 (0.67–1.01)	*	*	*	*
Hip extension	0.33 (0.06–0.79)	0.88 (0.81–0.93)	2.90 (0.54–15.55)	0.75 (0.34–1.68)	0.03 (0.01–0.17)	0.85 (0.76–0.91)	0.22 (0.03–1.61)	1.14 (1.02–1.27)	0.18 (0.08–0.37)	0.90 (0.82–0.94)	1.83 (0.67–5.00)	0.91 (0.75–1.10)
Hip abduction	*	*	*	*	0.07 (0.02–0.21)	0.92 (0.84–0.96)	0.82 (0.18–3.73)	1.01 (0.91–1.13)	0.04 (0.01–0.18)	0.91 (0.83–0.95)	0.41 (0.05–3.15)	1.06 (0.96–1.17)
Knee flexion	0.67 (0.21–0.94)	0.45 (0.36–0.54)	1.22 (0.54–2.75)	0.74 (0.15–3.71)	0.50 (0.33–0.67)	0.43 (0.33–0.53)	0.88 (0.59–1.31)	1.16 (0.75–1.79)	0.70 (0.51–0.84)	0.49 (0.39–0.60)	1.39 (1.01–1.92)	0.60 (0.32–1.11)
Knee extension	*	*	*	*	*	*	*	*	*	*	*	*
Ankle dorsiflexion	0.33 (0.06–0.79)	0.68 (0.59–0.76)	1.05 (0.20–5.30)	0.98 (0.44–2.20)	0.40 (0.25–0.58)	0.71 (0.61–0.79)	1.38 (0.80–2.38)	0.85 (0.61–1.17)	0.26 (0.13–0.45)	0.66 (0.56–0.75)	0.77 (0.38–1.55)	1.12 (0.85–1.46)
Ankle plantarflexion	0.67 (0.21–0.94)	0.62 (0.53–0.70)	1.75 (0.76–4.03)	0.54 (0.11–2.68)	0.27 (0.14–0.44)	0.57 (0.46–0.67)	0.62 (0.33–1.18)	1.29 (0.97–1.71)	0.44 (0.27–0.63)	0.63 (0.52–0.72)	1.20 (0.73–1.98)	0.88 (0.61–1.28)
Ankle eversion	0.67 (0.21–0.94)	0.31 (0.23–0.40)	0.97 (0.43–2.17)	1.08 (0.21–5.46)	0.45 (0.27–0.65)	0.28 (0.19–0.38)	0.63 (0.39–1.01)	1.96 (1.17–3.26)	0.70 (0.51–0.84)	0.31 (0.23–0.42)	1.03 (0.77–1.36)	0.94 (0.49–1.82)
Big toe extension	*	*	*	*	0.33 (0.19–0.51)	0.83 (0.73–0.89)	1.91 (0.97–3.79)	0.81 (0.62–1.06)	0.15 (0.06–0.32)	0.76 (0.67–0.84)	0.63 (0.24–1.67)	1.11 (0.49–1.82)

Values in each cell are estimates and 95% confidence intervals.

Sens indicates sensitivity (TP/TP+FN).

Spec indicates specificity (TN/TN+FP).

+LR indicates positive likelihood ratio (Sens/1-Spec).

-LR indicates negative likelihood ratio (1-Sens/Spec).

*No TP (True Positive).

Table 4 Diagnostic accuracy of clinician examination conclusion

Predictor	L4 nerve root impingement				L5 nerve root impingement				S1 nerve root impingement			
	Sens	Spec	+LR	-LR	Sens	Spec	+LR	-LR	Sens	Spec	+LR	-LR
Clinician concluded L4 nerve root impingement	0.33 (0.06–0.79)	0.95 (0.89–0.97)	6.28 (1.06–37.21)	0.70 (0.32–1.57)	0.10 (0.03–0.26)	0.95 (0.89–0.98)	2.15 (0.51–9.06)	0.94 (0.83–1.07)	*	*	*	*
Clinician concluded L5 nerve root impingement	0.33 (0.06–0.79)	0.68 (0.59–0.76)	1.05 (0.21–5.30)	0.98 (0.43–2.20)	0.47 (0.30–0.64)	0.73 (0.63–0.81)	1.74 (1.04–2.93)	0.73 (0.51–1.04)	0.26 (0.13–0.45)	0.66 (0.56–0.75)	0.77 (0.38–1.55)	1.12 (0.85–1.46)
Clinician concluded S1 nerve root impingement	0.33 (0.06–0.79)	0.38 (0.30–0.47)	0.54 (0.11–2.68)	1.75 (0.76–4.03)	0.43 (0.27–0.61)	0.32 (0.23–0.43)	0.64 (0.42–0.99)	1.74 (1.12–2.69)	0.74 (0.55–0.87)	0.43 (0.33–0.53)	1.29 (0.97–1.72)	0.61 (0.31–1.20)

Values in each cell are an estimate and 95% confidence intervals.

Sens indicates sensitivity (TP/TP+FN).

Spec indicates specificity (TN/TN+FP).

+LR indicates positive likelihood ratio (Sens/1-Spec).

-LR indicates negative likelihood ratio (1-Sens/Spec).

*No TP (True Positive).

numerous positive imaging findings are to be considered clinically relevant.

The main finding is that individual clinical index tests lack diagnostic accuracy for predicting whether a lumbar nerve root is impinged or not at a specific level in patients with chronic lumbar radiculopathy in specialised care. The overall clinical evaluation, consisting of the specialists' combined interpretation of the patients' history and all index tests, was somewhat more accurate. For L5 and S1 nerve root impingement, however, LRs did not reach the levels usually considered necessary to influence post-test probability and thereby clinical decision-making (positive LR >5.0 and negative LR <0.2) [31]. Accuracy was better (positive LR 6.28, negative LR 0.70) for L4 nerve root impingement. This was probably because L4 nerve root involvement occurred only in 3 (2.6%) cases, and was suspected after the overall clinical evaluation only in 7 (6.0%) cases. This resulted in a high number of true negatives, and thereby high specificity. Clinically, the low pre-test probability for L4 nerve root involvement is well known [32], and these test properties are therefore not very useful. Accordingly, clinical examination is inaccurate both for predicting the presence or absence of nerve root impingement, and for clarifying the relevant level and side in patients with multiple positive imaging findings.

Our findings are mainly in accordance with other studies of selected populations from specialised care [13]. Most previous studies have, however, aimed for a generalised understanding of test properties from such selected materials [13]. This approach is confusing, as the pre-test probability always must be taken into consideration. Recently, a study aimed to specifically investigate the accuracy of clinical index tests from the neurological examination for identification of the level of disc herniation in patients with the target condition already confirmed by MRI [33]. Unfortunately the study did not find evidence to support this. The results were disappointing, with no single test reaching an AUC >0.75, and only slightly better results (AUC = 0.80) for the neurologists' overall evaluation.

It has been a weakness of most previous studies that interpretation of the imaging findings has been limited to categorising the target condition (usually a disc herniation) as present or not, without considering whether a nerve root actually was impinged at the relevant spinal level and side [34]. We therefore improved the study design by specifically addressing findings relevant for clinical decision-making: correspondence between index tests and impingement of specific nerve roots as revealed by MRI [32]. Disappointingly, this did not improve diagnostic accuracy, neither for individual tests nor for the clinicians' overall evaluation. AUCs for L5 and S1 nerve root impingement did not reach levels

above 0.66, which are even lower than those observed by Hancock et al. in an almost similar specialised care setting [33]. This could be because we used one or more positive index tests as an inclusion criterion, which probably increased both the proportion of false positives and false negatives. The false negatives increased because the index tests are not independent of each other, implying that inclusion based on one or more positive tests entails an increased proportion of false negatives, since many tests are performed in each patient. We do not consider the selection of patients in our study a methodological weakness, but rather an expression of clinical reality in specialised care. There should, however, be concern about both the definition of the target condition and the reference standard being subjects to bias. First, neuroanatomical overlap between spinal segments influences accuracy when the analysis is done on the level of each single nerve root [35-37]. Patients may have radiculopathy from causes other than ongoing nerve root impingement, and even when an impingement is present, this is not necessarily the cause of the pain. Imaging showed no sign of nerve root impingement in 56 (48.3%) of the included cases despite a clear history and clinical findings suggesting lumbar radiculopathy. This confirms that radiculopathy may have other causes, such as neuropathic and inflammatory conditions, or be mimicked by myofascial pain [6,38-40]. Moreover, disc herniation without nerve root impingement was demonstrated in 25.9% of the included patients, and in 73.8% of those excluded due to symptoms classified as unspecific low back pain with referred leg pain. This is not surprising, since the prevalence of disc herniation revealed by MRI in the general population is known to be as high as 30% [3,18,41-44].

We suggest that our findings reflect clinical reality very well: in a population selected by referral from primary care and exclusion of the most obvious surgical cases, co-morbidity bias and imaging findings not related to the symptoms are common. Diagnostic imaging combined with clinical tests is therefore inaccurate for clarifying the cause of radicular pain. This is probably one of the reasons why these patients are so difficult to treat, and the same inaccuracy may cause significant inclusion bias in clinical trials evaluating treatments for lumbar radiculopathy.

The present study has weaknesses. We did not register inter-tester variability for the clinical tests and image interpretations. However, all clinicians were trained to perform the tests in a standardised manner, and agreement should thus be superior to that achieved between clinicians in daily practice [22]. MRI was substituted with CT in 7 (6.0%) of the study subjects. A few cases of nerve root impingement may have been missed, but this is unlikely to have influenced the results significantly.

Further, the duration of symptoms (average 42 weeks) was relatively long. Development of chronic centralised pain followed by regression of nerve root impingement may have occurred in some patients, and our results may not be generalisable to situations with shorter symptom duration.

Finally, it must be emphasised that the index tests work differently when applied in other settings. In unselected primary care populations, the proportion of false positives will be lower and the specificity of the tests higher. Accordingly, the tests may be useful in primary care to reduce the post-test likelihood of lumbar radiculopathy, and thereby restrict unnecessary referrals for imaging and specialised care. On the other hand, when applied in a highly selected surgical patient population with shorter duration of symptoms and a large disc herniation obviously corresponding with the symptoms, the proportion of true positives will be high and the proportion of false positives low, resulting in high sensitivity and specificity. The results from the present study should therefore not be generalised to unselected patient populations in primary care nor to even more selected surgical populations.

Conclusions

In conclusion, the accuracy of individual clinical index tests used to predict imaging findings of nerve root impingement in patients with lumbar radiculopathy is low when applied in specialised care, and clinicians' overall evaluation does not improve diagnostic accuracy significantly. Accordingly, the tests are not very helpful in clarifying the cause of radicular pain, and are therefore inaccurate for treatment guidance of patients who often have multiple positive imaging findings. These results suggest that previous belief in the benefit of combining different neurological tests to accurately diagnose the level of nerve root affection has been exaggerated [45,46]. Co-morbidity and imaging findings not related to the symptoms are probably the most important causes for diagnostic inaccuracy in chronic lumbar radiculopathy [3,28,39,47-49].

Abbreviations

AUC: Area under the curve; CI: Confidence interval; CT: Computer tomography; LR: Likelihood ratio; MRI: Magnetic resonance imaging; ROC: Receiver operating characteristic; SD: Standard deviation.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

TI contributed to the study design, data collection, data analysis, interpretation, and writing of the manuscript. TKS, ØN, Tol, TW, and BR contributed to the study design, data analysis, interpretation, and writing of the manuscript. JIB and KW contributed to data analysis, interpretation, and writing of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Appendix 2 Paper II

RESEARCH ARTICLE

Open Access

Outcome prediction in chronic unilateral lumbar radiculopathy: prospective cohort study

Trond Iversen^{1,2*}, Tore K Solberg^{3,4}, Tom Wilsgaard⁵, Knut Waterloo^{6,7}, Jens Ivar Brox⁸ and Tor Ingebrigtsen⁹

Abstract

Background: Identification of prognostic factors for persistent pain and disability are important for better understanding of the clinical course of chronic unilateral lumbar radiculopathy and to assist clinical decision-making. There is a lack of scientific evidence concerning prognostic factors. The aim of this study was to identify clinically relevant predictors for outcome at 52 weeks.

Methods: 116 patients were included in a sham controlled clinical trial on epidural injection of glucocorticoids in patients with chronic unilateral lumbar radiculopathy. Success at follow-up was ≤ 17.5 for visual analogue scale (VAS) leg pain, ≤ 22.5 for VAS back pain and ≤ 20 for Oswestry Disability Index (ODI). Fifteen clinically relevant variables included demographic, psychosocial, clinical and radiological data and were analysed using a logistic multivariable regression analysis.

Results: At follow-up, 75 (64.7%) patients had reached a successful outcome with an ODI score ≤ 20 , 54 (46.6%) with a VAS leg pain score ≤ 17.5 , and 47 (40.5%) with a VAS back pain score ≤ 22.5 . Lower age (OR 0.94 (CI 0.89–0.99) for each year decrease in age) and FABQ Work ≥ 34 (OR 0.16 (CI 0.04–0.61)) were independent variables predicting a successful outcome on the ODI. Higher education (OR 5.77 (CI 1.46–22.87)) and working full-time (OR 2.70 (CI 1.02–7.18)) were statistically significant ($P < 0.05$) independent predictors for successful outcome (VAS score ≤ 17.5) on the measure of leg pain. Lower age predicted success on ODI (OR 0.94 (95% CI 0.89 to 0.99) for each year) and less back pain (OR 0.94 (0.90 to 0.99)), while higher education (OR 5.77 (1.46 to 22.87)), working full-time (OR 2.70 (1.02 to 7.18)) and muscle weakness at baseline (OR 4.11 (1.24 to 13.61)) predicted less leg pain, and reflex impairment at baseline predicted the contrary (OR 0.39 (0.15 to 0.97)).

Conclusions: Lower age, higher education, working full-time and low fear avoidance beliefs each predict a better outcome of chronic unilateral lumbar radiculopathy. Specifically, lower age and low fear avoidance predict a better functional outcome and less back pain, while higher education and working full-time predict less leg pain. These results should be validated in further studies before being used to inform patients.

Trial registration: Current Controlled Trials ISRCTN12574253. Registered 18 May 2005.

Keywords: Chronic unilateral lumbar radiculopathy, Lumbar nerve root impingement, Outcome prediction, Radiculopathy, Sciatica

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Background

Radiculopathy, or sciatica, is defined as radiating leg pain below knee level with neurological deficits in the distribution of the lumbosacral nerves [1,2]. The most common cause of radiculopathy is lumbar disc herniation [3,4]. Annual prevalence rates vary widely from 2 to 34%, probably due to differences in the definition of symptoms and interpretation of clinical findings [2,5,6].

The natural course of radiculopathy also varies between studies, as do the success rates after treatment, both depending on the inclusion criteria and outcome measures used [7]. For example, a study on primary care patients indicated a good prognosis, with approximately 75% of the patients experiencing full recovery after 3 months [8]. In a study of patients who were referred to hospital, nearly 70% had persistent symptoms 13 years later [9].

Previous studies have assessed many possible predictors associated with the prognosis of radiculopathy, such as clinical, demographic, psychosocial and work-related risk factors, radiological findings and treatment modalities [10,11]. Female gender [12], symptoms of depression and anxiety [13], psychosomatic symptoms [14], long-lasting leg pain, carrying heavy loads, driving at least 2 hours per day [15], and positive nerve stretch tests are among the numerous factors reported to be associated with a less favourable outcome [8,16].

Two recent systematic reviews attempted to synthesize the evidence on prognostic factors for sciatica [17,18]. Heterogeneity of the included studies precluded pooling of results and meta-analysis in both reviews. The review by Ashworth et al. [17] included eight studies of non-surgically treated patients. No strong or consistent predictor for persistent disability could be identified, but clinical, occupational and individual factors were found to be more strongly associated with outcome than psychological factors in sciatica populations. The authors recommended that prospective studies with high methodological quality (multivariable models) using a well-defined and consistent definition of radiculopathy should be performed, and that psychosocial, clinical and radiological data should be included in risk factor analyses. The review by Verwoerd et al. [18] screened 168 articles and included 23 studies. Only nine articles reported results from multivariable analysis [8,12,19-25]. Most articles reported results from studies of patients in secondary care, and the diagnosis of sciatica was frequently based on clinical criteria only. The review included surgery as outcome and found that only high leg pain intensity at baseline was strongly associated with subsequent surgery. The authors commented that clinical decision-making is hampered by lack of scientific evidence concerning prognostic factors.

To study possible predictors for outcome, validated patient-reported outcome measures should be used with

standardized cut-offs that distinguish between success and non-success [26]. In this study, we used validated cut-offs on the Oswestry Disability Index (ODI) and visual analogue scales (VAS) for leg and back pain [27-30].

In summary, the reviews on predictors referred to above for the study of outcome of sciatica have identified a limited number of variables of clinical importance but the studies vary in the use of inclusion criteria and outcome measures, use unclear definitions of success criteria, and use statistical methods inconsistently. In the present study of chronic unilateral lumbar radiculopathy, we included a homogeneous patient sample selected with clear inclusion criteria in a specialized care setting, and clinically relevant outcome measures with well-defined cut-offs for successful outcomes. The aim of this study was to identify clinically relevant predictors for outcome among patients with chronic radiculopathy.

Methods

Setting

The study was performed as part of a multicentre randomized controlled trial (RCT) on the treatment effect of caudal epidural injections for chronic unilateral lumbar radiculopathy [31], and as part of a study on the association between findings at clinical examination and lumbar nerve root impingement [32]. We used the Oswestry Disability Index (ODI) and the Visual Analogue Scale (VAS) score for low back pain and leg pain as outcome measures in the RCT. The treatment intervention in the RCT had no short or long-term effect on chronic unilateral lumbar radiculopathy. This allowed the use of the trial data in this study [33].

Patients

Eligible patients with suspected chronic unilateral lumbar radiculopathy, aged between 20 and 60 years, referred to outpatient multidisciplinary back clinics of five Norwegian hospitals, were consecutively assessed for inclusion. The inclusion period was 3 years, between 2005 and 2009. 461 patients with suspected chronic unilateral lumbar radiculopathy were assessed for inclusion: 376 (81.6%) were referred from general practitioners and 85 (18.4%) were internally referred in the participating hospitals.

The inclusion criterion was chronic unilateral lumbar radiculopathy lasting more than 12 weeks. The intensity of the leg pain, radiating from the back to below the knee, had to be comparable to or worse than the back pain. A clinical examination was carried out by trained physicians and physiotherapists. The assessment included muscle strength, sensory loss, reflexes of the Achilles tendon and patella, and the straight leg raising test. The results of each clinical test were dichotomized as normal or abnormal as described previously [32]. These inclusion criteria ensured a homogeneous patient population with clinically verified

chronic unilateral lumbar radiculopathy. Magnetic resonance imaging (MRI) in 109 (94.0%) or computer tomography (CT) in 7 (6.0%) patients was used to specifically clarify whether the nerve root in question was impinged or not. Two experienced neuroradiologists evaluated all MRI and CT scans. They were not provided any clinical information and had not been involved in the selection or care of the included patients. There were no requests for a correspondence between demonstrated level of radiculopathy by clinical examination and findings on imaging.

We excluded 345 (74.8%) patients fulfilling predefined exclusion criteria according to the original RCT: 146 (42.3%) due to unspecific low back pain with referred leg pain, 105 (30.4%) due to radiculopathy improving during the last 2 weeks before the inclusion examination, 24 (7.0%) due to radiculopathy requiring necessary urgent referral to surgery, 16 (4.6%) because of back surgery prior to this study, 37 (10.7%) due to different medical conditions (pregnancy, breastfeeding, use of anticoagulating medication), and 17 (4.9%) because they declined to participate.

At this point, 116 patients with chronic unilateral lumbar radiculopathy were included in the study. At all study sites the patients received standardized oral and written information about spine anatomy and function at baseline and follow-up. They were encouraged to engage in physical activity, and all patients received the brochure 'Worth knowing about bad backs. What experts agree on' [34]. The decision about surgery during follow-up was made for individual patients at each centre, and no standardized criteria were established for surgical treatment. 99 (85.3%) of the included patients were followed up at 52 weeks. Written informed consent was obtained and the Regional Committee for Medical and Health Research Ethics in North Norway approved the study.

Procedure and measurements

At baseline, a questionnaire on sociodemographic factors, fear avoidance belief (FABQ), duration of low back pain and leg pain and outcome measures was completed by the patients.

Outcome measures

We used functional status assessed with the ODI as the primary outcome measure and leg pain and back pain as secondary outcome measures. At follow-up after 52 weeks the ODI score, the VAS leg pain and the VAS back pain were registered. A successful outcome score was set to ≤ 17.5 for VAS leg pain, ≤ 22.5 for VAS back pain and ≤ 20 for ODI, as recommended by Haugen et al. after Receiver Operating Curves (ROC) analysis of outcomes in 466 patients [30]. Change scores were calculated as difference between baseline and follow-up scores [35,36].

The ODI contains 10 questions on limitations of daily living activities [37-39]. Each variable was rated on a 0

to 5-point scale, added up, and converted into a percentage score. The range of possible values is from 0 to 100 (where 0 = no disability). Leg pain and low back pain were measured using the VAS 0-100 (where 0 = no pain).

Predictors for outcome

Table 1 shows that we analysed sociodemographic variables, psychological variables, pain history, findings from clinical examination, and imaging as possible predictors. These were predefined based on findings in previous literature, including results reported from the Norwegian Registry for Spine Surgery [40,41] and our assessment of clinical relevance. Age, duration of leg and back pain and body mass index were analysed as continuous variables. Gender, current smoking, university or college education, working full-time, positive straight leg test, presence of muscle weakness, sensory loss or reflex impairment, concordance between nerve root impingement on MRI and clinical radiculopathy, presence of Modic type I or II changes and FABQ [42] were dichotomized. We chose ≥ 34 as cut-off for an elevated fear avoidance belief for the FABQ subscale for work (FABQW) [43] and ≥ 15 for the FABQ subscale for physical activity (FABQPA) [44].

Statistical analysis

We calculated means and standard deviations (SD) for continuous variables, and frequencies and proportions for

Table 1 Characteristics of the patients (n = 116) at baseline

<i>Sociodemographic variables</i>	
Age years, mean (SD)	42.0 (10.3)
Male gender, n (%)	68.0 (58.6)
Current smoker, n (%)	49.0 (42.2)
University or college education, n (%)	22.0 (19.0)
Working full-time, n (%)	43.0 (37.1)
<i>Low back pain/sciatica history/fear avoidance</i>	
Low back pain weeks, mean (SD)	53.4 (110.0)
Leg pain weeks, mean (SD)	42.0 (99.0)
Fear avoidance belief questionnaire about work, mean (SD)	12.8 (5.0)
Fear avoidance belief questionnaire about physical activity, mean (SD)	23.4 (10.2)
<i>Clinical examination</i>	
Straight leg raising $<60^\circ$, n (%)	62.0 (53.4)
Muscle weakness, n (%)	94.0 (81.0)
Dermatome sensory loss, n (%)	83.0 (71.6)
Reflex impairment, n (%)	55.0 (47.4)
Body mass index, mean (SD)	26.3 (3.8)
<i>Magnetic resonance or CT imaging</i>	
Concordance between nerve root impingement on MRI and clinical radiculopathy n (%)	60 (51.7)
Modic type I and II, n (%)	66.0 (56.9)

categorical variables. Paired samples t-tests were used to test change scores between baseline and follow-up for patient-reported outcomes. ANalysis Of VAriance (ANOVA) was used to compare mean differences between groups. We used univariable and stepwise backward (Wald) multivariable binary logistic regression to analyse associations between predictors and outcome measures. Predictors with P value <0.20 from the univariable analysis were used in the multivariable analysis. In the analysis we adjusted for the baseline values. Odds ratios (ORs) with 95% confidence intervals (CI) were calculated. P values <0.05 were considered statistically significant. All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software version 22 (IBM Software, NY, USA).

Results

In total, 116 patients with chronic unilateral lumbar radiculopathy were included. Their clinical and demographic characteristics are summarized in Table 1. All 15 variables were included in the subsequent predictor analysis. We defined high correlation between prognostic factors to be >0.60. Duration of leg pain and back pain were highly correlated (Spearman's $\rho = 0.71$) and duration of back pain was therefore not included in the analysis.

Table 2 shows that there was a statistically significant ($P < 0.001$) mean improvement for both the ODI and the VAS leg pain and VAS back pain outcome measures from baseline to follow-up after 52 weeks. The mean improvement was substantial (VAS decrease ≥ 20) for leg pain.

At follow-up, 75 (64.7%) of the patients had reached a successful outcome with an ODI score ≤ 20 , 54 (46.6%) with a VAS leg pain score ≤ 17.5 , and 47 (40.5%) with a VAS back pain score ≤ 22.5 . These outcome values were used in the multivariable logistic regression analysis.

Table 3 shows that lower age (OR 0.94 (CI 0.89–0.99) for each year decrease in age) and FABQ Work ≥ 34 (OR 0.16 (CI 0.04–0.61)) were independent variables predicting a successful outcome on the ODI in multivariable analysis.

Table 3 also shows predictors for the secondary outcome measures VAS leg pain and VAS back pain. Higher education (university or college level) (OR 5.77 (CI 1.46–22.87)) and working full-time (OR 2.70 (CI 1.02–

7.18)) were statistically significant ($P < 0.05$) independent predictors for a successful outcome (VAS score ≤ 17.5) on the measure of leg pain. The presence of muscle weakness (OR 4.11 (CI 1.24–13.61)) also predicted a VAS score for leg pain ≤ 17.5 , while the presence of reflex impairment predicted the contrary (OR 0.39 (CI 0.15–0.97)).

Lower age (OR 0.94 (CI 0.90–0.99) for each year decrease in age) and working full-time (OR 2.77 (CI 1.02–7.56)) predicted a successful outcome (VAS score ≤ 22.5) for back pain, while FABQ Physical activity ≥ 15 (OR 0.31 (CI 0.11–0.85)) predicted the contrary.

Fifteen (13%) patients underwent surgical decompression of the clinically affected nerve root during follow-up, and outcome data for 12 of them were available. A subanalysis comparing operated and non-operated patients showed that the operated patients had significantly higher baseline scores for ODI, VAS leg pain and VAS back pain and improved significantly more. There were, however, no differences between the groups with regard to the ODI and the VAS leg pain and VAS back pain scores at 52 weeks follow-up (Table 4).

Discussion

The main finding of this study is that lower age, higher education, working full-time and low fear avoidance beliefs each predict a better outcome of chronic unilateral lumbar radiculopathy. Specifically, lower age and low fear avoidance predict a better functional outcome and less back pain, while higher education and working full-time predict less leg pain.

This study also shows that the prognosis for patients referred to multidisciplinary back clinics for chronic unilateral lumbar radiculopathy is good. A total of 75 (64.7%) patients at follow-up had an ODI score below 20, 54 (46.6%) had a VAS leg pain score below 17.5 and 47 (40.5%) had a VAS leg pain score below 22.5.

Identification of prognostic factors predicting persistent pain and disability is important for better understanding of the clinical course – information that can be provided to patients and physicians – and decision-making in treatment and guidance of patients with radiculopathy. We identified higher age and reflex impairment as prognostic factors for non-success, and higher education, working full-time and low fear avoidance as prognostic factors for

Table 2 Paired samples t-test for patient-reported measures at baseline and follow-up

Patient-reported measures	n	Baseline	Follow-up	Change	t	P
ODI (0–100)	99	30.0 (13.2)	15.5 (13.3)	14.4 (16.3)	8.84	0.001
Leg pain intensity (VAS 0–100)	97	50.6 (24.7)	23.0 (25.8)	27.5 (31.3)	8.67	0.001
Low back pain intensity (VAS 0–100)	93	47.6 (24.3)	27.9 (24.3)	17.9 (30.6)	5.66	0.001

Numbers are mean (SD).

VAS: 0 = no pain.

ODI: 0 = normal function.

Table 3 Multivariable logistic regression analysis

Predictors	Successful outcome ODI		Successful outcome VAS leg pain		Successful outcome VAS back pain	
	Absolute value at follow-up ≤20, adjusted for its baseline value		Absolute value at follow-up ≤17.5, adjusted for its baseline value		Absolute value at follow-up ≤22.5, adjusted for its baseline value	
	Univariable	Multivariable	Univariable	Multivariable	Univariable	Multivariable
Age (year)	0.95 (0.90–1.00)*	0.94 (0.88–0.99)*	0.98 (0.94–1.02)		0.95 (0.91–0.99)*	0.93 (0.89–0.98)*
Male gender	0.63 (0.23–1.77)		0.84 (0.37–1.95)		0.82 (0.35–1.91)	
Current smoker	1.26 (0.44–3.55)		1.06 (0.45–2.48)		1.20 (0.51–2.81)	
University or college education	5.90 (0.72–48.60)**		4.24 (1.23–14.63)*	5.77 (1.46–22.87)*	2.64 (0.84–8.26)**	
Working full-time	2.10 (0.67–6.56)		2.61 (1.07–6.34)*	2.70 (1.02–7.18)*	1.75 (0.74–4.12)**	2.77 (1.02–7.56)*
Leg pain duration (4wk)	0.97 (0.93–1.01)**		0.95 (0.89–1.01)**		0.98 (0.93–1.03)	
Straight leg raising <60°	1.03 (0.38–2.77)		0.97 (0.43–2.19)		1.41 (0.61–3.23)	
Muscle weakness (yes)	0.72 (0.20–2.41)		3.32 (1.12–9.81)*	4.11 (1.24–13.61)*	1.70 (0.58–4.97)	
Dermatomal sensory loss (yes)	1.22 (0.41–3.69)		1.02 (0.42–2.48)		0.79 (0.32–1.96)	
Reflex impairment (yes)	0.50 (0.18–1.40)**		0.40 (0.17–0.92)*	0.39 (0.15–0.97)*	0.90 (0.93–2.07)	
Body mass index (kg/m ²)	0.92 (0.81–1.04)**		1.04 (0.93–1.17)		1.04 (0.92–1.17)	
Concordance between nerve root impingement on MRI and clinical radiculopathy	0.63 (0.23–1.77)		1.04 (0.46–2.37)		0.93 (0.40–2.16)	
Modic type I and I/II (yes)	0.35 (0.12–1.05)**		0.68 (0.30–1.56)		0.72 (0.31–1.66)	
FABQW ≥34 at baseline	0.27 (0.09–0.85)*	0.16 (0.04–0.61)*	0.38 (0.13–1.07)**		0.34 (0.11–1.07)**	
FABQPA ≥15 at baseline	0.38 (0.14–1.07)**		0.44 (0.19–1.03)**		0.33 (0.14–0.81)*	0.31 (0.11–0.85)*

Odds ratio for successful outcome on ODI and VAS leg and back pain. 95% confidence interval in brackets.

*P < 0.05; **P < 0.20; wk = week.

a successful outcome. These prognostic factors may be used by clinicians to inform patients about the one-year prognosis of chronic unilateral lumbar radiculopathy. In addition, studies show that high fear avoidance can be reduced with cognitive intervention with the prospect of improved outcomes [45–47].

Prognostic research is aimed at using multiple variables to predict the outcome as accurately as possible [33]. Reviews show, however, that most previous studies suffer from methodological weaknesses, which may explain why consistent predictors have not been identified [17,18]. This implies a careful study design and use of multivariable analysis to determine adjusted and independent risk factors for different outcomes, often expressed as

probabilities or Odds Ratios. Few studies meet these requests. A single predictor or variable rarely gives an adequate estimate of prognosis.

Two recent studies have explored prognostic factors for outcome of radiculopathy using a multivariable approach. A Norwegian prospective observational multicentre cohort study used the Maine Seattle Back Questionnaire, which is equivalent to the ODI, as the primary outcome measure [7]. The authors used clearly defined cut-off values for non-success validated against the 7-point Likert scale of global perceived recovery. Another randomized controlled study comparing surgery versus prolonged conservative treatment used a similar method [48]. In these studies, the regression analyses were not adjusted

Table 4 ANOVA – difference in outcome scores between patients who did and did not undergo surgical decompression of lumbar spinal nerve root during follow-up

Back surgery during follow-up	Baseline score			Change score during follow-up			Follow-up score		
	ODI*	Leg pain*	Backpain*	ODI*	Leg pain*	Back pain*	ODI**	Leg pain**	Back pain**
Yes	40.4 (15.5)	70.8 (25.8)	64.1 (21.6)	34.2 (13.2)	56.0 (26.4)	49.8 (26.1)	9.7 (10.8)	18.5 (31.9)	17.5 (22.8)
No	28.4 (12.1)	47.6 (23.2)	45.1 (23.8)	11.7 (14.7)	23.5 (29.9)	13.2 (28.4)	16.3 (13.4)	23.6 (24.9)	29.1 (24.2)

Baseline, change and follow-up scores for ODI, VAS leg pain and VAS back pain. Numbers are mean with SD in brackets; P values are for the between group differences. *P < 0.05.

**Not significant.

for baseline pain scores. Unfortunately, differences in inclusion criteria and categorization of possible predictors complicate comparisons between these two studies and the present study, despite concurrent definitions of successful outcomes. Our study and the study of Lequin et al. [48] both identified lower age as a predictor for success, while other results were conflicting. Accordingly, further methodological standardization is necessary before predictors for the prognosis of sciatica can be validated across studies.

In addition to the main findings in our study, the presence of muscle weakness at baseline predicted a better outcome on the secondary outcome measure VAS leg pain, while the presence of reflex impairment predicted the contrary. The study by Haugen et al. [30] observed the same effect of reflex impairment, while muscle weakness predicted non-success in their study. Again, comparisons are difficult because in the study by Haugen et al., 44.5% of the patients had muscular weakness and 46.2% reduced reflexes at baseline, while the corresponding figures in our study were 81.0% and 47.4%, respectively. Obviously, the patient populations are not directly comparable despite similar inclusion criteria.

Surgically treated patients had more complaints at baseline and improved more during follow-up than those treated non-surgically, but after 52 weeks there were no differences in outcomes between the two groups. Those who had intolerable symptoms seem to benefit from surgery due to rapid pain relief. In previous studies, patients selected for surgery had more disability and pain (higher baseline scores) and more rapid decline of symptoms than those not operated on [49,50]. However, the outcomes at one-year follow-up were similar, which is in agreement with our findings [51,52].

It is a strength that we analysed multiple clinically relevant variables using a multivariable method. Our study is limited by a relatively small number of patients, which precluded explorative analysis of the effect of different combinations of predictors [53,54]. We chose to analyse 15 possible predictors, and thereby exceeded the generally accepted recommendation of a minimum of 10 events per tested predictor [50]. In our multivariable analyses, only 5–8 predictors were included. It is a weakness that this approach entails a risk for type 1 error.

Many previous prognostic studies of chronic radiculopathy have focused on patients encountered in primary care or at the surgical units. The present study deals with patients referred to outpatient multidisciplinary back clinics. Our results should not be generalized to surgical patient populations or to patients from unselected primary care.

Conclusions

We found that lower age, higher education, working full-time and low fear avoidance beliefs each predict a better

outcome of chronic unilateral lumbar radiculopathy. Specifically, lower age and low fear avoidance predict a better functional outcome and less back pain, while higher education and working full-time predict less leg pain. These results should be validated in further studies before being used to inform patients. Unfortunately, comparison with results from two other recent studies conducted with similar methods was difficult because of minor differences in inclusion criteria and categorization of possible predictors. Accordingly, rigorous standardization of the methodology is necessary for future studies before reliable predictors can be identified across studies.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

T Iversen contributed to the study design, data collection, data analysis, interpretation and writing of the manuscript. TKS, T Ingebrigtsen and TW contributed to the study design, data analysis, interpretation and writing of the manuscript. JIB and KW contributed to data analysis, interpretation and writing of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Appendix 3 Paper III

RESEARCH

Effect of caudal epidural steroid or saline injection in chronic lumbar radiculopathy: multicentre, blinded, randomised controlled trial

 OPEN ACCESS

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Abstract

Objective To assess the efficacy of caudal epidural steroid or saline injection in chronic lumbar radiculopathy in the short (6 weeks), intermediate (12 weeks), and long term (52 weeks).

Design Multicentre, blinded, randomised controlled trial.

Setting Outpatient multidisciplinary back clinics of five Norwegian hospitals.

Participants Between October 2005 and February 2009, 461 patients assessed for inclusion (presenting with lumbar radiculopathy >12 weeks). 328 patients excluded for cauda equina syndrome, severe paresis, severe pain, previous spinal injection or surgery, deformity, pregnancy, ongoing breast feeding, warfarin therapy, ongoing treatment with non-steroidal anti-inflammatory drugs, body mass index >30, poorly controlled psychiatric conditions with possible secondary gain, and severe comorbidity.

Interventions Subcutaneous sham injections of 2 mL 0.9% saline, caudal epidural injections of 30 mL 0.9% saline, and caudal epidural injections of 40 mg triamcinolone acetonide in 29 mL 0.9% saline. Participants received two injections with a two week interval.

Main outcome measures Primary: Oswestry disability index scores. Secondary: European quality of life measure, visual analogue scale scores for low back pain and for leg pain.

Results Power calculations required the inclusion of 41 patients per group. We did not allocate 17 of 133 eligible patients because their symptoms improved before randomisation. All groups improved after the interventions, but we found no statistical or clinical differences between the groups over time. For the sham group (n=40), estimated change in the Oswestry disability index from the adjusted baseline value was -4.7 (95% confidence intervals -0.6 to -8.8) at 6 weeks, -11.4

(-6.3 to -14.5) at 12 weeks, and -14.3 (-10.0 to -18.7) at 52 weeks. For the epidural saline intervention group (n=39) compared with the sham group, differences in primary outcome were -0.5 (-6.3 to 5.4) at 6 weeks, 1.4 (-4.5 to 7.2) at 12 weeks, and -1.9 (-8.0 to 4.3) at 52 weeks; for the epidural steroid group (n=37), corresponding differences were -2.9 (-8.7 to 3.0), 4.0 (-1.9 to 9.9), and 1.9 (-4.2 to 8.0). Analysis adjusted for duration of leg pain, back pain, and sick leave did not change this trend.

Conclusions Caudal epidural steroid or saline injections are not recommended for chronic lumbar radiculopathy.

Trial registration Current Controlled Trials ISRCTN No 12574253.

Introduction

Chronic lumbar radiculopathy is defined as a clinical syndrome of back and leg pain accompanied by sensory, reflex, or motor deficits in a nerve root distribution lasting for more than 12 weeks.¹⁻⁴ The lifetime prevalence of lumbar radiculopathy has been reported to be 5.3% in men and 3.7% in women.^{5,6} Lumbar radiculopathy due to a prolapsed disc resolves spontaneously in 23-48% of patients, but up to 30% will still have pronounced symptoms after one year, 20% will be out of work, and 5-15% will undergo surgery.⁷⁻¹⁰

Epidural steroid injections for lumbar radiculopathy have been used since 1953.¹¹ Along with mechanical compression of nerve roots, lumbar radiculopathy can be triggered by different proinflammatory chemical agents,¹²⁻¹⁵ causing ectopic neuron firing.¹⁶ Steroids injected into the epidural space or around the affected nerve root are thought to inhibit these inflammatory mediators. However, there is conflicting evidence for a potential

benefit of epidural steroid injections.¹⁷⁻²¹ Some studies have shown a moderate short term benefit,¹⁸⁻²⁵ whereas others have shown little difference between epidural steroid and placebo injections.²⁶⁻²⁸ Studies comparing epidural steroid injections with epidural saline or local anaesthetic injections have shown less benefit from steroids²⁶⁻²⁹⁻³⁰ than those comparing epidural steroid injections with sham or soft tissue injections.²²⁻²³⁻³¹⁻³² Furthermore, recent studies have concluded that epidural local anaesthetic or saline alone could have a positive effect by itself.³³⁻³⁴

At the one year follow-up after epidural steroid injection, improvement of pain and disability has been reported for 36% to 43% of the patients.²⁵⁻³⁵ However, this outcome does not differ greatly from the natural history of the disease.³⁶ The true effect of epidural steroid injections might be to reduce radicular pain before natural recovery occurs.³⁷ Despite the lack of evidence for long term efficacy, the use of epidural steroid injection in the United States increased from 553 to 2055 per 100 000 patients from 1994 to 2001.³⁸ In the United Kingdom, epidural steroid injection for lumbar radiculopathy was one of the most common therapeutic spine injection procedures in 2002-03.¹

We aimed to assess the effects of caudal epidural steroid and saline injections compared with subcutaneous sham injections in patients with chronic radiculopathy, by measuring improvements in physical function, health related quality of life, and pain at short term (6 weeks), intermediate term (12 weeks), and long term (52 weeks) follow-up.

Methods

We used a subcutaneous sham injection to control for the possible effect of a high volume saline injected into the epidural space, and we compared epidural steroid injections with epidural saline injections to clarify the effect of steroids.

Participants

We referred patients with lumbar radiculopathy from the catchment area of the University Hospital of North Norway, St Olavs University Hospital, Levanger Hospital, Nordland Hospital, and Buskerud Hospital (population 1 146 076). The general practitioners, neurosurgeons, orthopaedic surgeons, neurologists, manual physiotherapists, and chiropractors working in these areas were informed by letter about the trial.

The inclusion criteria included unilateral lumbar radiculopathy lasting for more than 12 weeks. The intensity of the leg pain, radiating from the back to below the knee, had to be comparable or worse than the back pain. We assessed eligible patients aged between 20 and 60 years consecutively for inclusion and obtained written informed consent. The clinical examination followed a prepared study template to decide whether the patient had a lumbar radiculopathy and to determine the most probable nerve root affected. Trained neurologists or specialists in physical medicine and rehabilitation in cooperation with a physiotherapist undertook the inclusion examinations. We excluded 328 patients presenting with a cauda equina syndrome, severe paresis, severe pain, history of spinal injection or surgery, deformity, pregnancy, ongoing breast feeding, warfarin therapy, ongoing treatment with non-steroidal anti-inflammatory drugs, body mass index of more than 30, poorly controlled psychiatric conditions with possible secondary gain, or severe comorbidity. Twenty four (7%) excluded patients underwent back surgery.

We did magnetic resonance imaging (n=110) or computed tomography (n=6) in all included patients. Experienced radiologists at each centre assessed the images and produced a

written report for the investigators. Inclusion in the trial was not dependent on the results from the magnetic resonance imaging and computed tomography. The results did not have to correspond with those from the clinical examination. To be included, the patients had to have clinically proved radiculopathy. We excluded patients who showed severe intraspinal pathology (large disc herniations occupying more than 50% of the spinal canal, spinal stenosis, tumours, bleeding, dural fistula, synovial cysts, or dysraphia).

Each patient completed self administered questionnaires including the outcome measures, which were identical at baseline and follow-up. The baseline questionnaires contained additional questions about demographics, education, duration of pain, work status, avoidance of movement owing to fear of pain, medication, and lifestyle issues. We also monitored clinical signs of lumbar radiculopathy, need for physiotherapy or surgery during follow-up, whether the patient perceived benefit of the intervention, beliefs about fear avoidance,³⁹ and working capability at each follow-up. All patients received standardised oral and written information about spine anatomy and function at baseline and follow-up. Patients were encouraged to engage in physical activity,⁴⁰⁻⁴³ and received an information brochure.⁴⁴ Patients using non-steroidal anti-inflammatory drugs were told to stop this medical treatment.

Randomisation

The clinical research centre at the University Hospital of North Norway used a computer generated block scheme for randomisation, stratified by intervention hospital. The centre was contacted by telephone on the day of intervention. The individuals undertaking the randomisation did not take any further part in the trial.

Outcomes

The Oswestry disability index was the primary outcome measure. The Oswestry disability index questionnaire contains 10 questions on limitations of activities to daily living. Each variable was rated on a 0-5 point scale, added up, and converted into a percentage functional score ranging from 0 to 100 (where 0=no disability).⁴⁵⁻⁴⁷

We assessed secondary outcome measures by the European quality of life measure, the visual analogue scale for low back pain, and the visual analogue scale for leg pain. The European quality of life measure is a generic and preference weighted measure of health related quality of life. It evaluates five dimensions: mobility, self care, activities of daily life, pain, and anxiety or depression. For each dimension, the patient describes three possible levels of problems (none, mild to moderate, and severe). This descriptive system contains 243 (35) combinations or index values for health states.⁴⁸ We used the value set from the main survey of the EuroQol group,⁴⁹ which has been validated for patients with lumbar radiculopathy.⁵⁰ Total score range is from -0.594 to 1, where 1 corresponds to perfect health and 0 to death. Negative values are considered to be worse than death.⁴⁸ The intensity of leg pain and low back pain was indicated on a horizontal 100 mm visual analogue scale (where 0=no pain).⁵⁰⁻⁵¹

Follow-up

A blinded physiotherapist and doctor followed up patients at 6, 12, and 52 weeks. Use of physiotherapy was recorded during follow-up, but was not routinely offered to the patients. During the study, surgeons independently assessed the need for surgical treatment among patients with increasing pain or paresis.

We used a global question on a four point Likert scale to measure the benefit of the intervention at each follow-up.⁵² The patients were asked: "What benefit of the treatment have you had?" The response alternatives were: "much", "some", "no benefit", and "I am worse". We recoded these variables into a dichotomous outcome with "much" and "some" benefit representing that the patients had benefited from the treatment.

Intervention

A standardised referral letter for the intervention contained information about the patient's cardiac and pulmonary status, medication, and allergies, but did not include information about back pain and radiculopathy. There were three intervention groups. Group 1 received subcutaneous sham injections of 2 mL 0.9% saline, superficial to the sacral hiatus and not into the spinal canal. Group 2 received caudal epidural injections of 30 mL 0.9% saline. Group 3 received caudal epidural injections of 40 mg triamcinolone acetonide in 29 mL 0.9% saline. All three intervention groups received two injections with a two week interval; the second injection was cancelled if spontaneous recovery had occurred between inclusion and the first intervention.

An experienced anaesthesiologist gave the injections and followed a set template.^{53 54} Anatomical landmarks were used to identify the sacral hiatus. In addition, use of an ultrasound machine (Honda Diagnostic Scanner HS-2000 Cine, Honda Electronics Co) capable of examining musculoskeletal tissues with a 10 MHz real time linear array ultrasound transducer increased the precision of the injections.⁵⁵⁻⁵⁷

Blinding

We ensured that the patients, outcome assessors, and care providers were blinded during the study period; they were all unaware of the randomisation and intervention given by the anaesthesiologists. The anaesthesiologist giving the injections was not blinded because inclusion of a subcutaneous sham group made this impossible.⁵⁸ The injection products were concealed from the patients, and the anaesthesiologists were instructed not to discuss the injection procedure or the products used with the patients.

Statistical analysis

We did sample size calculations for a multicentre multilevel longitudinal model with repeated measurements on the primary continuous outcome variable, the Oswestry disability index. The study was powered to detect an assumed clinically significant difference between one of the two injection groups and the sham group of 10 points on average over time. Based on a standard deviation of 18, a significance level of 5%, a power of 80%, and a correlation coefficient of 0.6 between the three follow-up measurements, the number of patients in each intervention group needed to be 37. Adjusting for losses to follow-up and withdrawals from the study, we set the minimum number of patients to be included in each group to be 41.

The analyses for all outcome measures used all available data on an intention to treat basis. We analysed all patients according to the group to which they were allocated, regardless of crossovers, surgery, withdrawal from the study, or loss to follow-up. In the analysis of outcomes in patients who withdrew or were lost to follow-up, we used the available data in the mixed model analysis. We analysed data with Stata 11.0 (StataCorp) and SPSS 17.0 (SPSS Inc).

Descriptive statistics were presented as means with standard deviations, means with confidence intervals, or numbers with

percentages. We assessed groups at baseline by analysis of variance for continuous variables and by Pearson χ^2 tests for categorical variables.

We used linear mixed models to assess differences in time trends between the treatment groups for the primary and secondary outcome measures.⁵⁹ We added time to the model as a categorical variable represented by dummy variables to analyse the differences between the groups at different time points. In all mixed model analyses, we made a crude adjustment for the baseline values of the particular outcome variable. In secondary analysis, we made additional adjustments for any duration of back pain, leg pain, and sick leave before inclusion. All tests were two sided using a significance level of 5%.

Results

Between October 2005 and February 2009, 461 patients were assessed for inclusion, and 133 were included in the study (48, University Hospital of North Norway; 20, Nordland Hospital; 26, Levanger Hospital; 27, St Olavs University Hospital; 12, Buskerud Hospital). Of the 328 excluded patients, three exclusions (1%) were because of intraspinal pathology and eight (2%) because of psychiatric conditions. Seventeen patients did not undergo randomisation because their symptoms improved between assessment and randomisation (fig 1). Therefore, we included 116 (25%) patients in the intention to treat analysis.

After randomisation, we excluded another five patients because of spontaneous improvement before the first injection (fig 1). We analysed 37 patients in the caudal epidural steroid group, 39 in the caudal epidural saline group, and 40 in the sham group (fig 1). We followed up 109 patients at 6 weeks, 105 at 12 weeks, and 99 at 52 weeks (table 1). We did not record any crossovers between the treatment groups. The distribution between treatment groups within each hospital was roughly equal, and adjustment for hospital did not change these results (table 2). Table 3 shows baseline characteristics of the study population. We did not detect any significant differences between treatment groups, except for a significantly higher rate of the presence of ankle tendon reflex difference among patients in the caudal epidural saline group.

The median interval between inclusion and randomisation to the first injection was 3 (range 0-17) weeks, and the median interval between the two injections was 3 (2-5) weeks. This variation was caused by logistical and patient related factors affected by long travelling distance in rural Norway. We did not detect any difference in median time interval between inclusion and randomisation between the groups. We registered no serious complications from the injections. Six (5%) patients experienced local pain during the first injection and declined the second injection, thereby discontinuing the intervention (fig 1). The treatment groups did not differ significantly for the primary and secondary outcomes. Figures 2-5 show the between group differences for the primary and secondary outcome variables from baseline to follow-up.

For both the primary and secondary outcome measures at 6, 12, and 52 week follow-up, we did not see any significant differences between the epidural injection groups and the sham group. Furthermore, the observed differences were not clinically important.⁶⁰ The estimated change in the Oswestry disability index from the adjusted baseline value for the sham group was -4.7 (95% confidence intervals -0.6 to -8.8) at 6 week follow-up, -11.4 (-6.3 to -14.5) at 12 weeks, and -14.3 (-10.0 to -18.7) at 52 weeks. The observed between group differences at 6, 12, and 52 week follow-up between the epidural injection groups and the sham group were not clinically important. These

results did not change after we adjusted for both the baseline scores and the duration of leg pain, low back pain, and sick leave (tables 4 and 5).

Ancillary analysis

Fear avoidance belief scores decreased significantly from baseline to the 52 week follow-up in all three groups ($P < 0.001$) but did not differ significantly between the groups (table 6). We did not find a significant reduction in the use of pain relief medication from baseline to the 6 week follow-up, nor did we record any significant difference between the intervention groups in the use of paracetamol ($P = 0.26$), non-steroidal anti-inflammatory drugs ($P = 0.45$), or morphine ($P = 0.70$) (table 7).

Between baseline and 52 week follow-up, we detected a significant reduction in patients receiving sickness benefit in the sham group ($P = 0.01$) but not in either of the epidural injection groups. However, there were no significant differences between the groups ($P = 0.61$). At the 52 week follow-up, 28 (28%) patients received sickness benefit: 7 (22%) in the sham group, 10 (30%) in the epidural saline group, and 11 (32%) in the epidural steroid group.

During follow-up, 41 (13%) patients had physiotherapy: 12 (11%) at 6 weeks, 18 (17%) at 12 weeks, and 11 (11%) at 52 weeks, with no significant differences between the groups ($P = 0.69$). Fifteen (15%) patients had back surgery at the 52 week follow-up: one (1%) in the epidural steroid group, six (6%) in the epidural saline group, and eight (8%) in the sham group, with no significant differences between the groups ($P = 0.07$).

At baseline, all patients had clinically verified lumbar radiculopathy (table 1). At 52 week follow-up, 27 (27%) patients still had a lumbar radiculopathy, with no significant differences seen between the groups ($P = 0.95$). At 52 week follow-up, 49 (50%) patients stated that they had received "much" or "some" benefit from the treatment, with no significant differences seen between the groups ($P = 0.81$).

Discussion

This randomised controlled trial compared caudal epidural steroid or saline injections with subcutaneous sham injections. The results confirm the null hypothesis that treatment of chronic lumbar radiculopathy with caudal epidural injection of steroids or isotonic saline has no clinically important effect. We did not find any significant differences between the treatment groups in need of physiotherapy or surgery and the patients receiving sickness benefit. We expected fear avoidance belief scores to be low at baseline and to fall during follow-up, because patients were informed about the favourable prognosis of the lumbar radiculopathy and were repeatedly encouraged to stay active.

Comparison with existing literature

There is conflicting evidence on whether epidural steroid injections are efficacious,⁶¹⁻⁶³ and if so, what volume, composition, or concentration of injection is best.^{29 33 64-70} Two randomised studies found that transforaminal steroid injections, which deposit the medication directly over the affected nerve roots, are more effective than caudal epidural steroid injections in the short term.^{63 71} We did not address this issue in our study.

Four randomised placebo controlled trials published between 1971 and 2009 with at least 12 months' follow-up, including between 23 and 183 participants, found no long term effect of caudal epidural steroid injections.^{29 30 32 33 72} One study showed

a positive effect of caudal epidural steroid injection.⁷² However, the reported effect size (change in Oswestry disability index score of 8.1 points) was smaller than what is considered to be the minimal clinically significant difference.⁴³

High volumes of epidural solutions have been thought to clear or dilute locally concentrated chemical irritants around the spinal nerve roots.^{29 72} In our study, the effect of a high volume, caudal epidural saline injection did not differ from a sham injection. Our results suggest that the effect attributed to isotonic saline probably reflects the spontaneous, natural course of lumbar radiculopathy.⁷³

Strengths and limitations

This multicentre randomised controlled study was designed to determine whether high volume, epidural saline injections alone or epidural saline injections in combination with epidural steroid could benefit patients with longstanding radiculopathy. The study population was homogeneous with low psychosocial strain. We carefully selected patients on the basis of clinical criteria and not on strict magnetic resonance imaging findings. This method accords with how epidural steroid injections are used in daily clinical practice, improving the external validity of our study. We used the caudal epidural injection technique with ultrasound guiding to improve the precision. However, we did not use contrast to visualise where the medication spread. The use of large volumes (30 mL) for the epidural injections ensured sufficient spread of the medication, reducing the need for radiography during the injection procedure.

Our power calculation required inclusion of 41 patients in each group to detect a 10 point between group difference for the primary outcome measure. We did not reach this goal because of rapid improvement in 17 patients between inclusion and randomisation. Therefore, the study was slightly underpowered, with four patients missing from the epidural steroid group, two from the epidural saline group, and one from the sham group. However, the study showed no trend towards any group difference after 12 months. We therefore consider it highly unlikely that a larger study population would have affected the results. Furthermore, the patients in our study had longstanding symptoms of radiculopathy (range 26-57 weeks), and our results might not be as relevant for patients with radiculopathy of shorter duration.

Low efficacy, under-dosage, and a dilution effect due to the high volumes injected could have influenced the effect of the caudal epidural steroid injection in our study. The most commonly used steroids for epidural injections are triamcinolone acetate, betamethasone, and methylprednisolone. One study compared triamcinolone and betamethasone and favoured triamcinolone.⁷⁴ When given in equivalent doses, the efficacy of these three steroids is generally considered to be comparable.²² In one study, researchers also used triamcinolone to compare the effect of lumbar epidural steroid injection with placebo.²² They gave three 80 mg injections over nine weeks (total dose 240 mg), whereas we used two 40 mg injections over two weeks (total dose 80 mg). The observed effects from the previous study did not differ from our results. It is therefore unlikely that we could have improved the treatment effects by using another steroid, or by increasing the dose of triamcinolone.⁷⁵

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What is already known on this topic

Clinical studies indicate that epidural steroid and saline injections might reduce pain due to acute lumbar radiculopathy in the short term, but the middle term and long term effects are unknown

What this study adds

Neither caudal epidural steroid injections nor caudal epidural saline injections are effective for chronic lumbar radiculopathy and are not recommended as an adjunct to recovery in patients whose symptoms have extended beyond 12 weeks

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Data sharing: Technical appendix, statistical code, and dataset are available from the corresponding author.

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Tables

Table 1| Number (%) of patients at follow-up, by randomisation group

Follow-up	Sham group (n=40)	Caudal epidural saline group (n=39)	Caudal epidural steroid group (n=37)	Total no (n=116)
6 weeks	37 (93)	35 (90)	37 (100)	109 (94)
12 weeks	36 (90)	35 (90)	34 (92)	105 (91)
52 weeks	32 (80)	33 (85)	34 (92)	99 (85)

Table 2| Number of patients at follow-up, by randomisation group

Follow-up hospital/week	Sham group	Caudal epidural saline group	Caudal epidural steroid group	Total no
University Hospital of North Norway				
6	15	10	13	38
12	14	10	12	36
52	13	9	12	34
Nordland Hospital				
6	8	10	8	26
12	6	6	6	18
52	6	6	5	17
Levanger Hospital				
6	8	10	8	26
12	7	10	6	23
52	6	10	7	23
St Olavs University Hospital				
6	5	7	7	19
12	5	6	7	19
52	5	5	7	17
Buskerud Hospital				
6	3	3	3	9
12	4	3	3	13
52	2	3	3	5

Table 3| Baseline characteristics of study population with chronic lumbar radiculopathy

	Sham group (n=40)	Caudal epidural saline group (n=39)	Caudal epidural steroid group (n=37)
Mean (SD) age (years)	42.8 (9.2)	42.8 (11.6)	40.1 (10.0)
Male sex	24 (60)	24 (62)	20 (54)
Mean (SD) body mass index (kg/m ²)	26.0 (3.3)	26.1 (3.6)	26.7 (4.5)
Physically demanding work	19 (47)	18 (46)	21 (57)
Received sickness benefit*	22 (55)	26 (67)	25 (68)
Mean (SD) duration of sick leave (weeks)	14.0 (32.8)	21.3 (32.7)	20.1 (37.6)
Mean (SD) duration of leg pain (weeks)	26.7 (22.4)	57.1 (158.0)	42.5 (62.6)
Mean (SD) duration of back pain (weeks)	46.6 (86.3)	63.1 (157.8)	50.4 (64.3)
Use of analgesics			
Paracetamol	13 (33)	9 (23)	11 (30)
NSAID	6 (15)	4 (10)	10 (27)
Morphine	6 (15)	7 (18)	9 (24)
Positive straight leg raising test†	21 (53)	23 (59)	18 (49)
Dermatomal sensory loss	31 (78)	23 (59)	29 (78)
Dermatomal muscle weakness	31 (78)	31 (80)	32 (87)
Knee tendon reflex difference	6 (15)	9 (23)	6 (16)
Ankle tendon reflex difference‡	13 (33)	24 (62)	10 (27)
Clinically suspected level of lumbar radiculopathy			
L2-L3	–	–	1 (3)
L3-L4	3 (8)	2 (5)	2 (5)
L4-L5	12 (30)	11 (28)	14 (38)
L5-S1	25 (63)	26 (67)	20 (54)
MRI or CT findings			
Normal	–	1 (3)	–
Disc protrusion	1 (3)	–	–
Disc herniation	24 (60)	23 (59)	26 (70)
Disc sequestration	14 (35)	14 (36)	11 (30)
Recess stenosis	1 (3)	1 (3)	–
Mean (95% CI) FABQ work	21.6 (17.9 to 25.3)	25.0 (21.9 to 28.1)	23.5 (20.5 to 26.5)
Mean (95% CI) FABQ physical activity	13.0 (11.3 to 14.7)	13.5 (12.1 to 14.9)	11.9 (10.2 to 13.6)
Mean (95% CI) Oswestry disability index	26.3 (22.0 to 30.6)	31.4 (26.9 to 35.9)	32.5 (28.6 to 36.4)
Mean (95% CI) EQ5D	0.54 (0.47 to 0.56)	0.46 (0.35 to 0.56)	0.54 (0.45 to 0.62)
Mean (95% CI) VAS leg pain	48.3 (39.6 to 56.9)	53.5 (45.6 to 61.3)	50.1 (42.5 to 57.7)
Mean (95% CI) VAS back pain	46.3 (39.2 to 54.1)	49.6 (40.3 to 58.2)	46.8 (39.0 to 54.6)

Data are number (%) unless stated otherwise. SD=standard deviation; CI=confidence intervals; NSAID=non-steroidal anti-inflammatory drug; MRI=magnetic resonance imaging; CT=computer tomography; FABQ=fear avoidance beliefs questionnaire; EQ5D=European quality of life measure; VAS=visual analogue scale.

*On full or partial sick leave, government funded rehabilitation, or disability pension.

†When radiating leg pain >60° elevated leg.

‡P=0.004 difference.

Table 4| Estimated differences in Oswestry disability index score between epidural injection groups and sham group at follow-up

	Difference (95% confidence intervals) at follow-up		
	6 weeks	12 weeks	52 weeks
Crude analysis*			
Epidural saline injection	-0.5 (-6.3 to 5.4)	1.4 (-4.5 to 7.2)	-1.9 (-8.0 to 4.3)
Epidural steroid injection	-2.9 (-8.7 to 3.0)	4.0 (-1.9 to 9.9)	1.9 (-4.2 to 8.0)
Adjusted analysis†			
Epidural saline injection	-0.6 (-6.6 to 5.4)	1.5 (-4.5 to 7.5)	-2.6 (-8.9 to 3.6)
Epidural steroid injection	-3.2 (-9.1 to 2.7)	3.7 (-2.3 to 9.7)	1.7 (-4.5 to 7.8)

Data based on mixed model analysis with sham group as reference.

*Analysis adjusted for baseline values.

†Analysis adjusted for duration of leg pain, back pain, and sick leave.

Table 5| Estimated differences in secondary outcome measures between epidural injection groups and sham group at follow-up

	Difference (95% confidence intervals) at follow-up		
	6 weeks	12 weeks	52 weeks
Leg pain			
Crude analysis*			
Epidural saline injection	3.2 (-9.1 to 15.5)	2.5 (-9.6 to 14.6)	3.1 (-9.6 to 15.8)
Epidural steroid injection	-1.3 (-13.3 to 10.7)	11.2 (-1.0 to 23.4)	-0.2 (-12.9 to 12.5)
Adjusted analysis†			
Epidural saline injection	2.7 (-9.8 to 15.2)	1.7 (-10.7 to 14.0)	0.5 (-12.4 to 13.4)
Epidural steroid injection	-2.6 (-14.6 to 9.4)	10.0 (-2.2 to 22.3)	-1.4 (-14.1 to 11.4)
Low back pain			
Crude analysis*			
Epidural saline injection	-5.0 (-16.7 to 6.7)	-7.8 (-19.3 to 3.8)	-2.0 (-14.3 to 10.2)
Epidural steroid injection	-4.8 (-16.2 to 6.6)	6.6 (-5.0 to 18.2)	0.0 (-12.1 to 12.2)
Adjusted analysis†			
Epidural saline injection	-6.9 (-18.8 to 5.1)	-9.3 (-21.2 to 2.5)	-4.1 (-16.5 to 8.4)
Epidural steroid injection	-6.4 (-17.9 to 5.1)	5.1 (-6.5 to 16.8)	-1.4 (-13.6 to 10.8)
European quality of life measure			
Crude analysis*			
Epidural saline injection	-0.02 (-0.13 to 0.09)	-0.05 (-0.17 to 0.06)	-0.01 (-0.12 to 0.11)
Epidural steroid injection	-0.05 (-0.16 to 0.06)	-0.12 (-0.23 to -0.00)	-0.05 (-0.17 to 0.06)
Adjusted analysis†			
Epidural saline injection	-0.01 (-0.13 to 0.10)	-0.05 (-0.16 to 0.06)	0.01 (-1.06 to 0.13)
Epidural steroid injection	-0.04 (-0.15 to 0.07)	-0.11 (0.22 to 0.00)	-0.05 (-1.62 to 0.07)

Data based on mixed model analysis with sham group as reference.

*Analysis adjusted for baseline values.

†Analysis adjusted for duration of leg pain, back pain, and sick leave.

Table 6| Estimated differences in fear avoidance beliefs between epidural injection groups and sham group at follow-up

Analysis	Difference (95% confidence intervals) at follow-up		
	6 weeks	12 weeks	52 weeks
FABQ regarding physical activity			
Epidural saline injection	-0.24 (-2.69 to 2.21)	-2.10 (-4.66 to -4.5)	-0.24 (-2.69 to 2.21)
Epidural steroid injection	0.60 (-1.84 to 3.03)	-0.67 (-3.22 to 1.87)	0.60 (-1.84 to 3.03)
FABQ regarding work			
Epidural saline injection	0.72 (-3.10 to 4.55)	0.47 (-3.51 to 4.44)	0.72 (-3.10 to 4.55)
Epidural steroid injection	2.31 (-1.48 to 6.11)	2.40 (-1.55 to 6.34)	2.31 (-1.48 to 6.11)

FABQ=fear avoidance beliefs questionnaire. Data based on mixed model analysis with sham group as reference.

Table 7| Use of pain relief medication at 6 week follow-up

Drug	Sham group	Caudal epidural saline group	Caudal epidural steroid group
Paracetamol	9 (24.3)	7 (20.0)	9 (24.3)
Non-steroidal anti-inflammatory drugs	2 (5.4)	4 (11.4)	6 (16.2)
Morphine	4 (10.8)	6 (17.1)	3 (8.1)

Data are number (%) of patients.

Figures

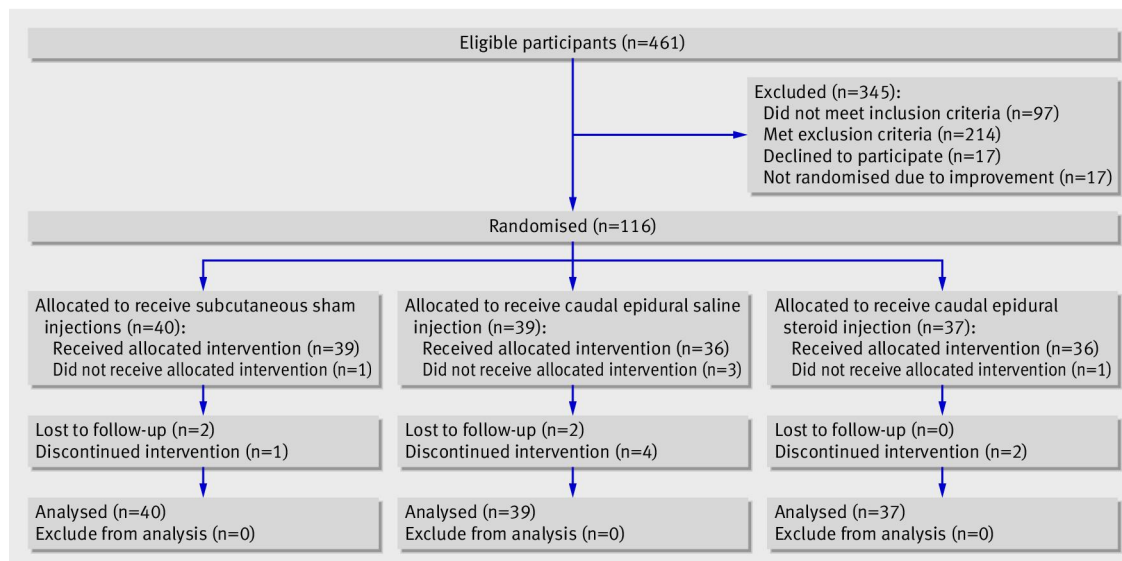


Fig 1 Flow of participants in study

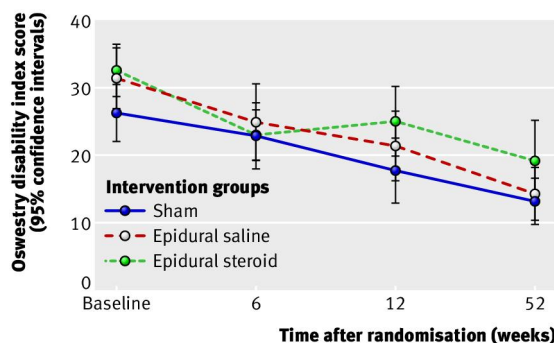


Fig 2 Mean Oswestry disability index score at follow-up

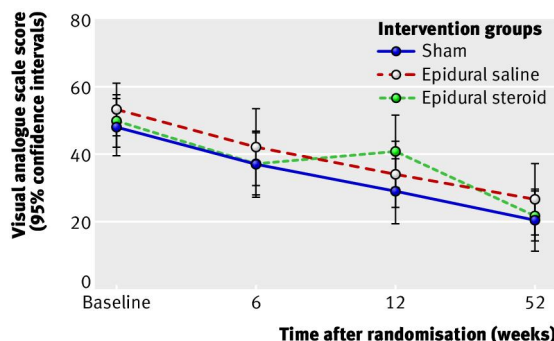


Fig 3 Mean visual analogue scale score for leg pain at follow-up

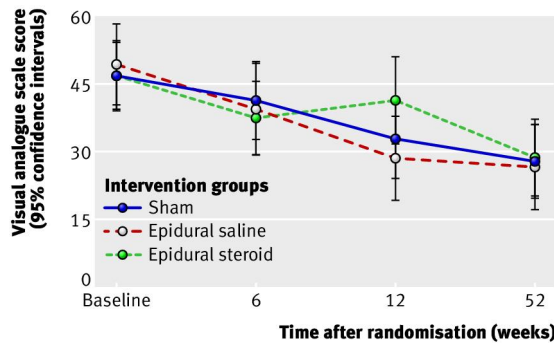


Fig 4 Mean visual analogue scale score for back pain at follow-up

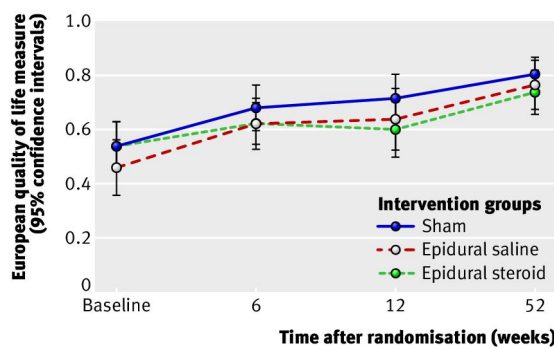


Fig 5 Repeated measurement of mean score for European quality of life measure

Appendix 4 Investigator's brochure

PROSEDYREBOK

Epidural sacral injection study.

Effect of volume and triamcinolone on chronic
lumbosacral radiculopathy?

Double blind multicentre randomised placebo-controlled trial.

Prosjektleder:

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Epidural sacral injection study

Prosedyrebok

Ryggundersøkelse

Selection and withdrawal of subjects.

Inclusion criteria based on medical history and clinical examination.

1. Patients aged 20 – 60 years old, of both sexes.
2. Duration of radicular symptoms \geq 12 weeks (chronic pain).
3. Clinically proven radiculopathy at nerve root L3, L4, L5 or S1. The radiculopathy may be unilateral/bilateral on the same level, or unilateral/bilateral on one or more levels at the same time.
4. Body Mass Index (BMI) $<$ 30.

Exclusion criteria based on medical history and clinical examination.

1. Indication of acute back surgery at the time of inclusion. To determine whether acute surgery is indicated, the guidelines drawn up by the Neurosurgery Department, UNN are followed (Solberg, 2000).
2. Previous back surgery.
3. Previous epidural or nerve root injection for low back pain or sciatica.
4. Red Flags (Rheumatic inflammatory disease, Malignant disease, Diabetes mellitus, Severe and uncompensated cardiovascular disease, Known autoimmune disease, Currently known infection, Haemophilia, Some other type of disease that affects the coagulation system)
5. Yellow Flags (Known severe mental disease, Known problems with alcohol or substance abuse)
6. The patient must not have noticed an improvement in symptoms for the previous two weeks before inclusion.

The person investigating the patient for the first time asks the following question:

Epidural sacral injection study, Inklusjons- og eksklusjonskriterier

“Have you got better over the past two weeks?” (Yes/No)

If the patient answers *Yes* to this question, the individual in question is excluded.

7. Nor must the patient have experienced centralisation of the pain, i.e. the pain has moved from the lower extremity towards the middle of the back, as this is regarded as a clinical sign of an already ongoing spontaneous improvement in the patient's condition (Lisi, 2001).

The person investigating the patient for the first time asks the following question:

“Over the past two weeks, have you experienced a shift in the pain from severe leg pain to severe pain in your back?” (Yes/No).

If the patient answers *Yes* to this question, the individual in question is excluded.

8. Women of childbearing age are asked about pregnancy and breast feeding.

HCG in urine are tested.

The person investigating the patient for the first time asks the following question:

“Are you pregnant or giving breast feeding?” (Yes/No)

If the patient answers *Yes* to this question, the individual in question is excluded.

9. Anticlotting therapy.

The person investigating the patient for the first time asks the following question:

“Are you taking Warfarin (Marevan)?” (Yes/No)

If the patient answers *Yes* to this question, the person in question is excluded.

Use of ASA is not an exclusion criterion (Horlocker et al 2002).

10. Ongoing drug treatment with Non-Steroidal-Anti-Inflammatory-Drug (NSAID).

The person investigating the patient for the first time asks the following question:

“Can you come off the NSAID?” (Yes/No)

If the patient answers *No* to this question, the individual in question is excluded.

Epidural sacral injection study, Inklusjons- og eksklusjonskriterier

Exclusion criteria based on MR findings.

The physician who conducts the inclusion check must, after the clinical examination is completed, assess the MR response provided by the radiologist for the patient. If, based on the radiologist's description, a *Yes* answer is given to one or more of the findings listed below, the patient must be excluded. If the MR description does not provide a basis for answering *Yes* or *No* to the questions, the radiologist who has described the scans must be contacted and asked to clarify his description.

- Lateral recess stenosis of osteogenic aetiology (Yes/No?)
- Tumour (Yes/No?).
- Bleeding (Yes/No?).
- Dural fistula (Yes/No?).
- Synovial cyst (Yes/No?).
- Dysraphia conditions (Yes/No?).

Written informed consent.

The patients in question, who are demonstrated as having a lumbosacral radiculopathy and fulfill the inclusion criteria and no exclusion criteria, provide written informed consent if they wish to take part in the study (Written informed consent).

Back information for patients included. The good back consultation.

All patients included who have given written informed consent to take part in the study are given a standardised oral information on back anatomy and back function with the emphasis on management and encouragement to engage in activity (Hagen et al 2003, Storheim et al 2003, Skouen et al 2002, Brox et al 2003, Mayo Clinic Health Information 2004). The

Epidural sacral injection study, Inklusjons- og eksklusjonskriterier

information are given by the doctor and physiotherapist conducting the inclusion check. A recently published study shows that back information alone can be just as effective in treating low back pain as standard physiotherapy treatment (Frost et al, 2004). In the back consultation that the doctor conducts with the patient, the Norwegian national guidelines as set out in “Acute low back pain. Interdisciplinary, clinical guidelines” (The Norwegian Back Pain Network, The Communication Unit, 2002a) and the European Guidelines for the management of chronic non-specific low back pain (COST B13 Working Group on Guidelines for Chronic Low Back pain 2004) are followed, with a special focus on the recommendations concerning “The good back consultation”. All patients included also receive the brochure “Worth knowing about bad backs. What experts agree on” (The Norwegian Back Pain Network, The Communication Unit, 2002b) after the inclusion check and back consultation have been conducted.

Recording use of medication.

1. The patient records his consumption of medication over one week before the first injection is performed. The names of the medicinal products, their strength and the number of tablets taken are recorded by the patient.
2. After the second injection is administered, the patient is asked to record his consumption of pain-killing medication in the same way over one week before the agreed checkups.
3. The consumption of each drug will be calculated with defined daily doses as a measurement unit and classified and presented by therapeutic group according to the anatomical therapeutic chemical system (Brox et al, 2003).

Kliniske undersøkelsen for å bestemme nivå nerverotaffeksjon

1. Forekomst av nevrologiske utfall registreres, og det utføres en klinisk diagnostikk hvor det bestemmes hvilket skivenivå nerverotaffeksjonen utgår fra. I undersøkelsene følges prinsippene for nivådiagnostikk i Conesa og Argote (1976), Hoppenfeld (1997) og Ombregt et al (2003).
2. Ved undersøkelsene utføres SLR (Strait Leg Raise) (Deville et al 2000, Thelander et al 1992, Kosteljanetz 1988, Xin et al 1987), og gradtall for eventuell positiv test (der pasienten angir smerteutstråling distalt for knehasen) registreres. L3 nervestrekktest utføres med pasienten i mageleie og fleksjon i kneleddet, smerteutstråling noteres.
3. Muskelkraften graderes fra 0-5 der 0 = total paralyse, 3 = at muskelen kan bevege leddet mot tyngdekraften, men ikke mot ekstra motstand, 5 = normal kraft.
4. De myotatiske refleksene graderes fra 0 - +++++, der + er moderat svekket refleks, ++ indikerer normalt refleksutslag, +++ forøket refleks og +++++ klonisk refleks.
5. Overfladisk sensibilitet undersøkes med henblikk på berøringssans, smerte – og temperatursans. Forekomst av eventuelt radikulært sensibilitetsutfall registreres.
6. ”Registreringsskjema for pasienter som injiseres i ryggen” (Modifisert etter Nevrokirurgisk avdeling, UNN) fylles ut før injeksjonsbehandlingen.
7. ”Registreringsskjema ved kontroll etter rygginjeksjon” (Modifisert etter Nevrokirurgisk avdeling, UNN) fylles ut ved kontrollene.
8. Disse skjemaene inneholder opplysninger om alder, kjønn, sykehistorie, symptomvarighet, kliniske funn, eventuelle komplikasjoner, sosioøkonomisk status, sykmelding og trygdeforhold.
9. Pasientene svarer ved inklusjon og ved hver oppfølgingsundersøkelse på et livskvalitetsskjema EuroQol-5D (EQ-5D) (Luo et al 2003, Hurst et al 1997, Burstrom et al 2001) og et symptom- og funksjonskåreskjema (Oswestry Low Back Pain

Disability Questionnaire) (Hagg et al 2003, Niskanen 2002, Little 1994) og de avgir på tre ulike VAS (Visual Analog Scale) grad av smerter i rygg og hofte (VAS rygg), grad av smerter i ben (VAS ben) og nåværende helsetilstand (VAS generell helse) (Carragee, 2001). Waddells Fear-Avoidance Beliefs Questionnaire (FABQ) fylles ut ved inklusjon og ved oppfølgingsundersøkelsene. Det avsettes tid på poliklinikken for pasientene til å fylle ut disse skjemaene. Dersom de trenger hjelp til å forstå spørsmålene får de råd og veiledning.

10. Livskvalitetskjemaet (EQ-5D), symptom- og funksjonskåreskjemaet (ODI) og VAS skalaene inngår i et spesialdesignet spørreskjema som er validert for bruk i Norge. Skjemaet vi bruker i studien er modifisert etter ”Spørreskjema for pasienter som skal opereres i ryggen” og ”Spørreskjema for pasienter etter ryggoperasjon”, Nevrokirurgisk avdeling, UNN.
11. Pasienter som ikke møter til etterkontroll får tilsendt et tilpasset spørreskjema i posten hvor både EQ-5D, ODI og VAS rygg/hofte, ben og generell helse inngår (Modifisert etter ”Spørreskjema for pasienter etter ryggoperasjon, Besvares per brev av pasienten”, Nevrokirurgisk avdeling UNN).
12. I forbindelse med oppfølgingsundersøkelsene får pasientene anledning til å gi uttrykk for misnøye eller fornøydhet med behandlingen.
13. Pasientene svarer også ved hver undersøkelse på følgende spørsmål;
”Får du for tiden noen annen type behandling for dine ryggplager?” (Ja/Nei)
14. De pasientene som svarer Ja på spørsmålet i punkt 13 blir anmodet om å angi type behandling eventuelt medikament type og dose.
15. De pasienter som etter at injeksjonene er utført har vedvarende sterke smerter og/eller neurologiske utfall, henvises tilbake til den legen som inkluderte pasienten som i sin

Epidural sacral injection study, Klinisk undersøkelse beskrevet

tur eventuelt viderehenviser til ortoped eller nevrokirurg for å avklare om det foreligger indikasjon for ryggoperasjon (Borenstein et al 2001, Komori et al 2002).

16. Pasienter som eventuelt blir ryggoperert fortsetter oppfølgingen i studien (intention to treat).

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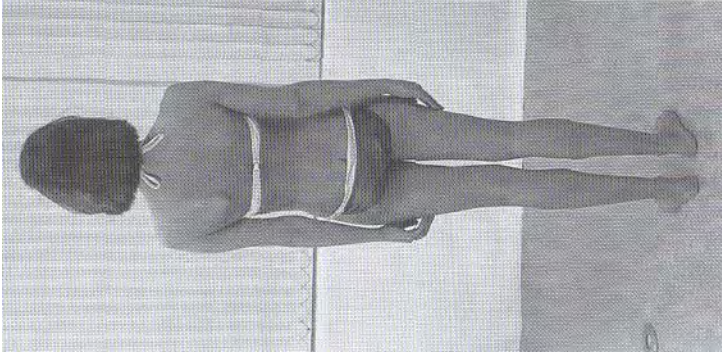
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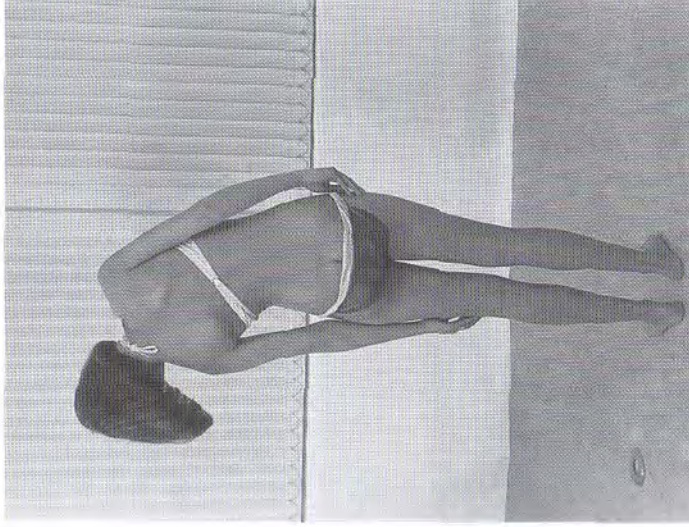
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EXTENSION

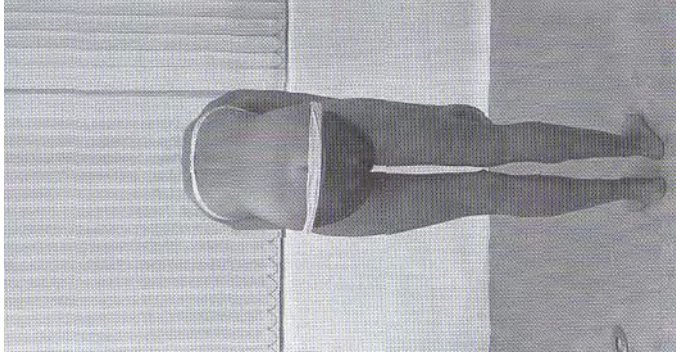
- Painful limitation: Large protrusion, Small protrusion+spondylosis, Spinal stenosis+spondylosis, Serious disease
- Painless limitation: Spondylosis, Long-standing ankylosing spondylitis, Vertebral hyperostosis
- Pain at full range: Small protrusion, Ligamentous lesion, Capsular lesion, Sacroiliac joint lesion, Hip joint lesion
- Deviation: Strong suggestion of disc protrusion



SIDE FLEXION

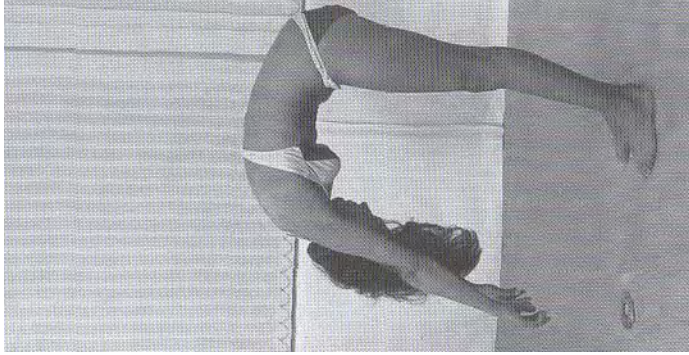
- Painful limitation of both side flexion movements: Serious disease, Ankylosing spondylitis
- Painless limitation of both side flexion movements: Spondylosis, Advance osteoporosis, Osteitis deformans
- Painful limitation of one side flexion movement: Large disc protrusion L4, Serious extra-articular lesion
- Pain at full range: Small disc protrusion, Minor fracture, Sprained ligament, Capsular lesion, Muscular lesion
- Painful arc: Disc lesion

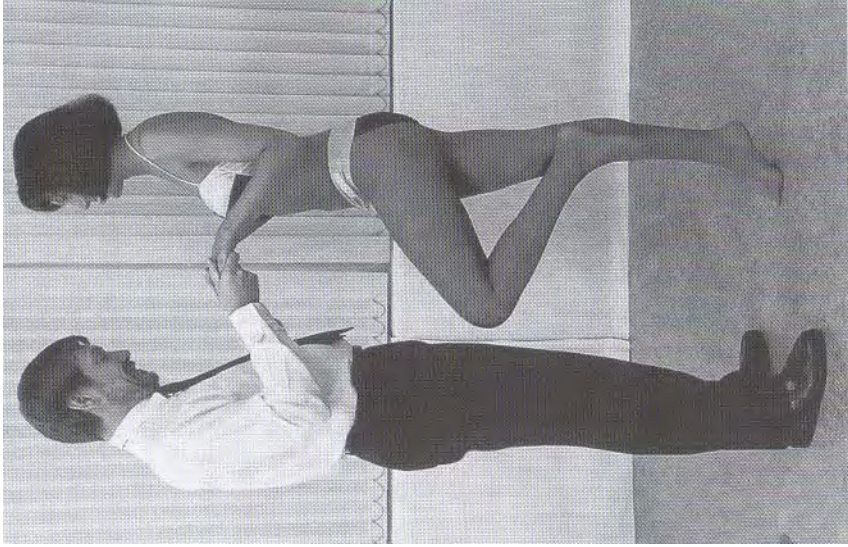




FLEXION

- Painful limitation: Large disc protrusion, Serious disease (+ limitation of both side bending movements), Major lesion at the buttock
- Painless limitation: Spondylosis
- Pain at full range: Small disc protrusion, Sprained ligament, Capsular lesion, Injured muscle, Sacroiliac joint lesion, Minor lesion at the buttock, Hip joint lesion
- Painful arc: Disc protrusion
- Deviation: Large disc protrusion, Large intraspinal lesion





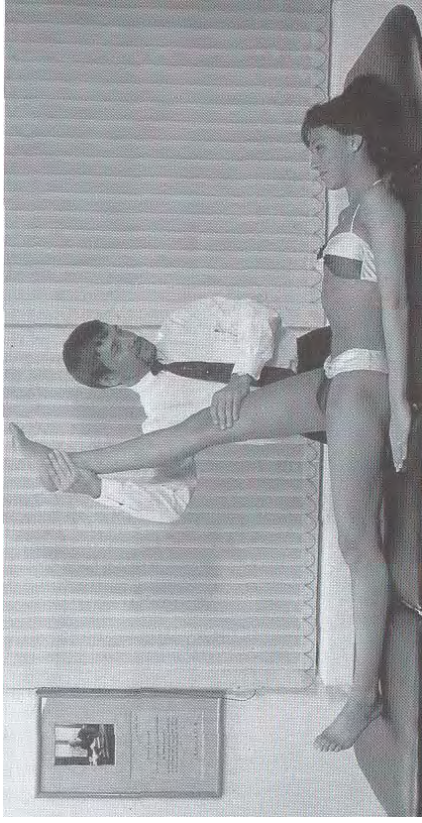
RISING ON TIPTOE

Examines the strength of the calf muscles and thus the integrity of the S1/S2 segment



SACROILLIAC JOINT

Distraction test: In a positive test, a deep-seated unilateral ache is evoked at the gluteal and/or posterior crural area



POSITIVE STRAIGHT LEG RAISING (SLR/LASEGUE)

Intraspinal lesions: Discogenic (Protrusion),
Non-discogenic (tumor, neuroma)

Extraspinal lesions: Sacroiliac joint lesions,
major lesions at the buttock, major lesions at the
hip joint, lesions of the hamstring muscle belly,
non-organic disorders



STAGES IN THE SLR (L4-S2)

Full and painless

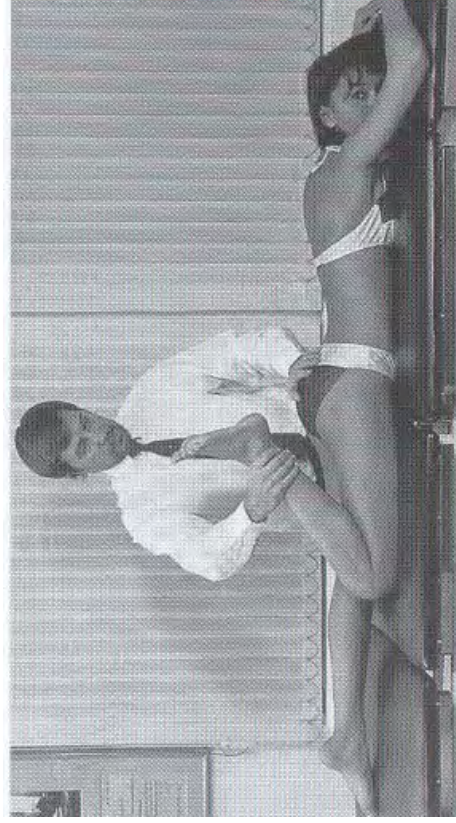
Pain on full range

Painful arc

Painful and limited without neurological deficit

Painful and limited with neurological deficit

Full and painless with neurological deficit



PASSIVE KNEE FLEXION

Test the mobility of the third lumbar nerve root.
Pain is felt in the back and/or the anterior part of the
upper leg, depending on whether the test provokes a
Discordural or a discoradicular interaction.

Ombregt (2003)

SIX STAGES IN THE SLR CAN BE DISTINGUISHED AND EACH USED AS A CRITERION TO ASCERTAIN THE SIZE OF THE PROTRUSION

Full and painless: This does not exclude disc protrusions. In the supine position these may be too small to make contact with the dura or the dural sleeve and thus these structures can move freely.

Pain on full range: A small protrusion is likely.

Painful arc: Suggestive of a small protrusion. The dura or nerve root slips over the protrusion.

Painful and limited without neurological deficit: The protrusion is larger, limiting the mobility of the dura or the dural sleeve of one of the lower lumbar or upper sacral nerve roots.

Painful and limited with neurological deficit: A large posterolateral protrusion is compressing a nerve root, impairing mobility and conduction. The severity of the palsy takes over from SLR as the criterion of the degree of interference.

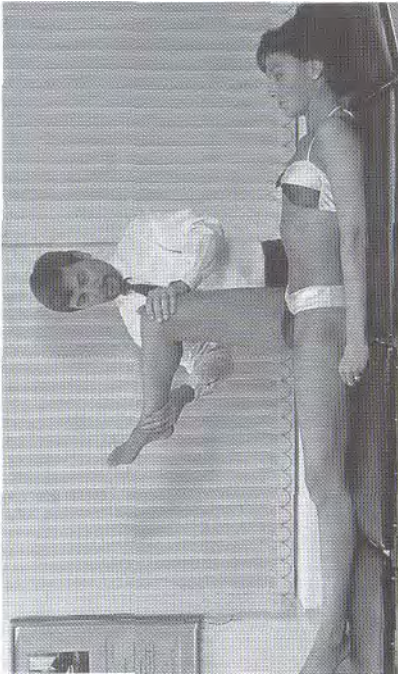
Full and painless with neurological deficit: A large posterolateral protrusion has become maximal, compressing the Nerve root so intensively that it has become ischaemic and atrophies.

FLEXION



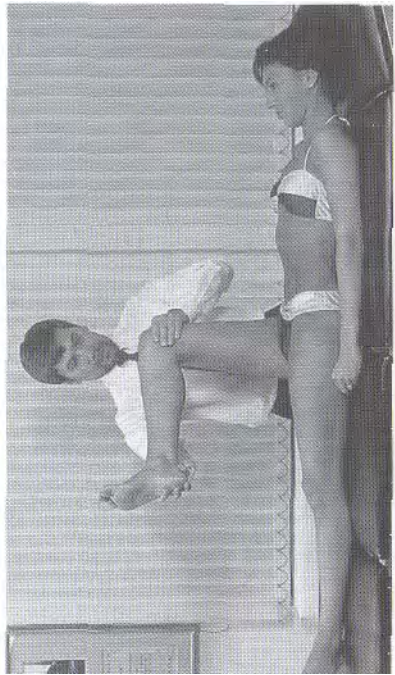
(a)

MEDIAL ROTATION



(b)

LATERAL ROTATION



(c)

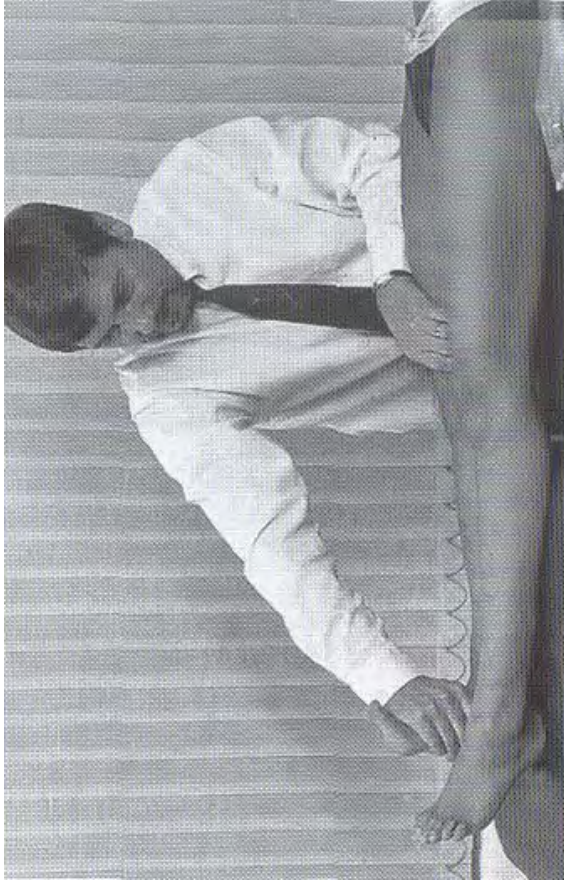
RESISTED FLEXION OF THE HIP JOINT

L2
L3



RESISTED DORSIFLEXION OF FOOT

L4





RESISTED DORSIFLEXION OF THE BIG TOE

L4
L5

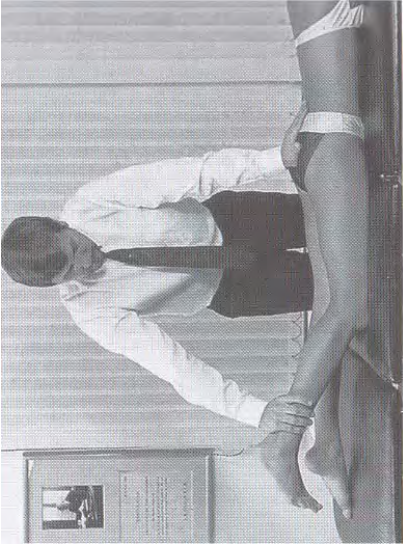


RESISTED EVERSION OF THE FOOT

L5
S1

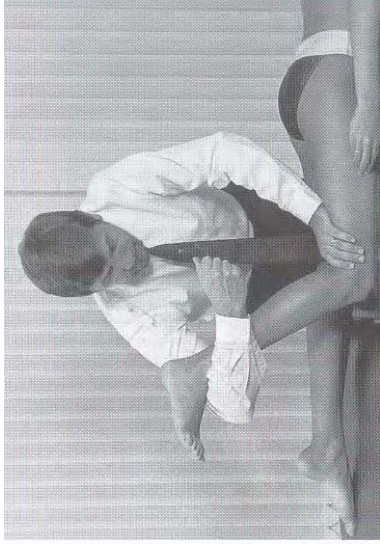
RESISTED FLEXION OF THE KNEE

S1
S2



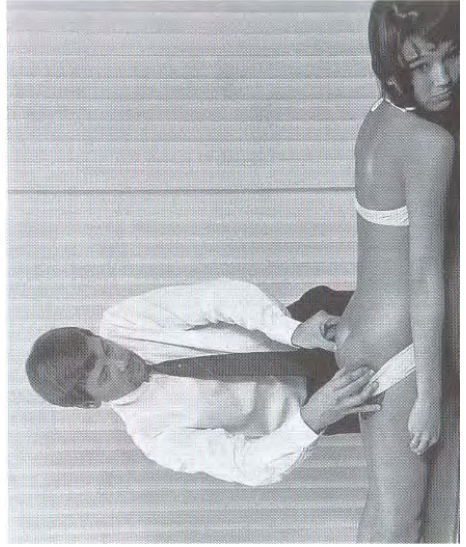
RESISTED EXTENSION OF THE KNEE

L3



CONTRACTION OF BUTTOCK MUSCLES

S1
S2



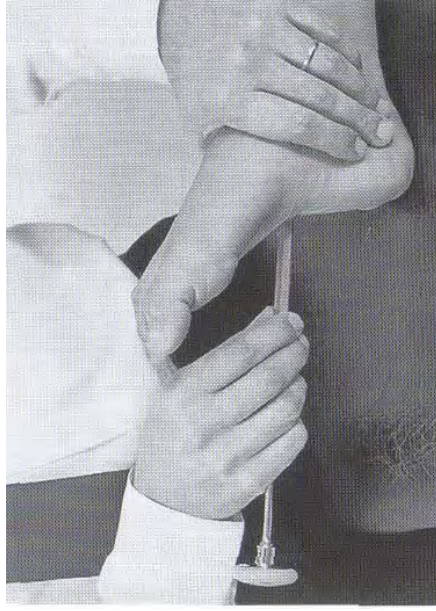
KNEE REFLEX

L3



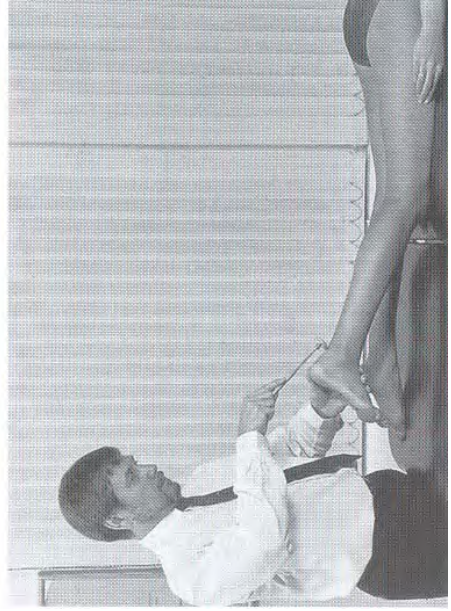
PLANTAR REFLEX

Spinal cord



ANKLE REFLEX

L5
S1
S2



Ombregt (2003)



TESTING FOR SENSORY CONDUCTION

L2: Front of the thigh.

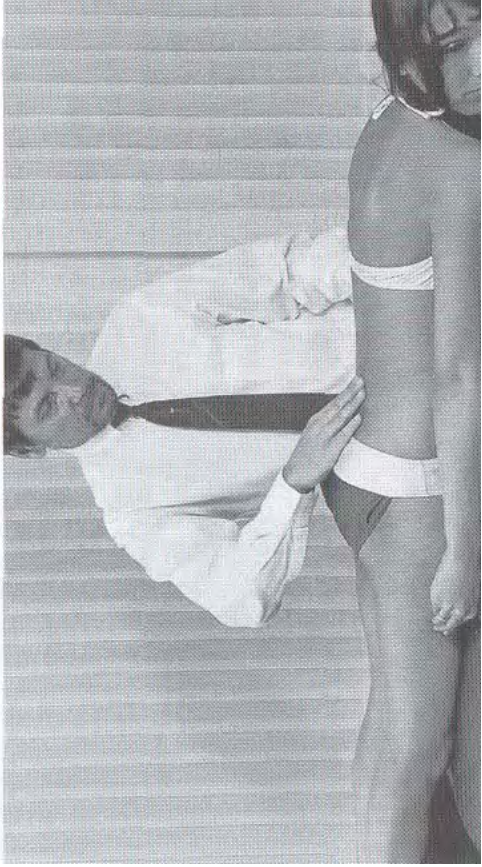
L3: Front and inner side of lower leg to just above the foot.

L4: Big toe alone.

L5: Big toe and two adjacent toes.

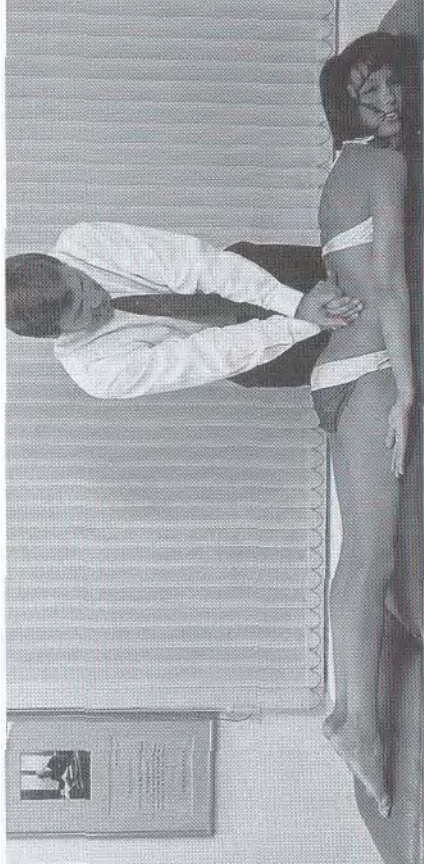
S1: Outer border of the foot, together with the two outer toes.

S2: Sole of the heel.



PALPATION

Lumbar spinous processes to detect irregularities or a shelf between L4-L5 (indicating spondylolisthesis)



EXTENSION PRESSURE

To detect the level of the lesion, note at which level pain and muscle guarding are most provoked and the end-feel (normal elastic, hard in ankylosing spondylitis)

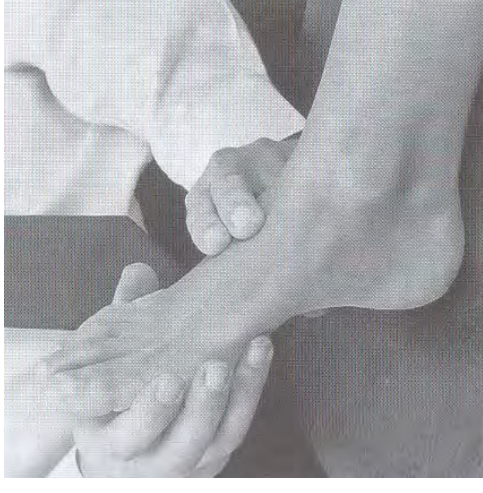
FEMORAL ARTERY



POSTERIOR TIBIAL ARTERY



DORSALIS PEDIS ARTERY

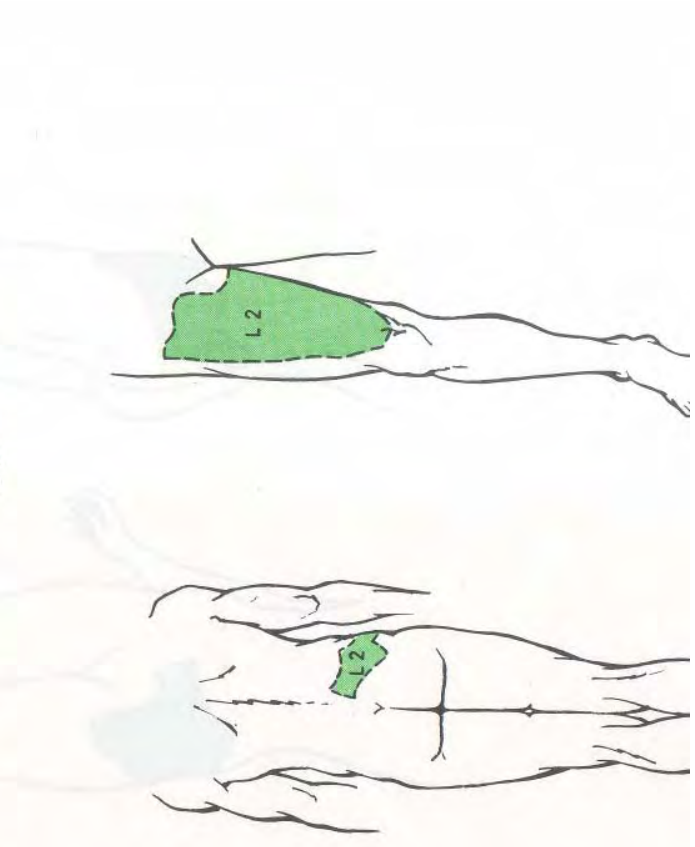


Ombregt (2003)



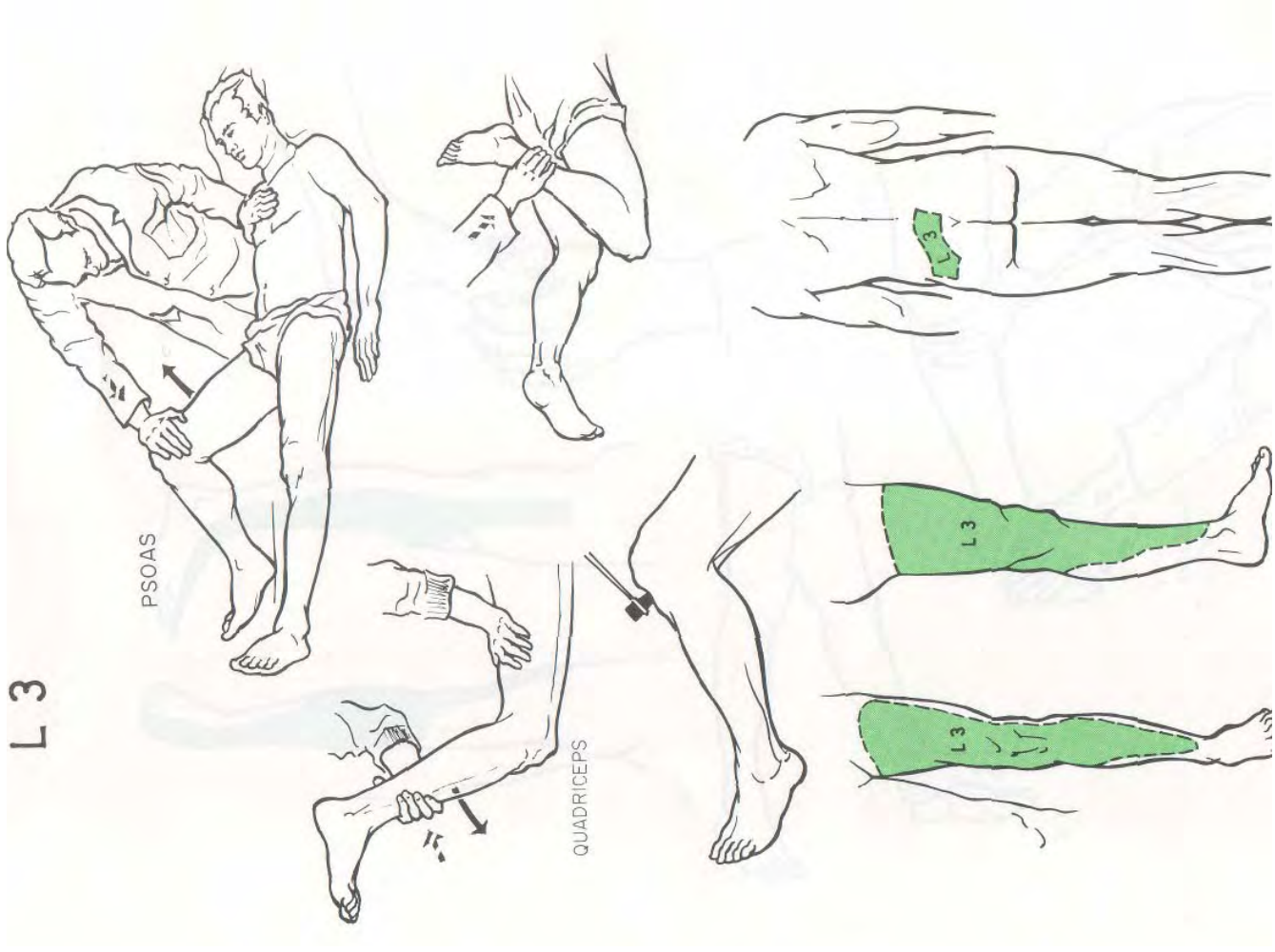
Conesa (1976)

L 2



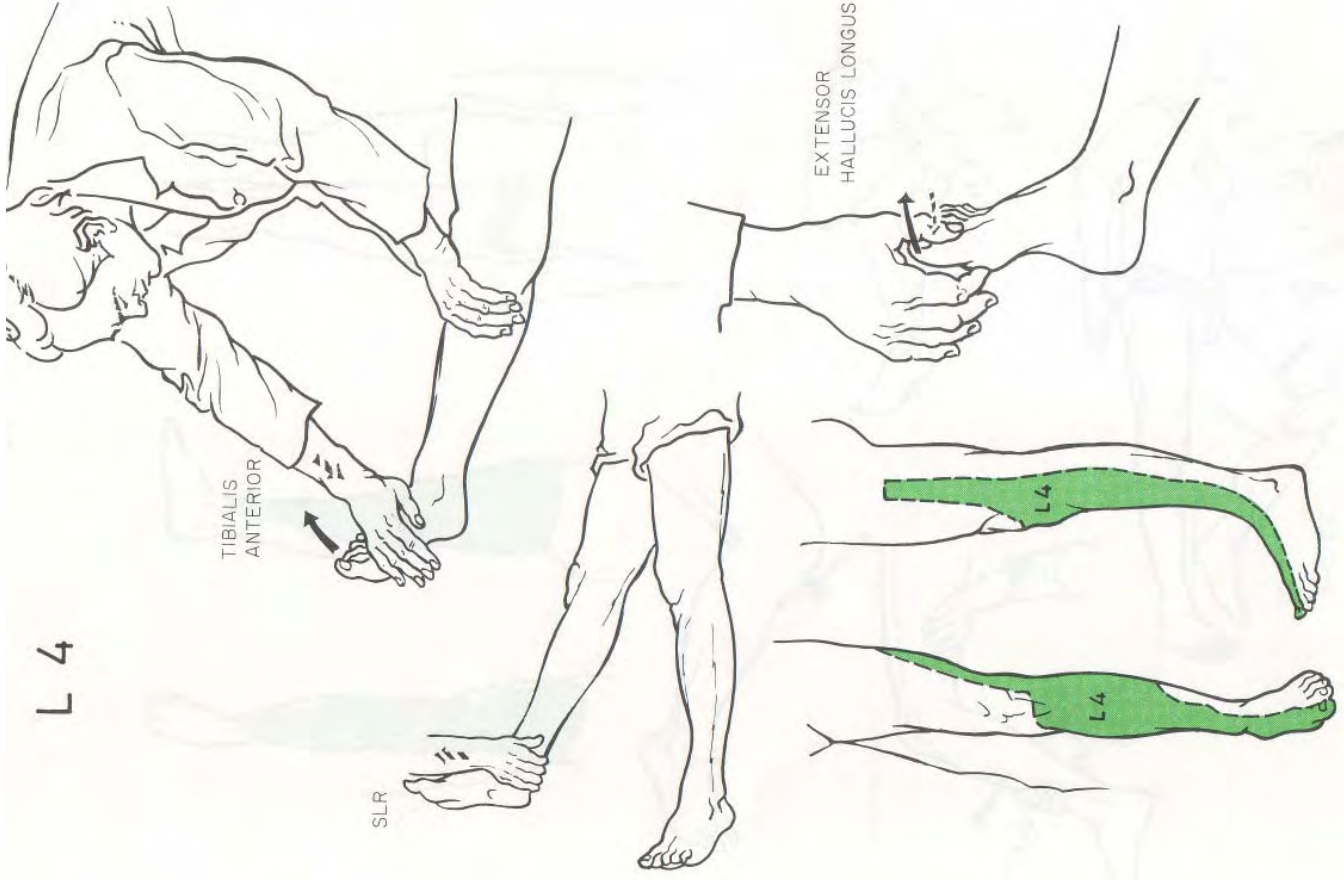
Conesa (1976)

L 3



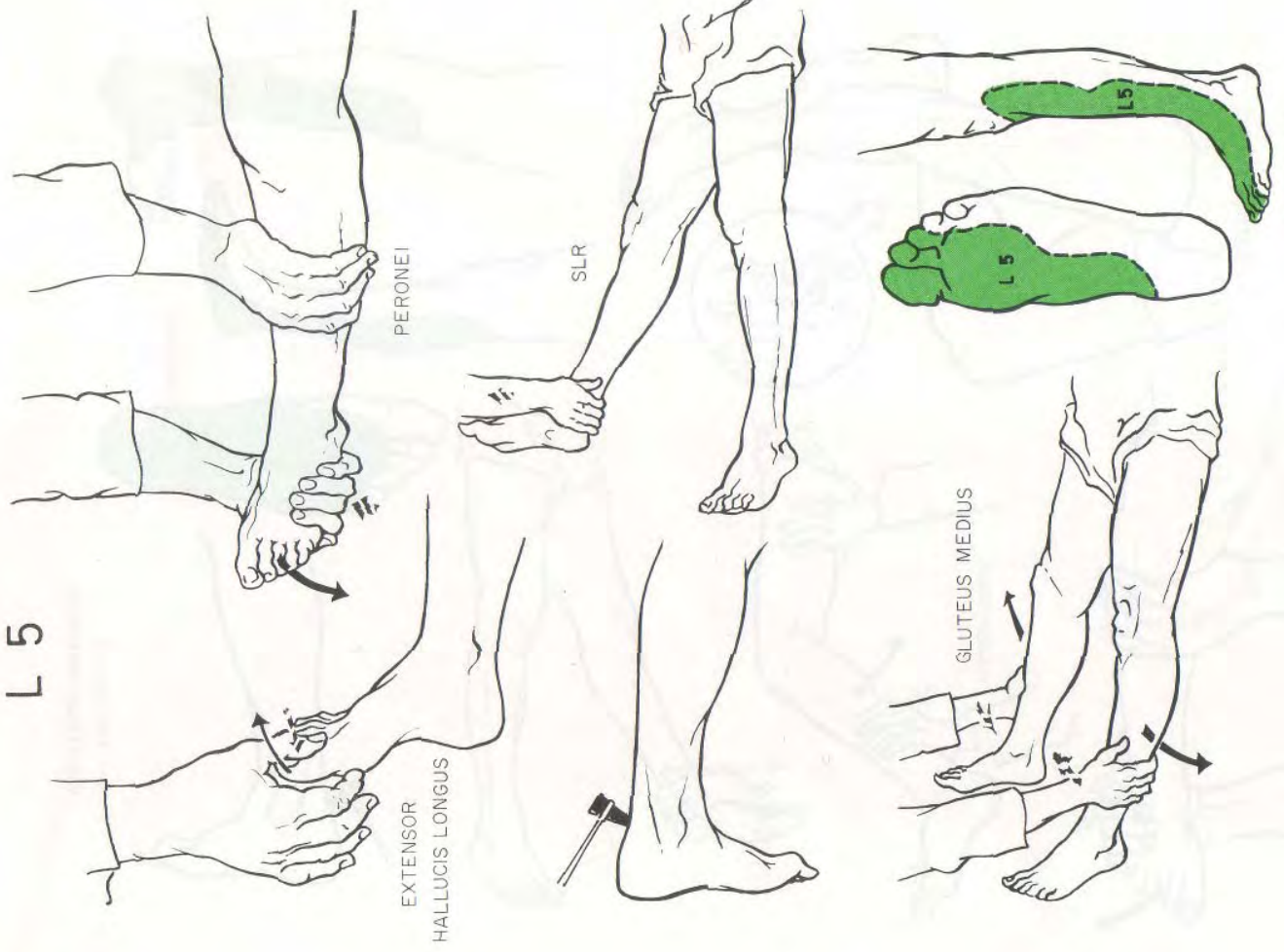
Conesa (1976)

L 4



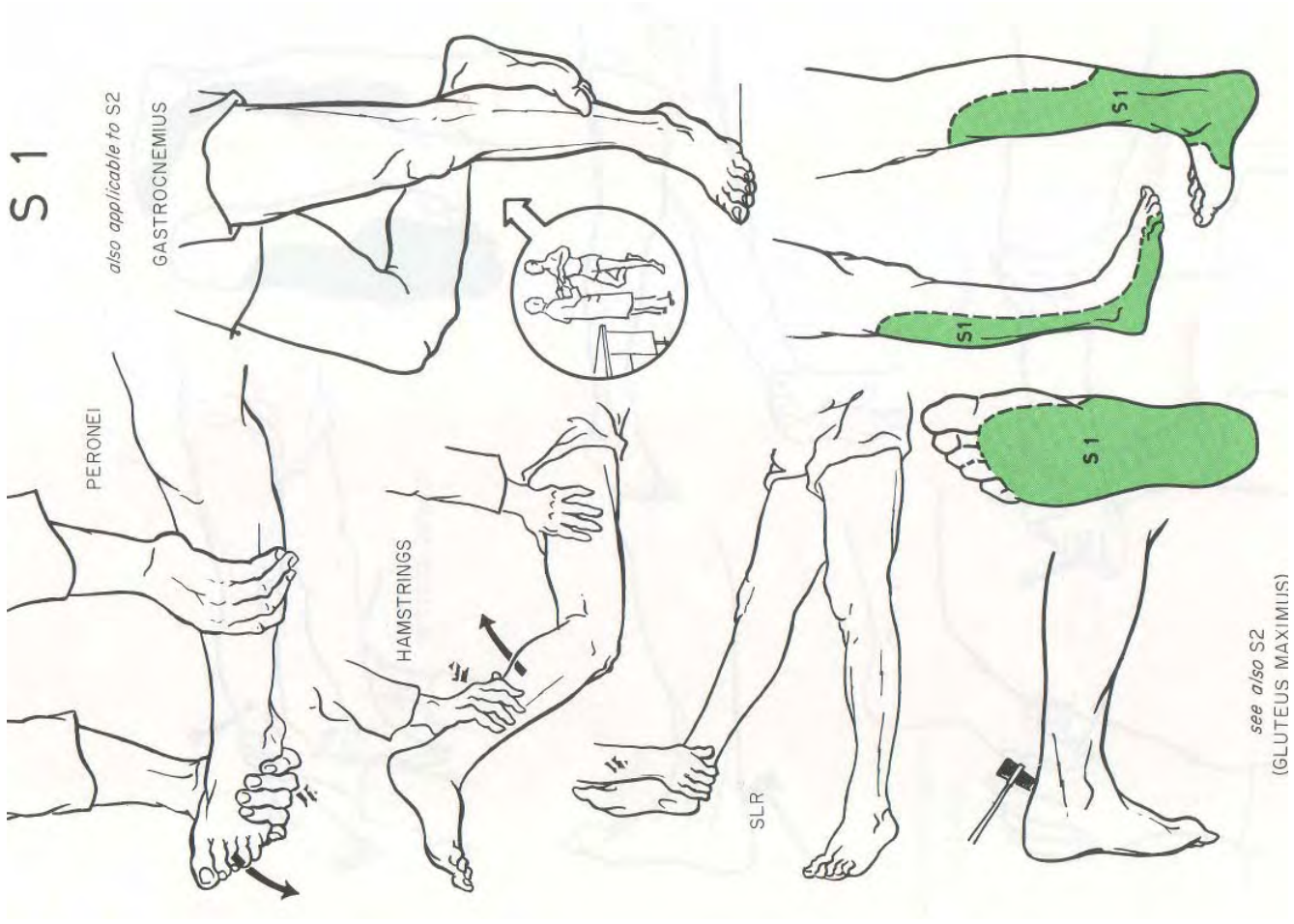
Conesa (1976)

L 5



Conesa (1976)

S1



PERONEI

also applicable to S2

GASTROCNEMIUS

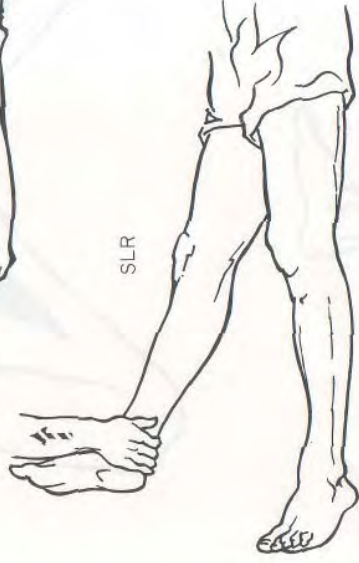
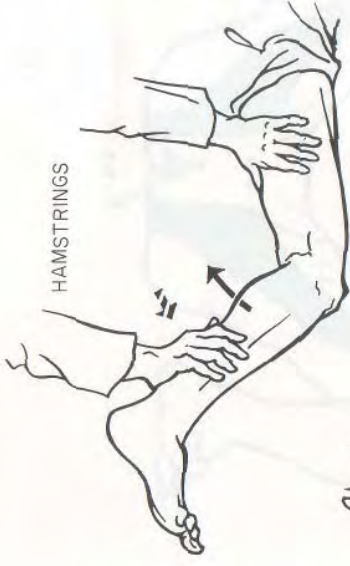
HAMSTRINGS

SLR

see also S2
(GLUTEUS MAXIMUS)

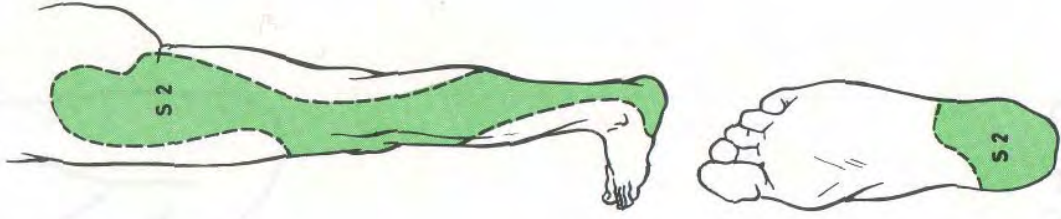
Conesa (1976)

S 2



also applicable to SI

(GASTROCNEMIUS)
see also SI

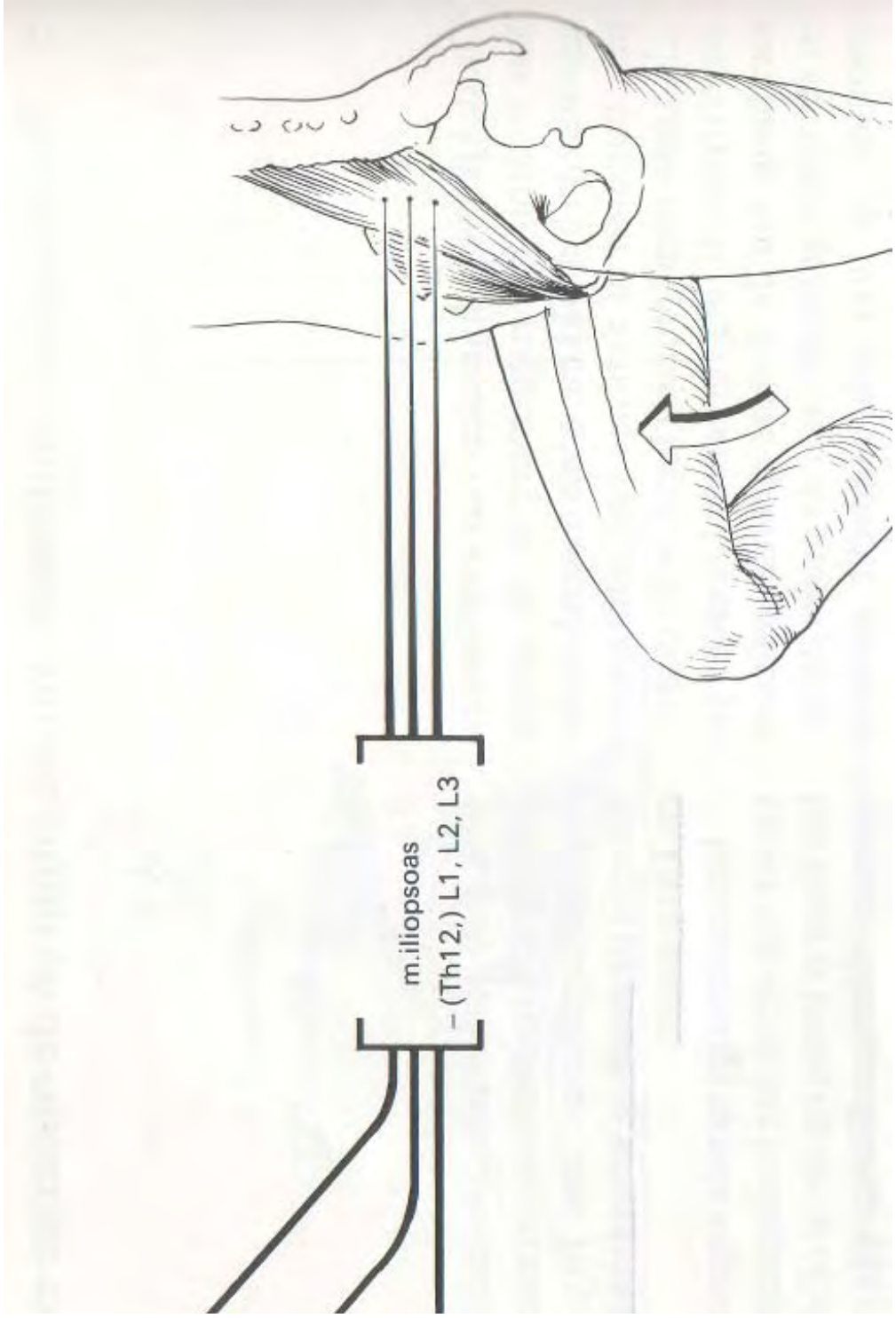


Conesa (1976)

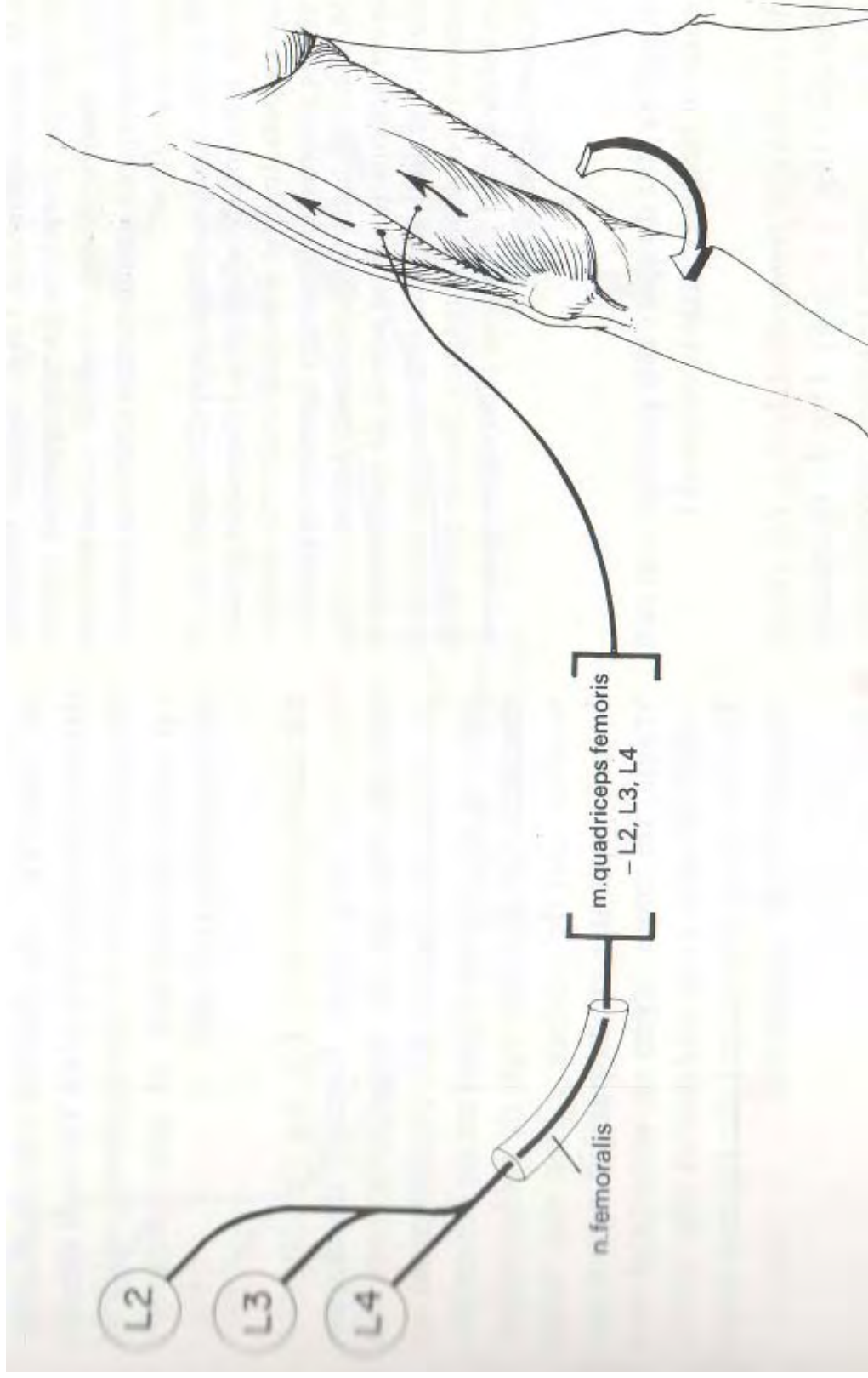
S 3,4, 5



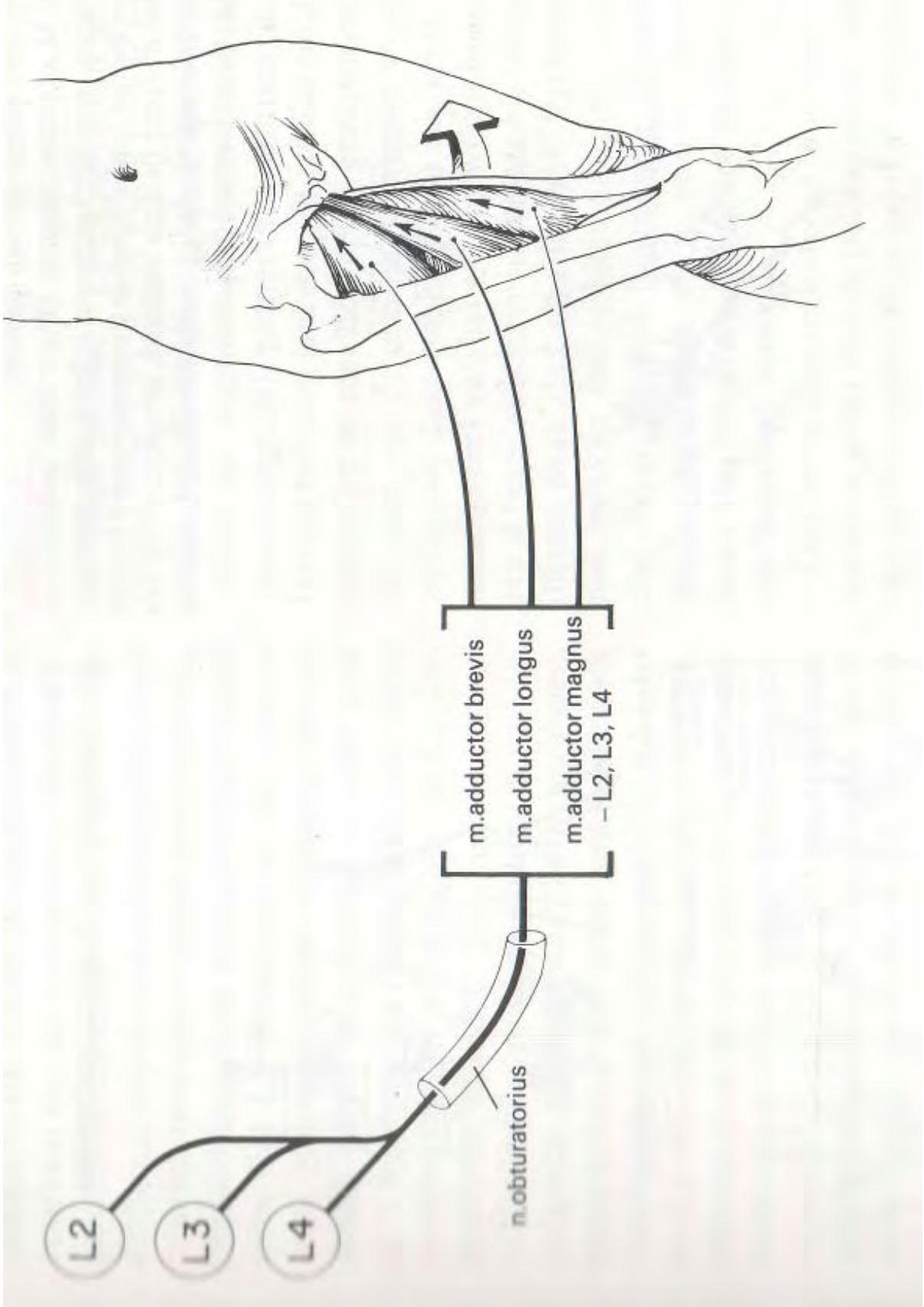
Conesa (1976)



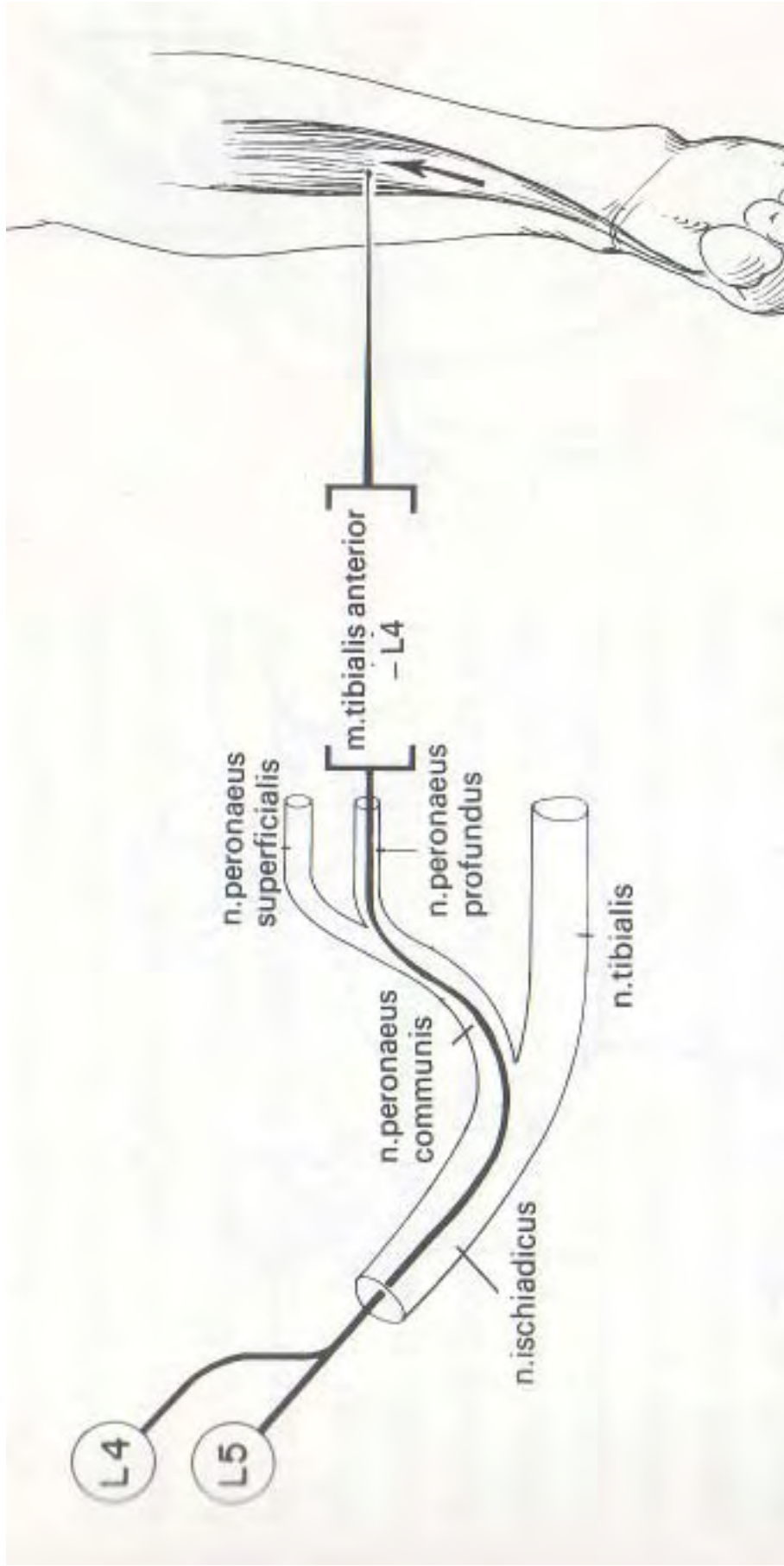
Hoppenfeld (1997)



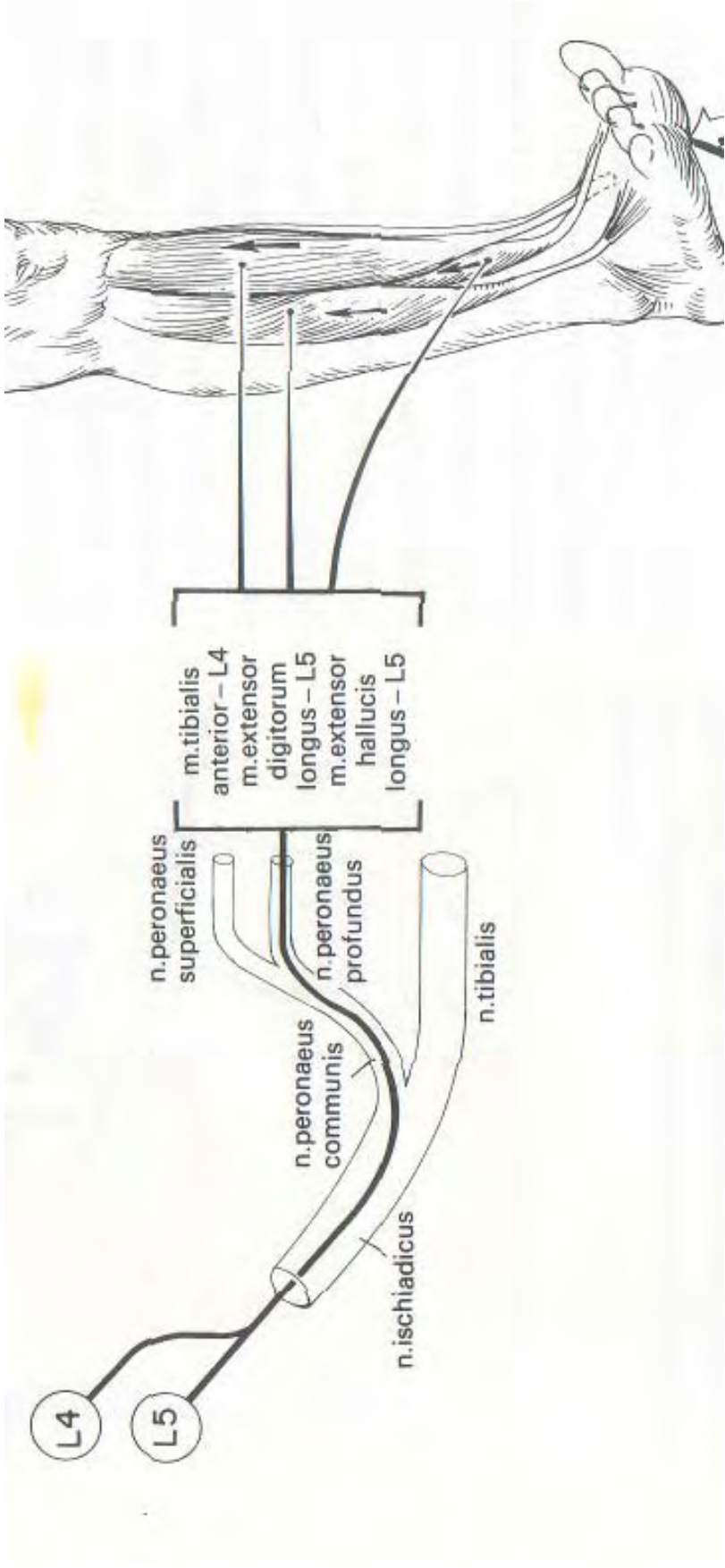
Hoppenfeld (1997)



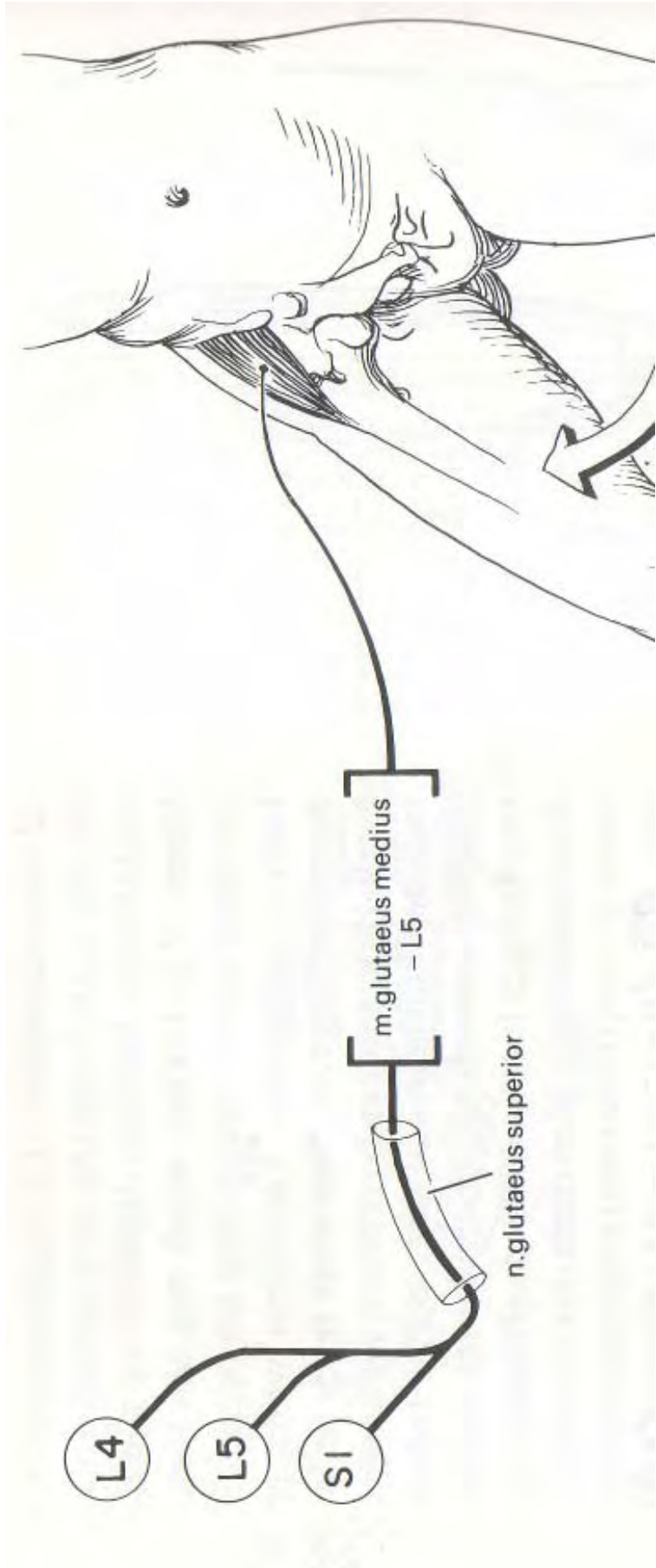
Hoppenfeld (1997)



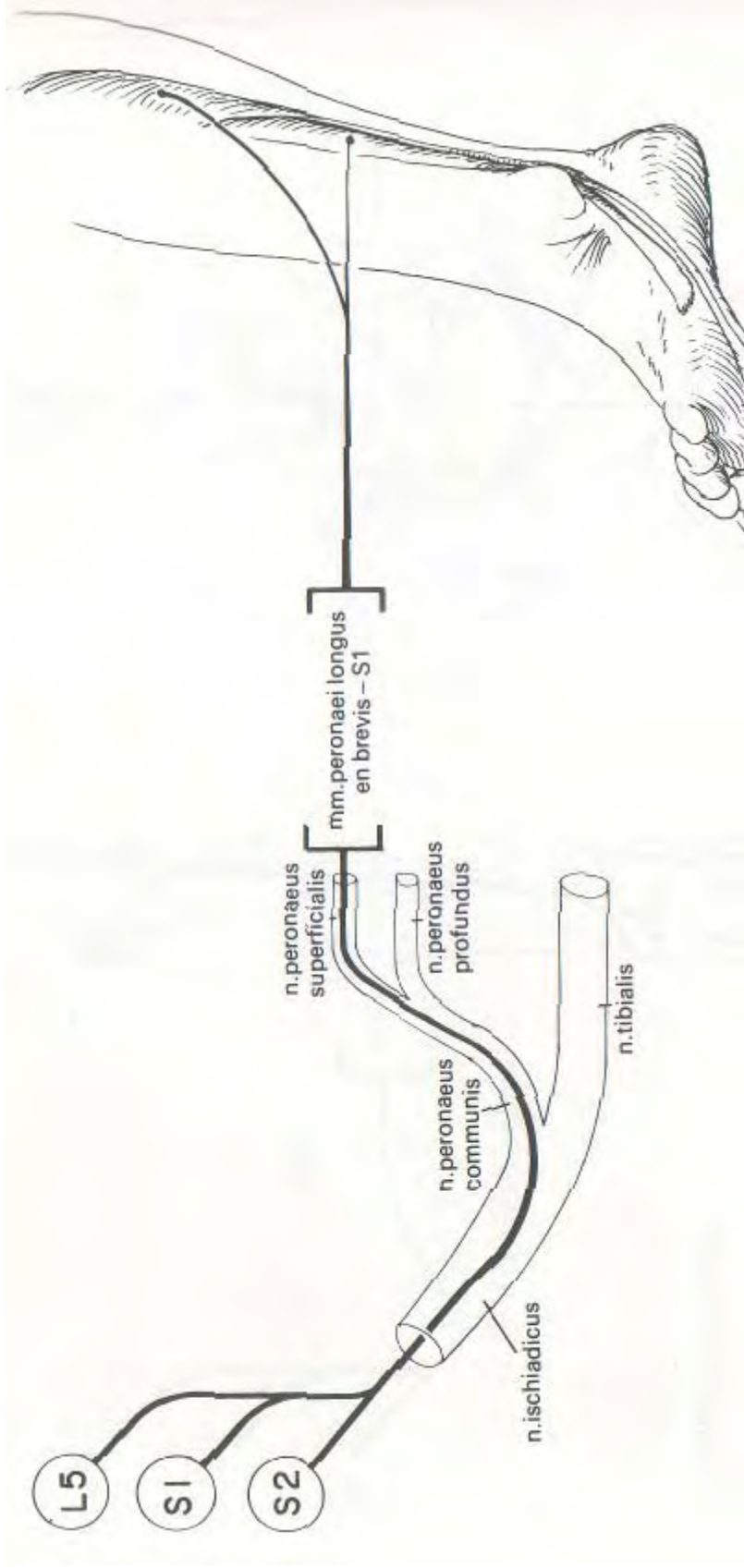
Hoppenfeld (1997)

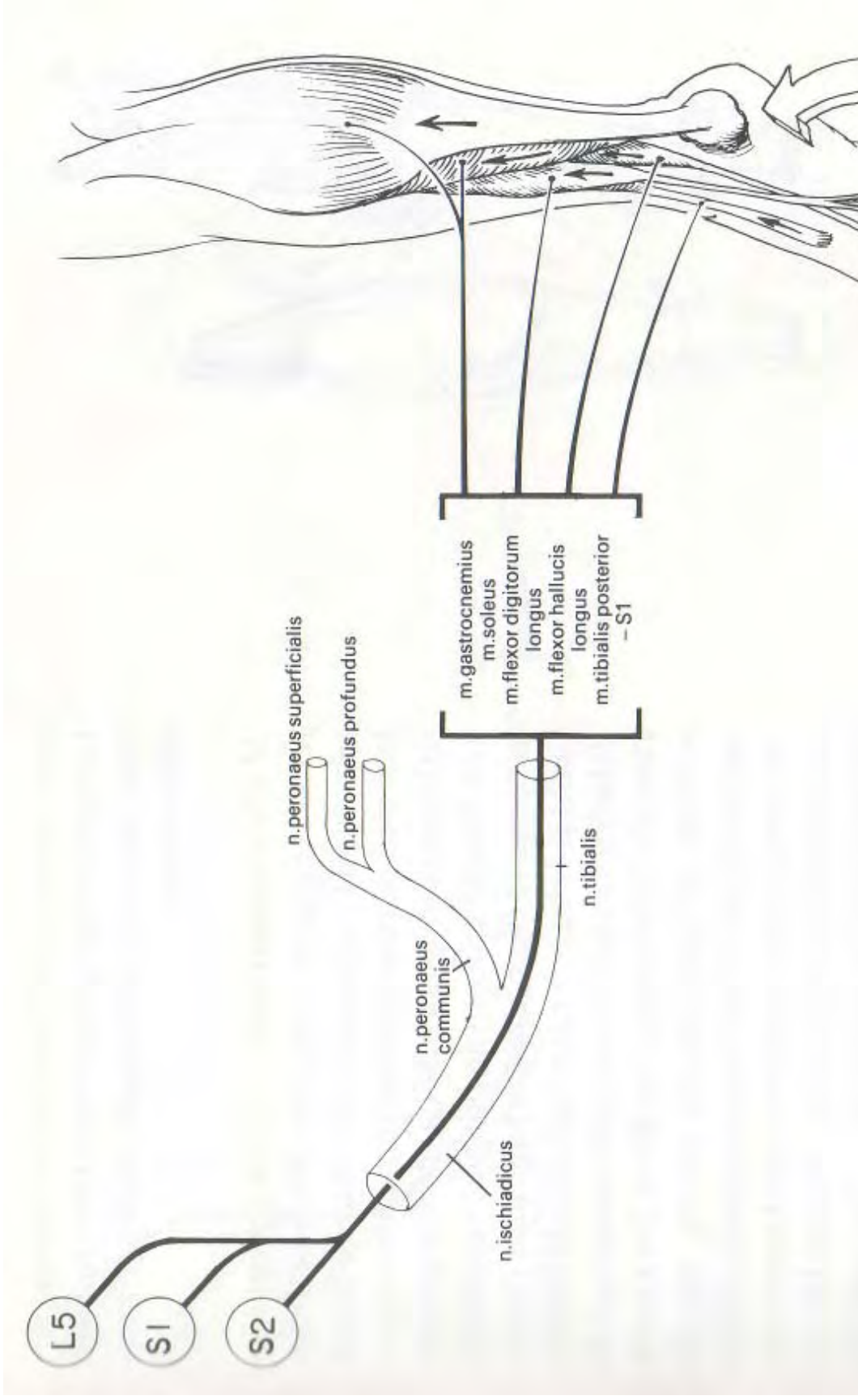


Hoppenfeld (1997)

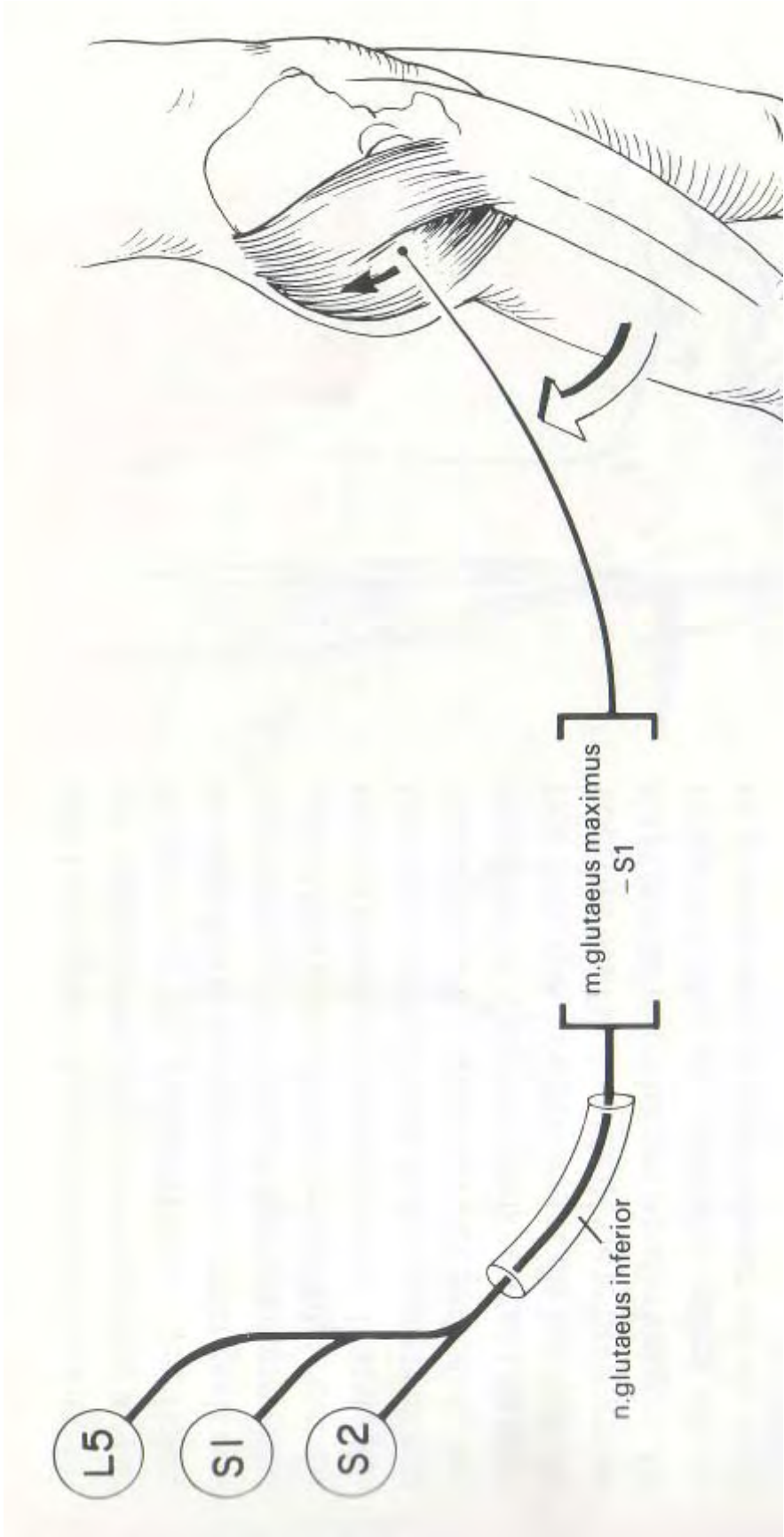


Hoppenfeld (1997)

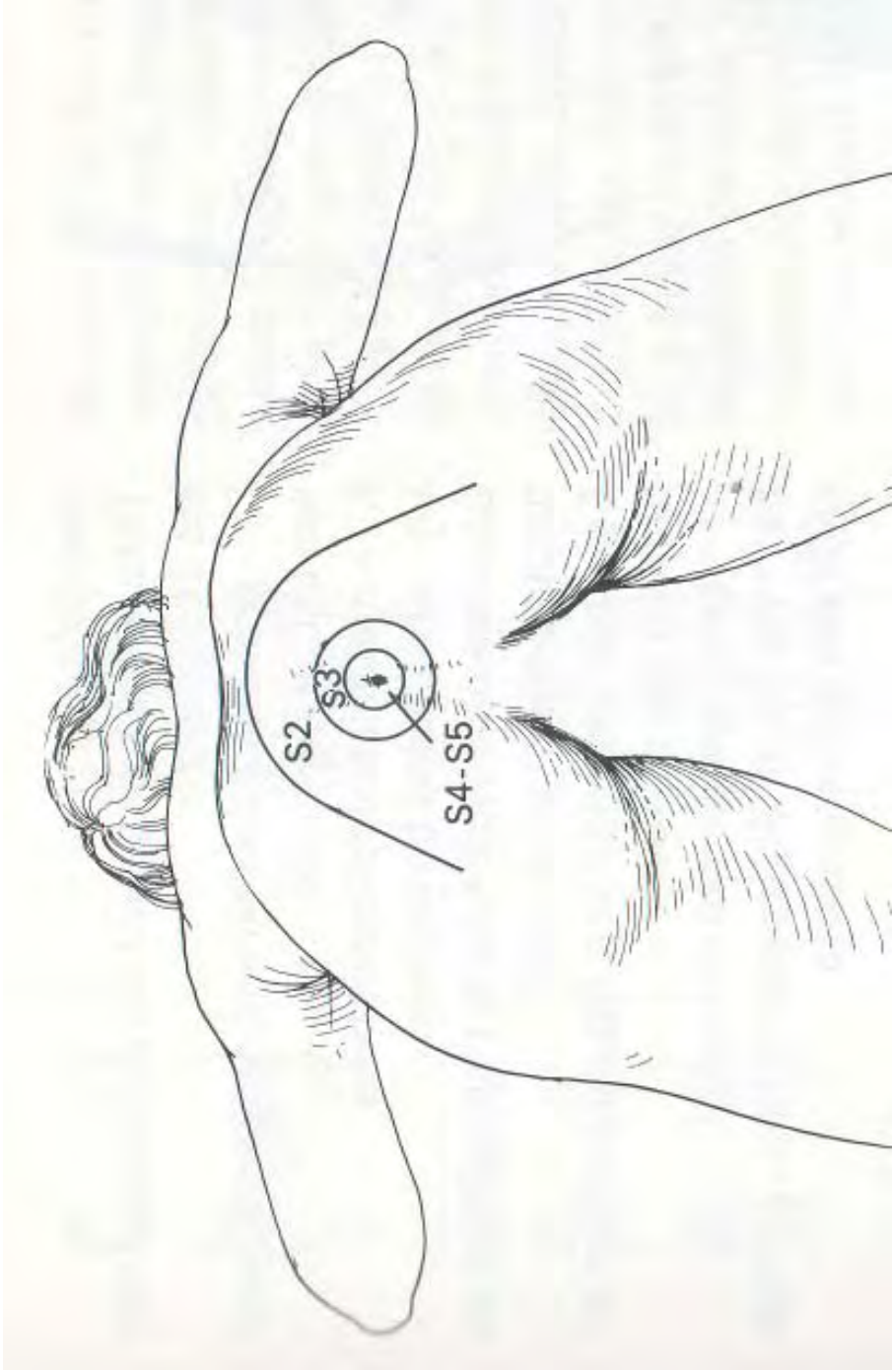




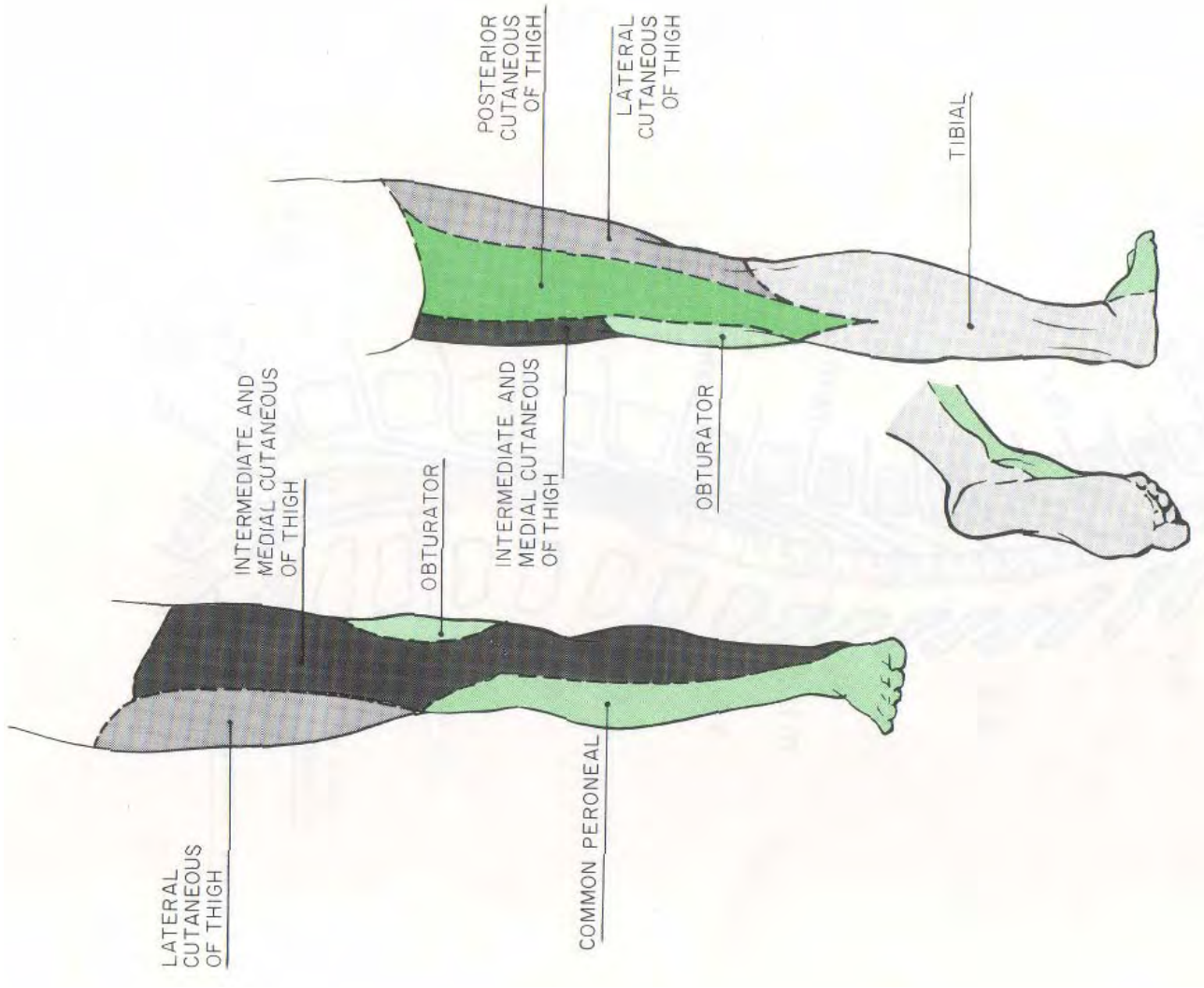
Hoppenfeld (1997)



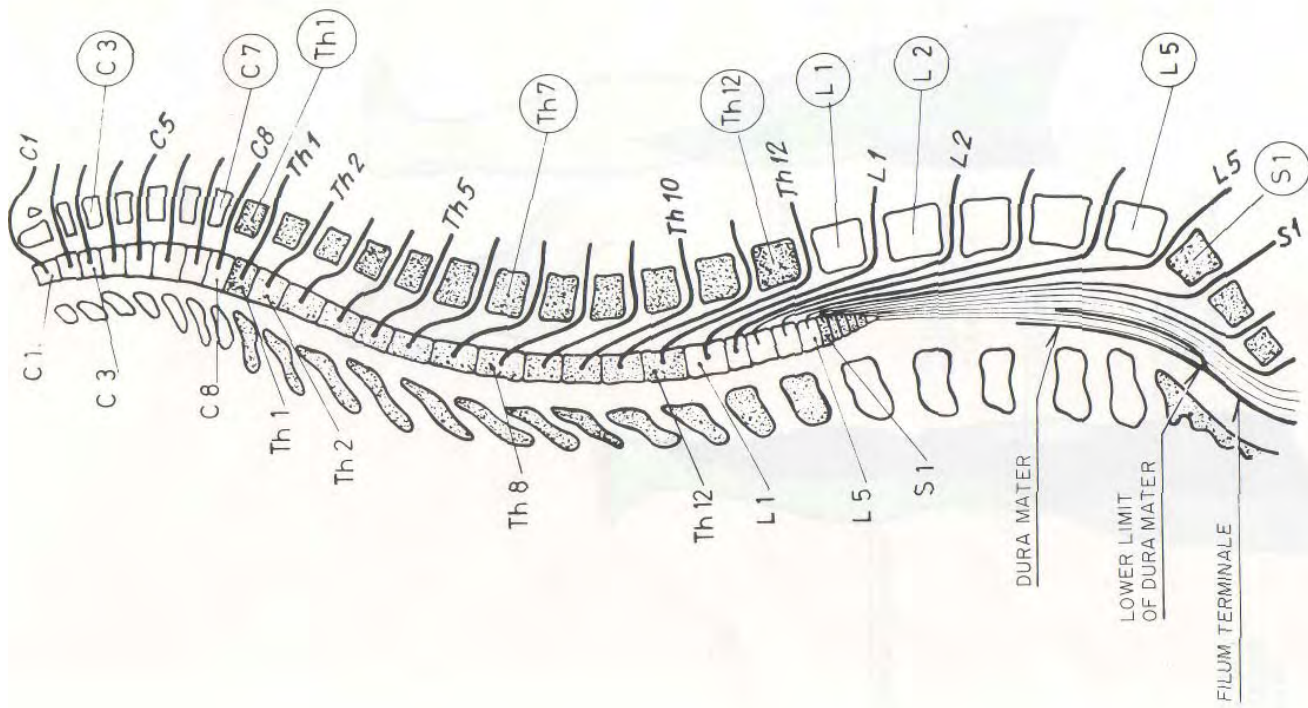
Hoppenfeld (1997)



Hoppenfeld (1997)



Conesa (1976)



Conesa (1976)

Criteria for the Classification of Fibromyalgia^a

1. History of widespread pain

Definition. Pain is considered widespread when all of the following are present: pain in the left side of the body, pain in the right side of the body, pain above the waist, and pain below the waist. In addition, axial skeletal pain (cervical spine or anterior chest or thoracic spine or low back) must be present. In this definition, shoulder and buttock pain is considered as pain for each involved side. "Low back" pain is considered lower segment pain.

2. Pain in 11 of 18 tender point sites on digital palpation.[†]

Definition. Pain, on digital palpation, must be present in at least 11 of the following 18 tender point sites:

Occiput: bilateral, at the suboccipital muscle insertions.

Low cervical: bilateral, at the anterior aspects of the intertransverse spaces at C5-C7.

Trapezius: bilateral, at the midpoint of the upper border.

Supraspinatus: bilateral, at origins, above the scapula spine near the medial border.

Second rib: bilateral, at the second costochondral junctions, just lateral to the junctions on upper surfaces.

Lateral epicondyle: bilateral, 2 cm distal to the epicondyles.

Gluteal: bilateral, in upper outer quadrants of buttocks in anterior fold of muscle.

Greater trochanter: bilateral, posterior to the trochanteric prominence.

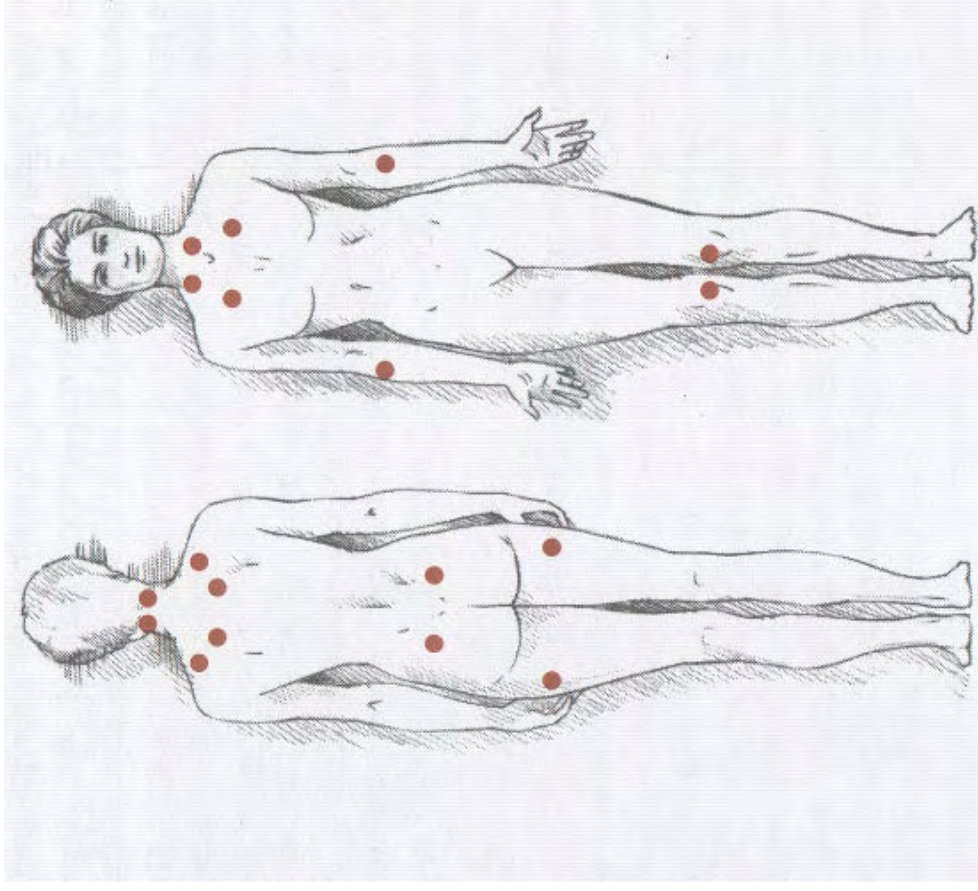
Knee: bilateral, at the medial fat pad proximal to the joint line.

a) For classification purposes, patients will be said to have fibromyalgia if both criteria are Satisfied. Widespread pain must have been present at least 3 months. The presence of a second Clinical disorder does not exclude the diagnosis of fibromyalgia.

Adapted from Wolfe F, Smythe HA, Yunus MB, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. Report of the multicenter criteria committee. *Arthritis Rheum* 1990;33:160-172, with Permission of the American College of Rheumatology.

The location of the nine paired tender points that comprise the 1990 American College of Rheumatology criteria for fibromyalgia

Digital palpation should be performed with an approximate force of 4 kg. For a tender point to be considered "positive", the subject must state that the palpation was painful. "Tender" is not to be considered "painful".



Den gode ryggsamtalen

Generelt

God klinisk kommunikasjon med pasienten (her kalt ”Den gode ryggsamtalen”) har generelt signifikant innvirkning på pasienttilfredshet, placeboeffekt, pasientens egenmestring, pasientens etterlevelse med hensyn til råd og behandling, prognose og klagesaker.

Det er vist at pasientens opplevelse av hva som er en god konsultasjon er knyttet til at behandleren viser empati, interesse og forståelse for pasientens plager og problemer inklusiv psykososiale aspekter (pasienten blir trodd og tatt på alvor). I tillegg til å bli lyttet til, er det viktig at pasienten får god og forståelig informasjon. Undersøkelser har også vist at psykiske og sosiale faktorer kan være viktigere enn organisk betingete smerteårsaker i ryggen når det gjelder fare for langvarige plager og uførhet.

Vær pasientsentrert

Forskning har i tråd med dette vist at det i samtalen er viktig å få fram de tanker, følelser og forventninger pasienten selv har om prognose, årsaker, hvorfor det gjør vondt, tiltak for å bli bra og rask tilbakevending til jobb. Ryggpasienter som er langvarig plaget sier ofte at de kan leve med smertene, men ikke med usikkerheten forbundet med ryggtilstanden. Usikkerheten dreier seg om hva som feiler dem, hvorfor det gjør vondt, hvordan dette vil gå og hva som er den beste måten å bli bedre på. Tre norske undersøkelser hvor disse elementene er en del av behandlingsopplegget dokumenterer effekt på tilbakevending til jobb.

Hensikten med å fokusere på psykososiale faktorer bør være å stimulere pasienten selv til å oppdage og erkjenne mulige sammenhenger og interaksjoner mellom kropp, psyke og livssituasjon. Vi vil imidlertid også her sterkt understreke at å drøfte psykiske og sosiale faktorer ikke må bære bud om bagatellisering av smertene og/eller at biomekaniske forhold ikke er av betydning. Signaler om at den vonde ryggen ”bare er psykisk” eller ”bare skyldes en vanskelig livssituasjon” (negativ psykologisering av plagene) har ingen plass i god pasientkommunikasjon. Eventuelle tiltak bør diskuteres ut fra en omforent og ikke behandler-diktert forståelse. En forklaring som er forståelig for pasienten (gjerne med bruk av modeller) på hvorfor det gjør vondt er også generelt et positivt kommunikasjonsmoment.

Det er viktig å få fram hva andre behandlere har fortalt er galt med ryggen og hva de har sagt er riktig behandling, og eventuelt få fram pasientens forklaring på hva tidligere røntgenfunn har vist. Pasientene har ofte hørt ulike versjoner fra ulike behandlere. Dette kan bidra til usikkerhet og manglende tro på at noe kan gjøres.

Avdramatisering og trygghetsskapende informasjon

Det er også viktig å avdramatisere og si direkte (hvis det er belegg for det) at ryggsmertene ikke er farlige, og at det ikke finnes holdepunkter for at annen sykdom ligger bak (ingen ”røde flagg”). Det beste for ryggen er å være i normal aktivitet, og at en viss smerteforverring er naturlig i begynnelsen. Videre er det viktig å klargjøre at smerter kan fortsette i ryggen selv om det ikke lenger foreligger tegn til skade eller sykdom. Økt følsomhet i mellomvirvelskiver, ledd og stramme muskler kan vedlikeholde smertene en tid. Til å begynne med bør pasientene oppfordres til å øke funksjonsnivået til de krav hverdagen stiller. Først når dette er oppnådd, vil ofte smertene gradvis avta.

”Den gode ryggsamtalen” er trygghetsskapende for pasienten og bør lede til at pasienten skjønner hvorfor det gjør vondt og at det ikke er noe farlig.

Ved langvarig forløp/fare for kronisitet ("gule flagg")

Initialt i forløpet vil det ofte være naturlig med hovedfokus på biomekaniske forhold. Hvis forløpet trekker ut (mer enn 4-6 uker uten tilfredsstillende bedring) bør det rettes mer oppmerksomhet mot potensielle betydningsfulle psykososiale faktorer. Imidlertid må det understrekes at det ennå mangler gode RCTs og systematiske oversikter (med enkelte unntak) på betydningen av intervensjoner rettet mot "gule flagg".

Psykososiale risikofaktorer kan være:

- Fortsatt engstelse for at ryggplagene er noe farlig
- Psykiske plager før ryggsmertene
- Påvisbar angst og depresjon (eventuelt maskert depresjon), somatisering
- Sosiale belastninger i familie eller trivselsproblemer på jobb
- Engstelse for å øke aktivitetsnivået
- Manglende tro på bedring og videre arbeidsevne
- Dårlig fysisk form, manglende fysisk aktivitet/trening

For hver måned pasienten er sykmeldt, jo mindre er sjansen for tilbakeføring til arbeid. (Etter 8 uker med sykefravær er sannsynlighet for tilbakevending til jobb redusert med 50%. Hvor hyppig den enkelte pasient må følges opp er ikke dokumentert, og bør være opp til behandlerens vurdering.

Til slutt: Gi pasienten brosjyren "Verdt å vite om vond rygg. Hva fagfolkene er enige om".



Original Article:

<http://www.mayoclinic.com/invoke.cfm?id=DS00516&dsection=8>

Sciatica

Treatment

For most people, sciatica responds well to self-care measures. You'll heal more quickly if you continue with your usual activities but avoid what may have triggered the pain in the first place. Although resting for a day or so may provide some relief, prolonged bed rest isn't a good idea. In the long run, inactivity will make your symptoms worse.

Here are conservative measures that you can take or that your doctor may suggest:

Cold packs. Initially, your doctor may suggest using cold packs to reduce inflammation and relieve discomfort. Wrap an ice pack or a package of frozen peas in a clean towel and apply to the painful areas for 15 to 20 minutes at least four times a day.

Hot packs. After 48 hours, apply heat to the areas that hurt. Use warm packs, a heat lamp or a heating pad on the lowest setting. If you continue to have pain, try alternating warm and cold packs.

Stretching. Initially, passive stretching exercises can help you feel better and may relieve compression, but avoid jerking, bouncing or twisting.

Over-the-counter medications. Pain relievers (analgesics) fall into two categories — those that reduce pain and inflammation and those that only treat pain. Nonsteroidal anti-inflammatory drugs (NSAIDs) such as aspirin and ibuprofen (Motrin, Advil, others) which help alleviate both discomfort and inflammation, are the most helpful for sciatica. Although they can provide real relief, NSAIDs have a "ceiling effect" — that is, there's a limit to how much pain they can control. If you have moderate to severe pain, exceeding the recommended dosage won't provide additional benefits. What's more, NSAIDs can cause side effects such as nausea, stomach bleeding or ulcers. If you take these medications, talk to your doctor so that you can be monitored for problems. In addition, periodically re-evaluate whether you still need NSAIDs. Exercise, stretching, massage and other nondrug treatments can often provide the same benefits without side effects.

Prescription drugs. In some cases, your doctor may prescribe an anti-inflammatory medication along with a muscle relaxant. Tricyclic antidepressants, such as nortriptyline (Aventyl, Pamelor) or amitriptyline (Elavil) and anticonvulsant drugs, such as gabapentin (Neurontin), also may be prescribed for chronic pain. They may help by blocking pain messages to the brain or by enhancing the production of endorphins, your body's natural painkillers.

Physical therapy. If you have a herniated disk, physical therapy can play a vital role in your recovery. Once acute pain improves, your doctor or a physical therapist can design a rehabilitation program to help prevent recurrent injuries. Rehabilitation typically

includes exercises to help correct your posture, strengthen the muscles supporting your back and improve your flexibility. Your doctor will have you start physical therapy, exercise or both as early as possible. It's the cornerstone of your treatment program and should become part of your permanent routine at home.

Regular exercise. It may seem counterintuitive to exercise when you're in pain, but the fact is that regular exercise is one of the best ways to combat chronic discomfort. Exercise prompts your body to release endorphins — chemicals that prevent pain signals from reaching your brain. Endorphins also help alleviate anxiety and depression, conditions that can make your pain more difficult to control. What's more, combining aerobics with strength training and exercises that maintain or improve flexibility can help prevent age-related degenerative changes in your back. If you're new to exercise, start out slowly and progress to at least 30 minutes most days. To prevent injury, consider learning proper weight lifting techniques from a certified personal trainer, fitness specialist or physical therapist.

When conservative measures don't alleviate your pain within a few months, one of the following may be an option:

Epidural steroid injections. In some cases, your doctor may inject a corticosteroid medication into the affected area. Corticosteroids mimic the effects of the hormones cortisone and hydrocortisone, which are made by the outer layer (cortex) of your adrenal glands. When prescribed in doses that exceed your natural levels, corticosteroids suppress inflammation, thereby relieving pressure and pain. Their usefulness in treating sciatica is a matter of debate, however, and they seem most effective when used in conjunction with a rehabilitation program. In addition, corticosteroids can cause serious side effects, so the number of injections you can receive is limited — usually no more than three in one year.

Surgery. This is usually reserved for times when the compressed nerve causes significant weakness or you have pain that gets progressively worse or doesn't improve with other therapies. Surgery is most often performed to remove a portion of a herniated disk that's pressing on a nerve, a procedure called discectomy. Ideally, most of the disk is left intact to preserve as much of the normal anatomy as possible. Sometimes a surgeon will perform this operation through a small incision while looking through a microscope (microdiscectomy). Success rates of standard discectomy and microdiscectomy are about equal, but you're likely to have less pain and to recover more quickly with microdiscectomy. Possible complications for either type of disk surgery include bleeding, infection, injury to the nerves or spinal cord, scarring and the risks of anesthesia. What's more, although you may experience immediate results from disk surgery, it doesn't stop degenerative changes and your pain may recur in time.

By Mayo Clinic staff

DS00516

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LUMBALT SKIVEPROLAPS

Undersøkelser:

- Rtg. LS kolumna
- CT. LS kolumna
- Radikulografi
- MR. LS kolumna

Operasjonsvurdering:

1. Konservativ behandling i 4-8 uker gir ingen/liten effekt. Alvorlig invalidiserende smerte distalt for knenivå i definert nerverot område. Positiv Laseque med eller uten nevrologisk funn. Smerteutstråling ved testing samsvarer med beskrevet radikulopathi. Utredningsfunn (CT/MR/Radikulografi) samsvarer med kliniske funn.
2. Tidligere intervensjon kreves ved økende intens isjias-smerter under den konservative behandlingsperioden. Rask behandling kreves ved pareseutvikling i underekstremitetene.
3. Akutt intervensjon ved Cauda Equina syndrom, dvs. ved nedsatt sensibilitet perianalt, vannlatningsforstyrrelser, sphinkterparese og rask utvikling av pareser i underekstremitetene.

Operasjonsprosedyre (Mikroteknikk):

- Peroperativ AB med Keflin 2g iv ved innledning av anestesi.
- Intubasjonsnarkose. Kne-albue leie.
- Preoperativ markering av nivå med gjennomlysning.
- Lokalbedøvelse i hud med adrenalin.
- 3 cm hudsnitt på aktuell side.
- Lumbodorsal fascie åpnes bueformet og hængles medialt. M. Multifidus løses fra prosessus spinosi.
- Caspar haker i såret. Mikroskop innstilles.
- Lig. Flavum insidieres med kniv og ekstirperes ved hjelp av stansetang.
- Partiell arcotomi utføres om nødvendig.
- Nerverot mobiliseres medialt.
- Frie prolaps ekstirperes med prolapsstang. Skiven sonderes og tømmes dersom det fortsatt er skivebukning eller løse fragmenter igjen i skiven.
- Subligamentære prolaps ekstirperes og skiven tømmes.
- Nerveroten skal nå forløpe fritt i rotkanalen. Rotkanalen bites opp hvis det foreligger sideleddsartrose og recesstenose i tillegg til prolapsset.
- Såret skylles med NaCl
- Såret lukkes lagvis, dren er sjelden nødvendig.

Komplikasjoner:

Peroperative: Blødning. Durarift. Nerveskade.

Postoperative: Hematom. Sårinfeksjon. Diskitt.

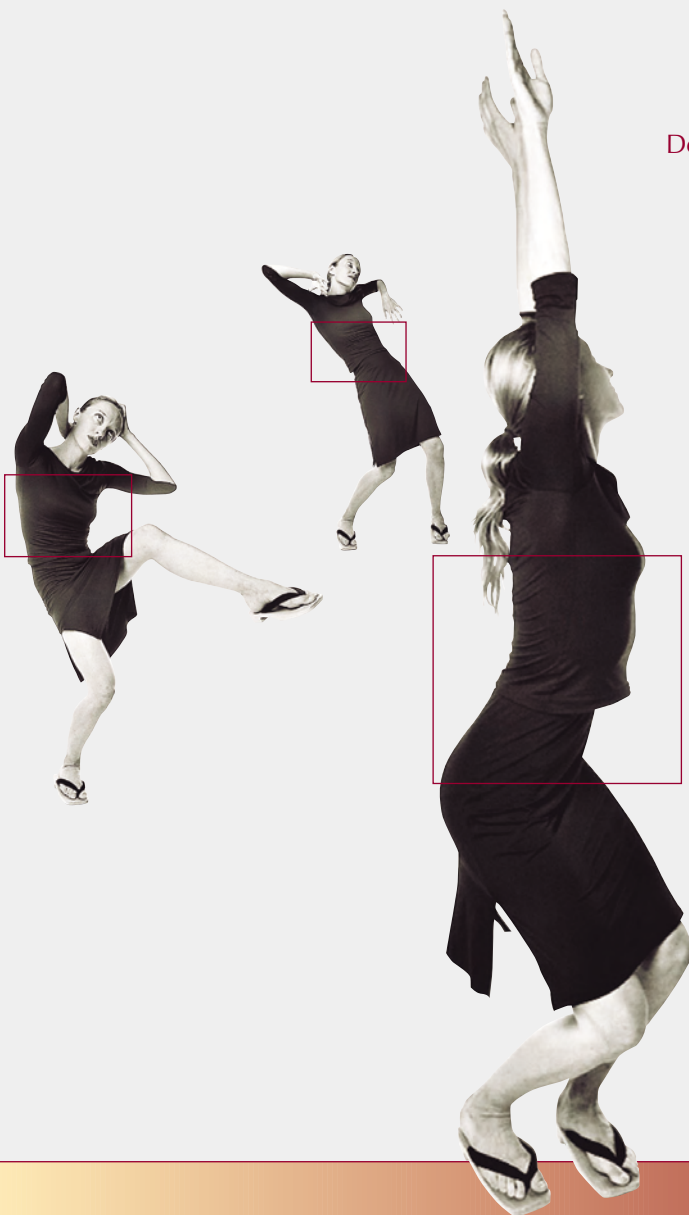
Oppfølging:

Mobilisering 1. postoperative dag ved hjelp av fysioterapeut. Utskrives 1.-3. postoperative dag. Ryggskole 4-6 uker postoperativt. Poliklinisk kontroll etter 3 måneder.

Verdt å vite om **vond rygg**

Hva fagfolk er enige om

Denne brosjyren er laget for deg som har akutte ryggplager.



- Forekomst
- Hvordan ryggen er bygget opp
- Årsaker og hvorfor det gjør vondt
- Hva du kan gjøre selv
- Når oppsøke hjelp
- Hva behandlerne kan bidra med
- Utsiktene til å bli bra igjen

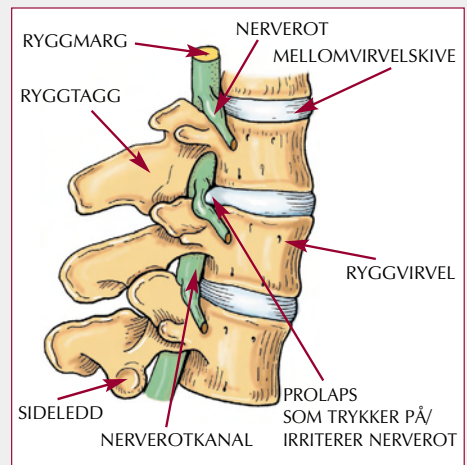
Brosjyren bygger på oppdatert kunnskap fra forskning og hva fagfolk er enige om. Ansvarlig for brosjyren er Nasjonalt ryggnettverk - Formidlingsenheten.

Hvor utbredt er ryggplager?

Smerter i ryggen er svært vanlig. 60-80% av befolkningen får ryggsmarter en eller flere ganger. Over en 12 måneders periode har ca. 50% hatt plager og til enhver tid angir 8-15% at de har vondt i ryggen. Dette er altså en folkeplage. Ryggplager kan være akutte eller kroniske. Akutt betyr at smertene varer i mindre enn tre måneder, og mange opplever flere episoder med akutte ryggsmarter i løpet av livet. Denne brosjyren handler om slike ryggplager.

Hvordan er rygg søylen bygget opp, og hvilke forandringer skjer med årene?

Ryggen er i utgangspunktet sterk og tåler mye. Den gjør at vi kan bevege oss oppreist og beskytter nervefibrene i ryggmargen. Den består av 7 virvler i nakken, 12 i brystdelen og 5 i korsryggen. Mellom virvlene er det bruskskiver med et mykt materiale i midten som fungerer som en "støtpute". Mellom hver virvel finnes sideledd ("styringsledd") som tillater bevegelser og sørger for stabilitet. Flere lag muskler er viktig for stabilitet og bevegelighet. Med årene skjer det normale aldersforandringer, særlig i bruskskivene. De blir lavere og kan få sprekker. I blant kan innholdet i midten av bruskskivene presses ut gjennom slike sprekker og trykke på en eller flere nerve-røtter i rygg- eller nervekanalen. Utpresset skiveinnhold kalles prolaps. Opptil 35% av oss har imidlertid prolaps uten at det gjør vondt.



Hva er årsakene?

Oftest vet vi ikke med sikkerhet hvorfor den enkelte får ryggplager. Følgende kan være av betydning (men vanligvis er sammenhengene svake): tunge løft og vridninger eller ensidig kroppslig arbeid; dårlig fysisk form og inaktivitet over tid; mistrivsel og problemer på jobb eller hjemme, og arvelig disponering. Ofte er det en kombinasjon av flere årsaker.

Hvordan oppstår smertene?

Vi kan i de fleste tilfeller ikke slå fast nøyaktig hvor smertene kommer fra. Som oftest dreier det seg om helt ufarlige tilstander, ofte kalt lumbago eller hekseskudd. Det kan imidlertid gjøre svært vondt. I noen tilfeller kan rifter eller sprekker i mellomvirvelskiven irritere små nerveender i ytterkant av skiven. Det kan også være prolaps, med trykk på og irritasjon av en nerverot. I en for trang nerverotkanal kan nerveroten komme i klem på grunn av slitasje og aldersforandringer (særlig rundt sideleddene). Ofte vil musklene "knyte seg" og bli vonde.

I sjeldne tilfeller kan det være annen (og mulig alvorlig) sykdom som ligger bak, f.eks. brudd i ryggen, svulster eller infeksjoner/revmatisk betennelse. Dette omfatter bare noen få prosent.

Ut fra dette kan vi dele inn ryggplager på følgende måte:

1. Vanlige (uspesifikke) rygg smerter eller lumbago (80-90%).
2. Nerverotsmerter med utstråling nedenfor kneet, oftest på grunn av prolaps eller trang nerverotkanal (10%). (Isjias er bare en betegnelse på smerter med utstråling langs hovednerven ned i foten.)
3. Mulig annen og sjelden sykdom (svulst, brudd, revmatisk sykdom) (1-5%).



Hva kan du gjøre selv?

Følgende råd er basert på oppdatert forskning:

- 1.** Ryggens tilhelning stimuleres best ved å være mest mulig i normal aktivitet. Dagligdags aktivitet og jobb bør derfor gjenopptas så fort som mulig. Kanskje kan delvis eller aktiv sykmelding være en løsning. Det er ikke skadelig eller farlig om det gjør noe vondt når du er i aktivitet.
- 2.** Du bør ligge minst mulig. I blant kan smertene være så sterke at det er nødvendig å ligge (særlig ved nerverotsmerter), men pass da på at sengeleiet ikke blir langvarig. Sengeleie er i seg selv ikke behandling, og ryggen helbredes ikke av å ligge.
- 3.** Plagene kan ofte lindres effektivt med reseptfrie medisiner. Hvis du tar smertestillende midler bør disse tas med jevne mellomrom, f.eks. 3-4 ganger daglig.
- 4.** Prøv å ha en optimistisk holdning til at dette kommer til å gå bra og at det ikke er farlig. Sammen med fysisk aktivitet stimulerer det kroppens evne til å lege seg selv.

Når oppsøke hjelp?

Selv om smertene er sterke er de sjelden uttrykk for noe alvorlig. Du bør imidlertid søke hjelp hvis:

- Du føler deg utrygg på hva det kan være
- Smertene er sterke og du ikke får nok hjelp av smertestillende tablettar eller ved avlastning av ryggen
- Du trenger sykmelding eller smertene ikke raskt blir bedre
- Du merker nedsatt muskelkraft
- Du får problemer med vannlatingen eller blir nummen i skrittet (dette kan skyldes stort prolaps som må opereres innen 24 timer)
- Du har hatt ufrivillig vekttap eller føler deg generelt syk

Hva kan legen eller annen behandler gjøre?

Punktene nedenfor tilpasses individuelt:

- Undersøke deg for å finne ut om du har "vanlige ryggsmarter" eller nerverotsmerter på grunn av prolaps eller trange forhold i ryggen. Det må også utelukkes at du hører til den sjeldne gruppen med mulig alvorlig sykdom.
- I noen tilfeller er det nødvendig å ta blodprøver og henvise til røntgen. Men røntgen er ikke rutinemessig nødvendig, bortsett fra når smertene er nesten uforandret etter 4-6 uker. Dette gjelder både vanlig ryggvondt og nerverotsmerter/mistanke om prolaps. Røntgen kan bare påvise årsaker til ryggsmarter hos et mindretall. Dessuten skal du ikke utsettes for unødvendig røntgenstråling.
- Forklare hva slags tilstand du har og gi deg råd om hva du kan gjøre selv.
- Foreskrive tilstrekkelig smertestillende medisiner hvis vanlig paracetamol ikke er nok.
- Vurdere om du greier å være på jobben eller tilrettelegge den i samarbeid med arbeidsgiver. Delvis eller aktiv sykmelding kan være aktuelt. De som klarer å være i vanlig aktivitet, inklusiv jobb, blir fortere bra.



- Vurdere om du kan ha nytte av manipulasjonsbehandling hvis du ikke blir bedre etter ca. 1-2 uker. Slik behandling gis av kiropraktor eller fysioterapeut med spesialutdanning i manuell terapi. Behandlingen kan lindre smerte og gjøre at du fungerer bedre.
- Vurdere om det er nødvendig med operasjon hvis du har nerverotsmerter. Det gjelder bare noen få prosent, de fleste blir raskt bedre og har ikke behov for operasjon.
- Vurdere om det etter hvert (ca. 4-6 uker) blir nødvendig med øvelses- eller aktivitetsprogram hos fysioterapeut eller annen behandler.
- Følge opp med kontroller for å se at det går rett vei. Hvis du ikke klarer å gjenoppta vanlige aktiviteter, kan det bli aktuelt å ta opp livssituasjonen din. Kanskje noe utover ryggsmertene plager deg og er med å hindre at du blir frisk.
- Dersom du har betydelige, langvarige plager (mer enn 8-12 uker), kan det være aktuelt å henvise deg til ryggpoliklinikk eller spesialist.

Blir du bra igjen?

De aller fleste med akutte ryggsmertener vil, med eller uten behandling, være bra eller betydelig bedre etter få uker.

Har du nerverotsmerter tar det ofte lengre tid, kanskje flere måneder. Endel får tilbakefall i løpet av 1-2 år. Mange har litt vondt innimellom, uten at det betyr noe farlig eller unormalt. Kunsten er å lære seg å mestre plagene.

Kan plagene forebygges?

Det er umulig å gi råd som passer for alle. Det finnes lite forskning på forebyggingstiltak. En del anbefalinger er likevel vanlige å gi, og kan oppleves nyttige for mange, særlig for å hindre tilbakefall:

- Prøv å hold deg i form gjennom lystbetont mosjon og variert aktivitet. Gjør noe som passer for deg. Ryggen er konstruert for å være i bevegelse, er i utgangspunktet sterk og tåler mye.
- Det er bra med 20-30 minutters daglig aktivitet som gange, sykling eller svømming.
- Unngå langvarig sitting, særlig når du har vondt.
- Mange har glede av øvelsesprogram med tøyninger og variert muskelaktivitet.
- Løft og bær bare det du vet du kan klare. Bær nært inntil kroppen.
- Prøv å gjør noe med en eventuell vanskelig arbeids- eller livssituasjon.
- Og husk: Trivsel og glede gjør også godt for ryggen!

For deg som vil vite mer

Pasientinformasjonsbasen www.rygginfo.no, som drives av Statens folkehelseinstitutt og pasientforeningen Ryggforeningen i Norge.

Nasjonalt ryggnettverks hjemmesider www.ryggnett.no.

Den danske boka "Kort og klart om rygsmerter" av M. Jayson, Nyt Nordisk Forlag.

Denne brosjyren kan bestilles via www.ryggnett.no

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I samarbeid med:

Den norske lægeförening,

Kommunenes Sentralforbund,

Norges teknisk-naturvitenskapelige universitet,

Norsk Ergoterapeutforbund, Norsk Forening

for Ryggforskning, Norsk Kiropraktorforening,

Norsk Sykepleierforbund, Norsk Fysioterapeutforbund,

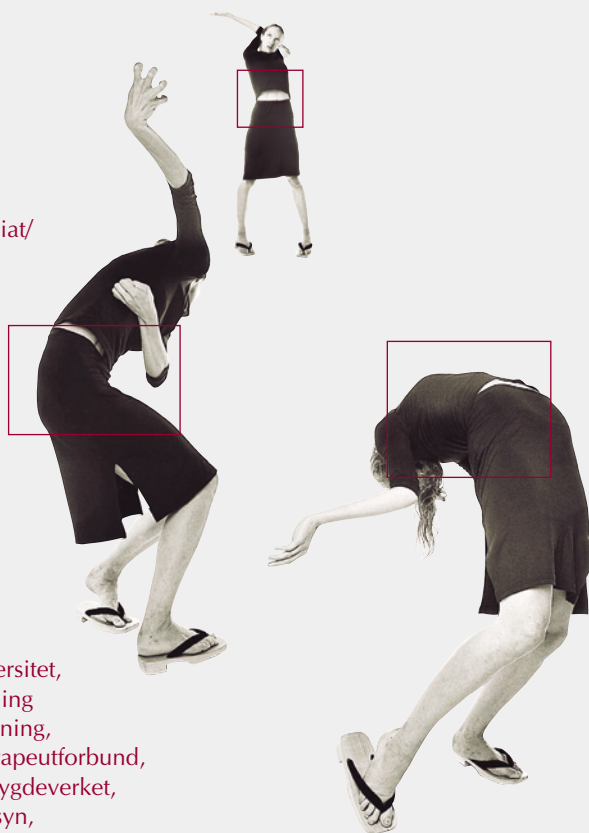
Næringslivets Hovedorganisasjon, Rikstrygdeverket,

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gruppen for Nasjonalt ryggnettverk, samt flere framtreddende ryggeksperter i Norge, Storbritannia og Nederland.



Epidural sacral injection study

Prosedyrebok

Epiduralinjeksjon

Guidance for the sacral epidural injection technique.

1. The patient is given either two epidural sacral injections of 30 ml NaCl 0.9 % (volume), two epidural sacral injections of 29 ml NaCl 0.9 % + Kenacort 40 mg/ml 1 ml (volume+steroid) or 1 ml NaCl 0.9 % subcutaneously (placebo).
2. The patients are prone while they are given the injection. If necessary, a small cushion can be put beneath their abdomens to raise the pelvis slightly so that the anatomical structures are easier to identify (Sekiguchi et al, 2004). The injection is given via the sacral hiatus. An aseptic technique is used, and the area is washed thoroughly using Chlorhexidine 5 % before the injection is administered.
3. The recommendations given in “Recommendations on the use of epidural injections for the treatment of back pain and leg pain of spinal origin” (The Royal College of Anaesthetists and Pain Society, 2002) are adhered to in order to ensure the quality of the epidural injections.
4. 0.5 ml local anaesthetic (lidocaine hydrochloride 20 mg/ml) is first administered using a 1 ml syringe and a blue needle (23G 0.6 x 0.25 mm) in the area around the sacral hiatus. Five minutes after the skin anaesthetic, a Spinocan spinal needle (22G 0.73 x 88 mm) is inserted via the sacral hiatus and no more than 2 cm up into the epidural space. Following insertion of the needle, the stylet is removed to see if there is any spinal fluid present in the needle. Aspiration is carried out as a precaution to check for the presence of blood. If any spinal fluid is found, the procedure is discontinued. Another attempt can be made after two days. If aspiration shows the presence of any blood, the position of the needle is adjusted slightly and a new aspiration is carried out. If there is no blood, the procedure can continue, otherwise it is stopped. It can then be repeated after two days.

Epidural sacral injection, Technique explained

5. A 30 ml syringe is used (Braun Omnifix Luer Lock), which is connected to the spinal needle. The injection is administered slowly over 10 minutes (3 ml/minute). There is continuous digital palpatory inspection over the sacrum to check that the injection is not being administered subcutaneously. If this palpatory check reveals that fluid is entering the subcutaneous region, the injection must be stopped. Careful aspiration is carried out regularly throughout the injection process. If there is any blood in the aspirate, and changing the position of the needle does not help, the injection must be stopped. Once the injection is completed, the spinal needle is removed and a plaster is applied to on the injection site.
6. During the injection procedure the patient might feel some pressure over the lumbar region and in the pelvic region. Occasionally there may also be some pain radiating out into the legs. If these pains become too intense, and the patient says that he or she cannot tolerate them despite a slow injection technique, the injection must be stopped.
7. After the injection, the patient continues lying in a prone position for ten minutes, and then for 15 minutes in a supine position. Before the patient leaves the treatment room, the anaesthetist must make sure there are no signs of acute complications and that the patient feels fine.
8. Verbal and written information is provided on what the patient should and should not do following the injection.

Sekiguchi, M ; Yabuki, S ; Satoh, K ; Kikuchi, S (2004) An anatomic study of the sacral hiatus: a basis for successful caudal epidural block.. *Clin J Pain Jan-Feb; 20(1):51-4*

The Royal College of Anaesthetists (2002) Recommendations on the use of epidural injections for the treatment of back pain and leg pain of spinal origin. *Bulletin 14, July 2002:695-97*

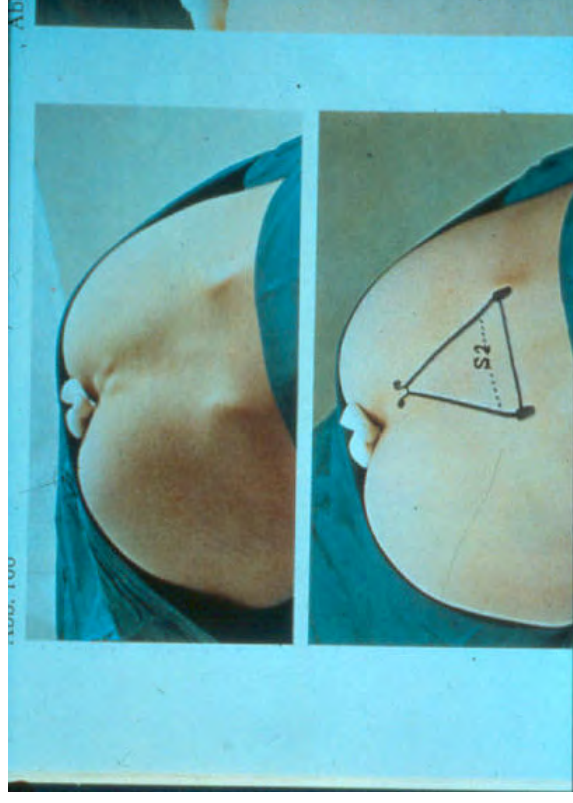
Anatomy of the epidural space

- Virtual space in between to cylinders
- Inner cylinder = dura mater + dural sleeves
- Outer cylinder = spinal canal
- Closed by intercornual ligament
- Venous plexus



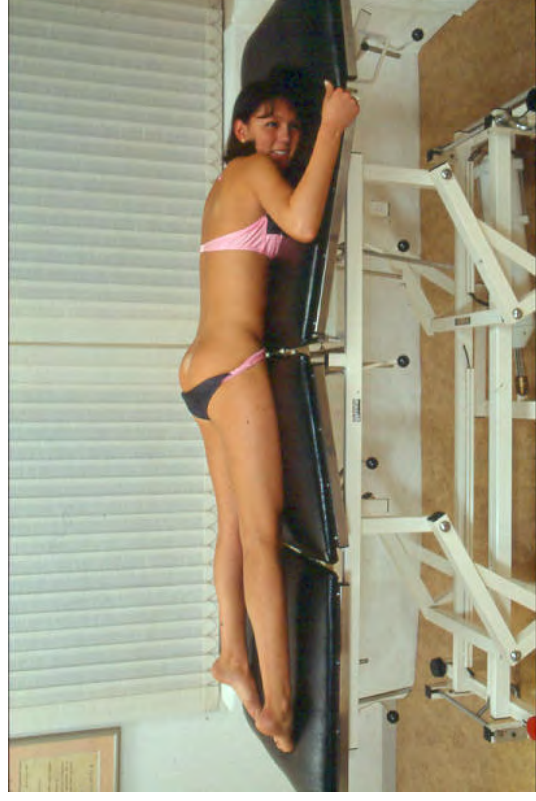
Injection technique

- Points of references:
 - cornua sacralia
 - intercornual ligament



Injection technique

- Positioning of the patient:
 - in kyphosis



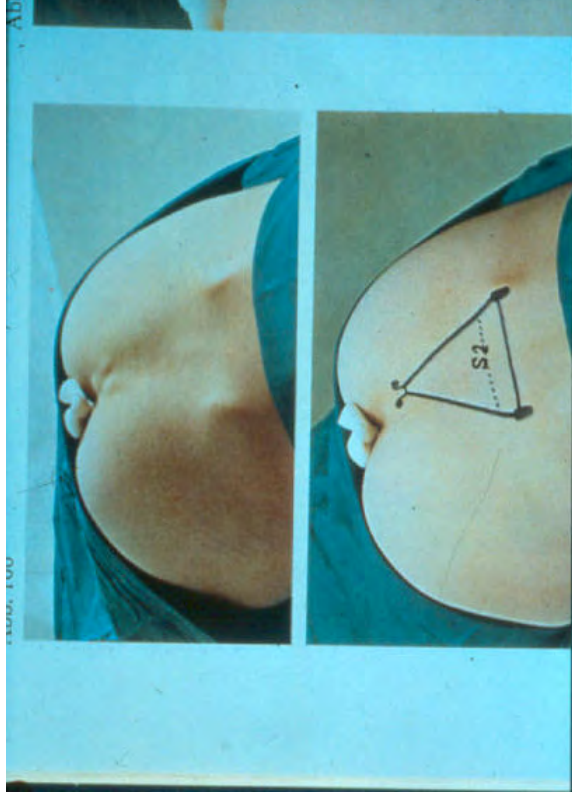
Injection technique

- Positioning of the patient:
 - in kyphosis
 - hips in internal rotation



Injection technique

- Positioning of the patient:
 - in kyphosis
 - hips in internal rotation
 - identifying points of reference



Injection technique

- Positioning of the patient:
 - in kyphosis
 - hips in internal rotation
 - identifying points of reference



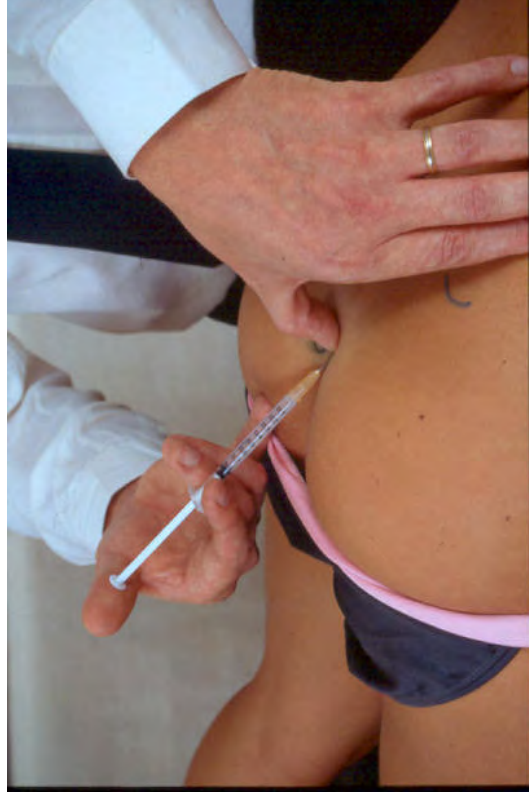
Injection technique

- Positioning of the patient:
 - in kyphosis
 - hips in internal rotation
 - identifying points of reference



Injection technique

- Shaving of the skin
- Desinfection of the skin
- Local anaesthesia of the skin and the intercornual ligament



Injection technique

- Introduction of the spinal needle



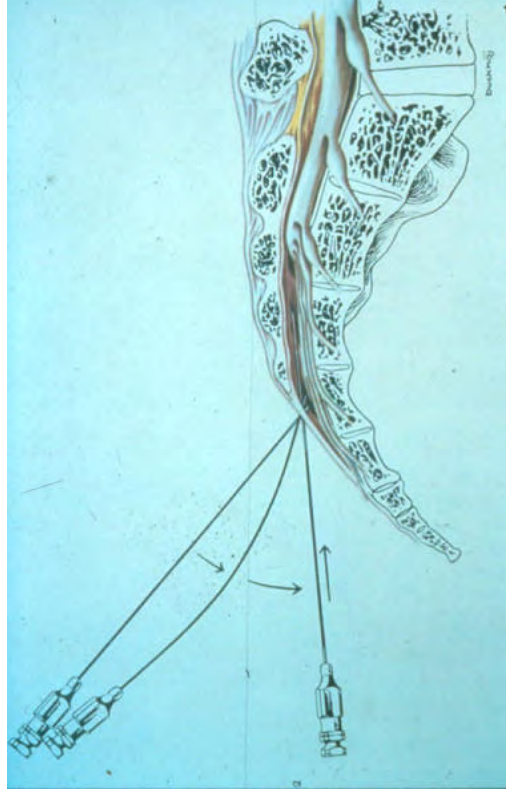
Injection technique

- Introduction of the spinal needle
- Between the cornua



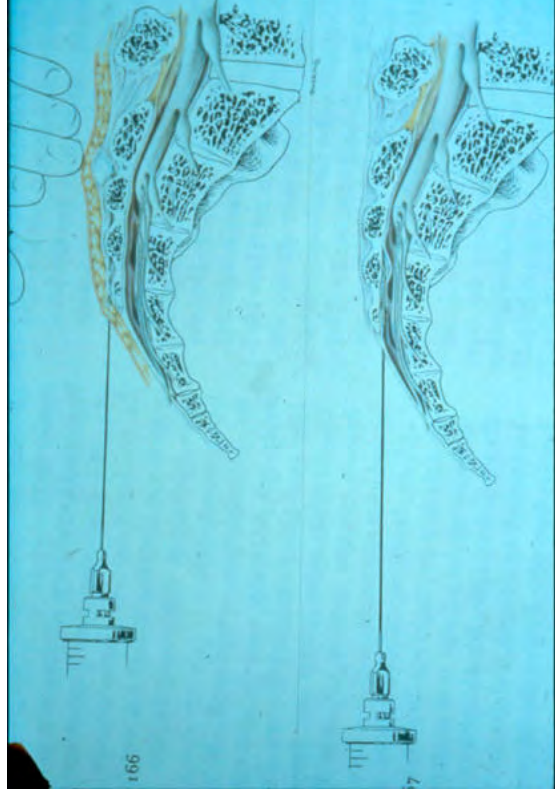
Injection technique

- Introduction of the spinal needle
- Between the cornua
- Adapt direction to shape of sacrum



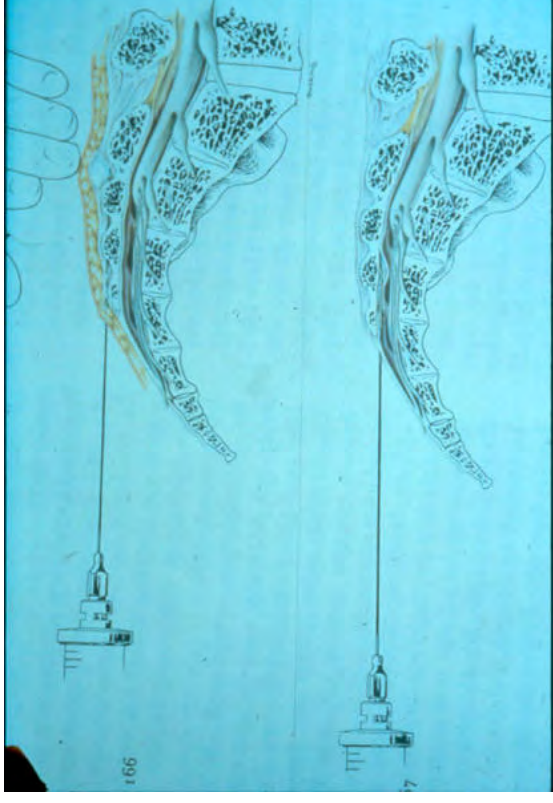
Injection technique

- Introduction of the spinal needle
- Between the cornua
- Adapt direction to shape of sacrum
- Technical problems



Injection technique

- Introduction of the spinal needle
- Between the cornua
- Adapt direction to shape of sacrum
- Removal of stylet:
 - blood ?
 - cerebrospinal fluid ?



Injection technique

- Injection:
 - slowly
 - verbal contact
 - palpation of sacrum
 - regular aspiration
 - after injection: rest





THE ROYAL COLLEGE OF ANAESTHETISTS AND THE PAIN SOCIETY

Recommendations on the use of epidural injections for the treatment of back pain and leg pain of spinal origin (March 2002)

Disclaimer

These recommendations are concerned with the competencies of doctors who perform epidural injections for the treatment of back pain and leg pain of spinal origin and with the clinical environment in which such injections are performed. The recommendations do not endorse or recommend the use of any particular medication or product for epidural injection. The choice of medication or product for epidural injection is the responsibility of the individual practitioner. The organisations involved in the preparation of these recommendations, including the Royal College of Anaesthetists and The Pain Society, take no responsibility legal or otherwise for the choice by an individual practitioner of a medication or product used for epidural injection.

Introduction

- 1 The General Medical Council advises doctors that they must 'make the care of your patient your first concern.' General Medical Council *Good Medical Practice* May 2001.
- 2 The desire to improve safety for patients receiving epidural injections reflects the evolution of professional standards in all areas of medical practice. Doctors must strive to provide the best possible care and safest treatment for all patients by reducing risk to an absolute minimum.
- 3 Historical precedent and tradition can no longer be regarded as justification for practices that are perceived to fall below the standards acceptable to a responsible body of doctors. If one patient is harmed by sub-standard practice then that is one too many.
- 4 The Royal College of Anaesthetists always encourages safe practice. It is the desire of the College to have safe practice adopted by all doctors who perform invasive treatment near the spinal cord and near potential sources of infection. This includes the anus and perineum in addition to obvious skin lesions.
- 5 The recommendations refer to 'single-shot' epidural injections that are performed by either the lumbar or caudal routes. The risks are similar with the two routes. There may be an increased risk of infection with the caudal approach because it is closer to potential sources of infection.
- 6 The recommendations do not refer to the insertion of indwelling epidural catheters.
- 7 The injection of local anaesthetic (whether amide or ester) is associated with specific risks. Additional precautions are necessary for patients who receive epidural local anaesthetic injections. In some techniques relatively large volumes of local anaesthetic are injected thereby delivering a large dose of the active drug even though the concentration is low.
- 8 The use of local anaesthetic for epidural injection is associated with the risk of inadvertent intrathecal injection leading to a 'total spinal' or of inadvertent intravenous injection resulting in local anaesthetic toxicity. These serious untoward incidents may occur during either lumbar or caudal injection. Both clinical situations are life threatening and require immediate resuscitation.
- 9 The recommendations do not address any issues concerning the evidence for effectiveness of epidural injections (including epidural steroid injections) in the management of back and leg pain. For an analysis of the evidence, and of long term safety, see:
 - a National Health and Medical Research Council of Australia. Epidural use of steroids in the management of back pain and sciatica of spinal origin. Canberra, NHMRC, 1994.
 - b Watts RW, Silagy CA. A meta-analysis on the efficacy of epidural corticosteroids in the treatment of sciatica. *Anaesthesia and Intensive Care* 1995;23:564-569.
 - c Koes BW, Scholten RJ, Mens JM, Bouter LM. Efficacy of epidural steroid injections for low-back pain and sciatica: a systematic review of randomised clinical trials. *Pain* 1995;63:279-288.
 - d Abram SE, O'Connor TC. Complications associated with epidural steroid injections. *Regional Anesthesia* 1996;21:149-162.
 - e McQuay H, Moore A. An evidence-based resource for pain relief. Oxford: Oxford University Press, 1998:216-218.
 - f van Tulder MW, Koes BW, Bouter LM. Conservative treatment of acute and chronic non-specific low back pain. *Spine* 1997;22: 2128-2156.

Recommendations

- 1** Doctors in training should possess defined competencies before performing epidural injections unsupervised (see Explanatory note **a**).
- 2** Established practitioners in non-training grades must ensure that they possess the competencies defined for trainees if they wish to perform epidural injections and/or train others (see Explanatory note **b**).
- 3** Any doctor who performs epidural injections at the request of another doctor must be aware that the doctor who performs the injections will be held wholly or jointly responsible for any adverse outcomes of the injections. The doctor who undertakes the procedure must possess the defined competencies or receive appropriate supervision. The doctor who undertakes the procedure must be satisfied that the indications for the injection are appropriate and that there are no contraindications to epidural injection.
- 4** All doctors who perform epidural injections must be competent in resuscitation (see Explanatory note **c**).
- 5** The process of obtaining consent from the patient before an epidural injection is performed must comply with the current guidance published by the General Medical Council and the Department of Health. The doctor who obtains consent, if he or she is not the person who carries out the epidural injection, must be suitably trained and qualified, must have sufficient knowledge of the proposed treatment, and must understand the risks involved. It is the responsibility of the doctor, or doctors, who prescribe and perform the injection to decide what to explain to the patient if any drug is being used for an indication and by a route that is not recommended in the product information sheet or drug licence.
- 6** Epidural injections must be performed using an aseptic technique. This should include: hand washing, sterile gloves, hat, mask, skin preparation and sterile drapes around the injection site. Normally a sterile gown should be included as a part of the aseptic technique.
- 7** Epidural injections must be performed in a setting that provides appropriate monitoring and resuscitation facilities. If local anaesthetic is to be injected there must be immediate availability of full resuscitation equipment and the presence of a skilled assistant for the operator. Minimum monitoring during the performance of an injection containing local anaesthetic should include regular measurement of blood pressure and pulse oximetry (see Explanatory note **d**).
- 8** Epidural injections for the treatment of back pain and leg pain of spinal origin should not be performed without good reason on a *patient whose conscious level is depressed (as a result of anaesthesia or sedation)*, or a patient who cannot communicate (as a result of mental health problems or language difficulties).
- 9** If local anaesthetic has been injected into the epidural space the minimum monitoring after injection should include regular measurement of pulse rate and blood pressure every five minutes for the first 30 minutes. Oxygen saturation should be monitored during recovery if sedation has been used during the procedure. If local anaesthetic has been injected into the epidural space there should be assessment of lower limb motor power and of ability to pass urine before discharging the patient (see Explanatory note **e**).
- 10** There must be contemporaneous records of the consent for the procedure, of the technique used and of the physiological monitoring before, during and after the procedure.
- 11** Following discharge the patient must be able to contact a member of the team should a problem arise in the immediate post-injection period.
- 12** Follow-up should be arranged with the person who performed the injection or with another member of the team who has responsibility for the patient's ongoing care and has access to the patient's records. The timing of this follow-up will depend upon clinical circumstances but normally should occur no later than six weeks after the injection.

Explanatory notes

- a** Competence describes possession of the knowledge, skills and attitudes required to undertake safe clinical practice at a level commensurate with the grade of the doctor. For epidural injections the following competencies apply:

Knowledge

Applied anatomy, pathology and clinical characteristics of acute and chronic spinal pain and radicular pain, interpretation of investigations such as CT and MRI scans, pharmacology of drugs injected into the epidural space, indications, contraindications (including coagulopathies, anticoagulant medication and local infection at the proposed site of injection), evidence of benefit, potential risks and complications.

ii Skills

Performance of caudal epidural injection, performance of lumbar epidural injection. (Some practitioners may confine their skills to caudal epidural injection.)

Identification of the epidural space. Recognition of incorrect needle placement. Recognition of dural puncture. Perioperative management of patient. Management of complications.

iii Attitudes

Ability to select appropriate patients. Ability to communicate with patients and to offer appropriate information. Gentle handling of patient throughout treatment.

It is important to note the standards set by CNST (Clinical Negligence Scheme for Trusts). From 1 October 1999 the CNST requires that all medical staff in training when taking up a new post are given by their supervisor a list of the technical skills they are expected to be able to perform. The trainees must indicate their competence to perform the specified tasks. A supervised training programme must rectify any deficiencies in initial, or continuing, competence.

- b** This is a matter of responsibility for the individual practitioner and also for the institution in which that practitioner performs epidural injections.
- c** Resuscitation skills must be appropriate for the type of epidural injection. The injection of local anaesthetic carries the risk of inadvertent intrathecal or intravascular injection. Both these situations require an advanced level of resuscitation skills. Competence in resuscitation includes:

i Knowledge

Resuscitation guidelines of Resuscitation Council (UK). Causes of cardiac arrest during epidural injections. Clinical features of local anaesthetic toxicity. The factors relating to brain injury at cardiac arrest. Factors influencing the effectiveness of cardiac compression. Drugs used during cardiopulmonary resuscitation (CPR) (adrenaline, atropine, lignocaine, calcium, magnesium, sodium bicarbonate). The ethics of CPR. Record keeping at CPR.

ii Skills

Able to recognise total spinal, local anaesthetic toxicity, cardiac and respiratory arrest. Able to perform cardiac compression. Able to manage the airway during CPR: using expired air breathing, bag and mask, laryngeal mask and endotracheal intubation. Able to perform CPR either single-handed or as a member of a team. Able to use a defibrillator. Able to interpret arrhythmias causing and associated with cardiac arrest. Able to perform resuscitation sequences for ventricular tachycardia, ventricular fibrillation, asystole, EMD (electromechanical dissociation). Able to move a patient into the recovery position.

iii Attitudes

Desire to offer the best possible chance of survival. Able to organise ongoing care after resuscitation.

- d** The use of local anaesthetic for epidural injection is associated with the risk of inadvertent intrathecal injection leading to a 'total spinal' or of inadvertent intravenous injection resulting in local anaesthetic toxicity. Both clinical situations are life threatening and require immediate resuscitation. The skilled assistant should be a doctor, nurse or operating department assistant who has undergone training in resuscitation and has kept up to date in resuscitation skills appropriate for the potential clinical situation.
- e** The introduction of minimal monitoring during anaesthesia represented a major advance in patient safety. Even though adverse events are relatively uncommon, if one patient is harmed by the absence of monitoring, then that is one too many.

An Anatomic Study of the Sacral Hiatus: A Basis for Successful Caudal Epidural Block

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Study Design: An anatomic study of the sacral hiatus using isolated sacra.

Objectives: To clarify the anatomic variations of the sacral hiatus using the bony landmarks of the sacrum for improving the reliability of caudal epidural block (CEB).

Background Data: The CEB has been widely used for the diagnosis and treatment of lumbar spinal disorders. The reliability of CEB is 70%–80% in the literatures. The cause of failure of CEB may depend on anatomic basis.

Methods: A total of 92 isolated sacra were used in this study. The bony landmarks were sacral hiatus and sacral cornua. Morphologic types of the sacral hiatus were classified using these landmarks. Also, location of the apex of sacral hiatus, diameter of the sacral canal at the apex of sacral hiatus, and the distance between bilateral cornua were measured. Two orthopedic surgeons performed measurements independently.

Results: Forty-two percent of the cases have both hiatus and cornu. Four percent of the cases showed the absent hiatus. The apex of sacral hiatus existed at the level of S4 vertebrae in 64% of the cases. The average diameter of the sacral canal was 6.0 ± 1.9 mm. The average distance of bilateral sacral cornua was 10.2 ± 0.35 mm. There were closed hiatus in 3% of cases.

Conclusions: The sacral hiatus has anatomic variations. Understanding of these variations may improve the reliability of CEB.

Key Words: caudal epidural block, sacral hiatus

(*Clin J Pain* 2004;20:51–54)

Caudal epidural block (CEB) has been widely used for the diagnosis and treatment of lumbar spinal disorders in the orthopedic field.^{1–5} In clinical studies, the success rate of CEB

has been reported to be about 70–80%.^{5–7} White and colleagues reported that 82% of patients with lumbar pain had pain relief 1 day after CEB.^{5–8} Stitz and colleagues showed that there was a successful injection without using fluoroscopic view in 74% of the cases.⁷ It has been reported that one of the anatomic reasons of CEB failure was caused by an absent hiatus and the frequency of absent hiatus was 7.7%.⁹ One of the important key factors of successful CEB may be a clear understanding of the normal anatomy of the sacral hiatus and the surrounding structures. The sacral hiatus is located at the caudal end of the sacrum and bordered laterally by two sacral cornua. Only skin, subcutaneous fat tissue, and the sacrococcygeal ligament cover the hiatus. When the needle has passed through the sacrococcygeal ligament, the hiatus communicates with the epidural space directly.

The purpose of the present study was to clarify the anatomic variations of the sacral hiatus using the bony landmarks of the sacrum for improving the reliability of CEB.

MATERIALS AND METHODS

The sacra in this study are from Fukushima Medical University and Nagoya University School of Medicine. Thirty-four were male, 13 were female, and 45 were unknown. The average age was 61.9 years old (range of age: 20–82 years old) in 46 of the 92 sacra (50% of the cases). In the other 46 of 92 sacra (50% of the cases), the age was unknown. A total of 92 cadaveric human sacra were stripped of all soft tissue in this study. All of them were Japanese. The bony landmarks used in this study were the sacral hiatus, the sacral cornua, and the median sacral crest (Fig. 1).

Macroscopic Observation

The Ratio of Existence or Absence of the Sacral Hiatus

The ratio of the existence or absence of the sacral hiatus and the sacral cornu was observed. The sacral hiatus were classified into two types, existence and absence. An absent hiatus means that no dimple exists at the posterior wall of the sacrum.

The Ratio of Existence or Absence of the Sacral Cornu

The sacral cornua were classified into three types: bilateral cornua, unilateral cornu, and absent cornu. An absent sa-

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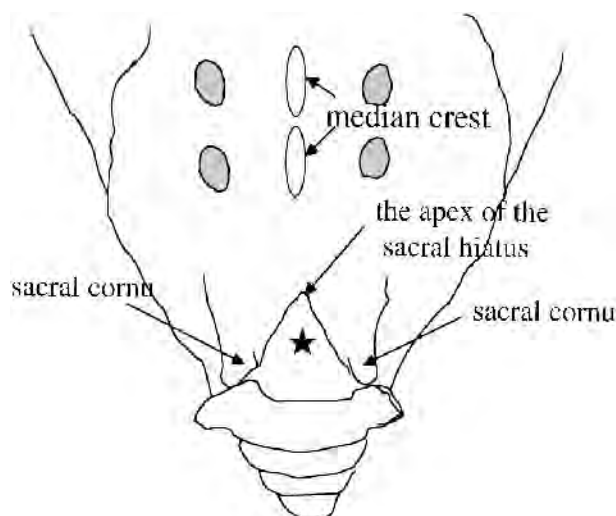


FIGURE 1. The bony landmarks. The sacral hiatus (★), the sacral cornua, and the median sacral crest.

cral cornu means that the height of the bony protrusion is less than 3 mm.

Morphologic Types of the Sacral Hiatus

Various morphologic types of sacral hiatus were classified into 4 types according to the existence or absence of two landmarks. Type A has both hiatus and cornua; Type B has hiatus, but absence of cornua; Type C has cornua, but absence of hiatus; and Type D has no hiatus or cornua.

Location of the Apex of the Sacral Hiatus

Location of the apex of sacral hiatus was determined by the level of the sacral vertebrae from S1 to S5.

Measurements

Diameter of the Sacral Canal at the Apex of Hiatus

The distance between anterior wall and posterior wall of the hiatus was measured at the apex (Fig. 2A).

Distance Between Bilateral Cornua

The distance between the apex of the bilateral sacral cornu was measured (Fig. 2B). When the height of the bony protrusion is less than 3 mm, the distance between the mcenter of the bilateral cornu was measured.

Distance Between the Caudal End of the Median Sacral Crest and the Apex of the Hiatus

The distance between the caudal edge of the median sacral crest and the apex of the hiatus was measured (Fig. 2B).

All of the measurements were performed independently by two orthopedic surgeons using a pair of calipers.

Statistical Analysis

Intra-observer reproducibility and inter-observer reliability were analyzed using Kappa coefficient.

RESULTS

Macroscopic Observation

The Ratio of Existence or Absence of the Sacral Hiatus

Sacral hiatus occurred in 88 of 92 sacra (96%). Absent hiatus occurred in 4 of 92 sacra (4%).

The Ratio of Existence or Absence of the Sacral Cornu

Sacral cornu occurred in 42 of 92 sacra (46%), and absent cornua occurred in 50 of 92 sacra (54%). Bilateral sacral cornua occurred in 19 of 42 sacra (45%), and unilateral cornu occurred in 23 of 42 sacra (55%).

Morphologic Types of the Sacral Hiatus

The incidences of each morphologic type of sacral hiatus were Type A: 39 of 92 sacra (42%); Type B: 49 of 92 sacra (53%); Type C: 3 of 92 sacra (3%); and Type D: 1 of 92 sacra (1%) (Fig. 3).

Location of the Apex of the Sacral Hiatus

The incidences of the apex of sacral hiatus located at the level of S1 to S5 vertebrae were: S1: 1 of 92 sacra (1%); S2: 4 of 92 sacra (4%); S3: 13 of 92 sacra (15%); S4: 60 of 92 sacra (65%); and S5: 14 of 92 sacra (15%). The apex of the sacral hiatus at the S4 or S5 level was 80% of the cases. The apex of the hiatus lies lower than the middle of the S5 vertebra in 3 of 92 sacra (3%).

Measurements

Intra-observer reproducibility was 0.86, and inter-observer reliability was 0.81 in this study.

Diameter of the Sacral Canal at the Apex of the Sacral Hiatus

The range of the diameter of the sacral canal was from 1.9 mm to 11.4 mm. The average diameter \pm standard deviation (SD) of the sacral canal was 6.0 ± 1.9 mm. The diameter of sacral canal at the apex of the hiatus was less than 2 mm in 1 of 92 sacra (1%).

Distance Between Bilateral Cornua

The range of the distance between the bilateral cornua was from 2.2 mm to 18.4 mm. The average distance \pm SD of bilateral sacral cornua was 10.2 ± 0.35 mm. In 5 of 92 sacra (5%), the distance between the bilateral cornua was less than 5 mm.

Distance Between the Caudal End of the Median Sacral Crest and Apex of the Hiatus

In 92 sacra, the distance was less than 5 mm in 34 cases (37%), more than 5 mm, but less than 10 mm in 12 cases

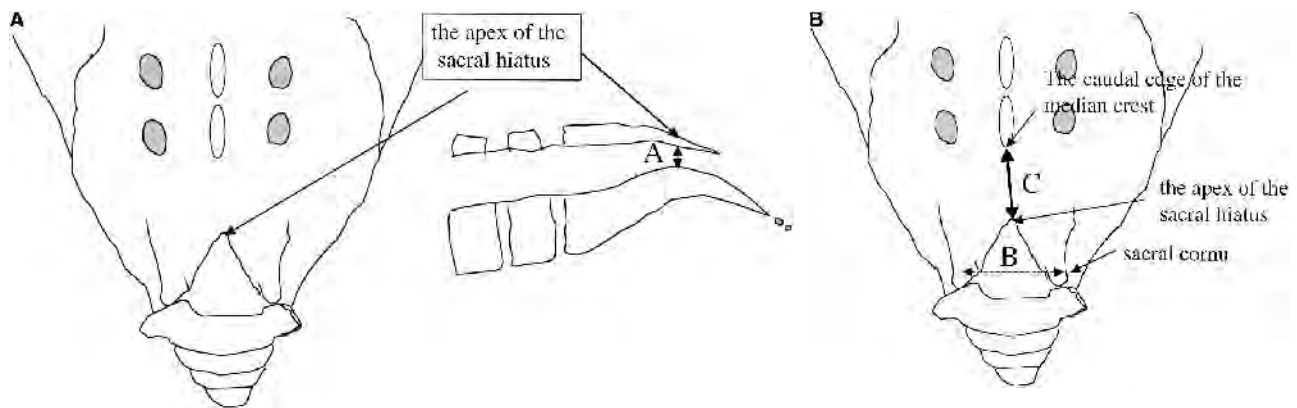


FIGURE 2. Measurements. Diameter of the sacral canal at the apex of hiatus (A), distance between the apex of the bilateral cornua (B), and distance between the caudal edge of the median sacral crest and the apex of the hiatus (C).

(13%), and more than 10 mm in 44 cases (49%). There was a wide range of distance variations in this series.

Anatomic Abnormalities of Sacrum

Anatomic abnormalities of the sacral hiatus were absent hiatus (4%), bony septum (2%), and complete agenesis which means that sacrum has no posterior wall (1%) (Fig. 4). A closed sacral canal occurred in 3 of 92 sacra (3%); however, two of them had sacral hiatus.

DISCUSSION

There are closed sacral canals in 3% of the cases. In 7% of the cases there are some anatomic abnormalities of sacral hiatus such as absent hiatus (4%), bony septum (2%), and com-

plete agenesis (1%). The diameter of sacral canal was less than 2 mm in 1% of the cases. Both sacral hiatus and cornua existed in only 42% of the cases. The cornua was absent in 54% of the cases.

One of the factors of CEB failure is anatomic variation. The sacral hiatus is the most important bony landmark for CEB since the apex of the sacral hiatus shows the existence of a sacral canal. Clinicians sometimes experience difficulties to palpate the sacral hiatus and other bony landmarks. Therefore, it is important to clarify the anatomic variations of the sacral hiatus without soft tissue.

In the current study, closed sacral canals make CEB impossible anatomically in 3% of the cases because the needle cannot be inserted into the sacral canal. When the location of the sacral canal is not identified, it is difficult to insert the needle through the canal. Cases of the absence of hiatus (absent hiatus), bony septum at sacral hiatus, and complete agenesis make it difficult to locate the sacral canal opening. These factors might cause CEB failure in 7% of the cases. Also, in a narrow canal it may be difficult to insert the needle into the sacral canal. The 22gauge needle is used for CEB. The diameter of sacral canals less than 2 mm might cause CEB failure in 1% of the cases. In our study, the apex of the hiatus was located higher than the S3 vertebra in 20% of the cases. The sacral spinal canal contains the terminal part of the dural sac, which is usually located at the S2 vertebral level.¹⁰ Therefore, 20% of the cases have a risk of puncturing the dural sac.

One may assume that palpation of the median sacral crest toward caudal direction may also indicate the location of the sacral hiatus. However, 44 of 92 sacra (49%) showed a distance of more than 10 mm between the distal end of median sacral crest and the apex of hiatus. This means that the median crest cannot be a landmark to detect the sacral canal.

Black has shown that the incidence of absent hiatus, which causes CEB failure, is 7.7%.⁹ Stitz and colleagues have reported that patients with successful CEB using the fluoro-


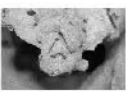


	(+) sacral cornua	(-) sacral cornua
(+) sacral hiatus	Type A: 42% 	Type B: 53% 
(-) sacral hiatus	Type C: 3% 	Type D: 1% 

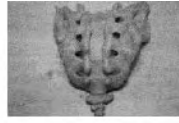
FIGURE 3. The incidences of morphologic types of sacral hiatus.



Absent hiatus
4/92 (4%)



bony septum
2/92 (2%)



complete agenesis
1/92 (1%)

FIGURE 4. Anatomic variations of the sacral hiatus. Absent hiatus: 4/92 (4%), bony septum 2/92 (2%), and complete agenesis 1/92 (1%).

scopic view are approximately 94%.⁷ The CEB failure occurs even if the fluoroscopic view is used. The present study showed that CEB failure might occur in 3–11% of patients because of anatomic abnormalities. Black showed that the rate of normal sacral cornua is 52% and unilateral cornu is 17%.⁹ The current study showed that the rate of normal sacral cornua was only 21% and absent cornua was more than 50%. The rate of absent cornua was quite different from Black's study, since we defined it as an absent cornua when the sacral cornu was less than 3 mm in height. In human patients, connective and fatty tissues existed between the hiatus and the skin. These factors may influence the palpation of the hiatus.

In conclusion, there are anatomic variations in the sacral hiatus, which may relate to the failure of CEB. The rate of impossible CEB is 3% since the sacral canal was closed. There are bony anatomic abnormalities: absent hiatus (4%), bony septum (2%), complete agenesis (1%), and narrow sacral space (1%). These anatomic abnormalities may be a factor to cause CEB failure. We should pay attention to anatomic variations of sacral hiatus when performing CEB. When the operator notices an abnormality of the hiatus, he should choose lumbar

epidural block or other treatments to avoid the risk of the soft tissue injury and the toxicity of local anesthetics.

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Ultrasound Guidance in Caudal Epidural Needle Placement

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Background: This study was conducted to investigate the feasibility of using ultrasound as an image tool to locate the sacral hiatus accurately for caudal epidural injections.

Methods: Between August 2002 and July 2003, 70 patients (39 male and 31 female patients) with low back pain and sciatica were studied. Soft tissue ultrasonography was performed to locate the sacral hiatus. A 21-gauge caudal epidural needle was inserted and guided by ultrasound to the sacral hiatus and into the caudal epidural space. Proper needle placement was confirmed by fluoroscopy.

Results: In all the recruited patients, the sacral hiatus was located accurately by ultrasound, and the caudal epidural needle was guided successfully to the sacral hiatus and into the caudal epidural space. There was 100% accuracy in caudal epidural needle placement into the caudal epidural space under ultrasound guidance as confirmed by contrast dye fluoroscopy.

Conclusions: Ultrasound is radiation free, is easy to use, and can provide real-time images in guiding the caudal epidural needle into the caudal epidural space. Ultrasound may therefore be used as an adjuvant tool in caudal needle placement.

CAUDAL epidural anesthesia is the injection of medications into the epidural space *via* the sacral hiatus. It is useful when anesthesia of the lumbar and sacral dermatomes is needed.¹ Successful caudal anesthesia relies on the proper placement of a needle in the epidural space. The most common method to identify the caudal epidural space is detecting the characteristic “give” or “pop” when the sacrococcygeal ligament is penetrated.^{1,2} Even with experienced physicians, the failure rate of the placement of needles into the caudal epidural space can be up to 25%.^{1,3}

In clinical practice, the “whoosh” test,³ nerve stimulation,¹ and fluoroscopy are the three methods that can be used to identify the caudal space before the injection of medications. The application of ultrasonography to locate the sacral hiatus for caudal epidural injections has not been described. The purpose of this study was to examine the practicality of using ultrasound guidance in the placement of a caudal needle into the caudal epidural space.

Materials and Methods

Seventy patients with low back pain and sciatica were studied. This study was approved by the local medical ethics and the human clinical trial committee (Chang Gung Memorial Hospital, Tao-Yuan County, Taiwan). All of the recruited subjects signed the informed consent and agreed to receive caudal injections.

The SONOS 4500 (Philips Medical Systems, Andover, MA) ultrasound machine was used in this study. The selected transducer was the S12 5-12 MHz real-time linear-array ultrasound transducer (Philips Medical Systems).

Design

Patients were placed in the prone position. The assistant's arms were placed horizontally, out of the physician's way, to hold the gluteal masses apart to achieve a flatter skin surface at the sacral hiatus area for the placement of ultrasound transducer. The examined area was prepared and draped in the usual sterile fashion. The transducer was covered with sterile plastic.

The transducer was first placed transversely at the midline to obtain the sonographic transverse view of the sacral hiatus. The following findings were observed (fig. 1):

1. The two hyperechoic reversed U-shaped structures were the two bony prominences of sacral cornua.
2. Between the two cornua, there were two hyperechoic band-like structures. The band-like structure on top was the sacrococcygeal ligament. The band-like structure at the bottom was the dorsal bony surface of the sacrum.
3. The sacral hiatus was the hypoechoic region observed between the two hyperechoic band-like structures.

The transducer was then rotated 90° to examine the sonographic longitudinal view of the sacral hiatus. Anatomically, the transducer then rested between the two cornua. A 21-gauge caudal epidural needle was inserted and advanced under the sonographic longitudinal view of the sacral hiatus. The caudal epidural needle appeared as a hyperechoic structure under sonography (fig. 2). The advancement of the caudal epidural needle between the two cornua to the sacral hiatus and into the caudal epidural space was observed as continuous and real-time sonographic images. As the caudal epidural needle pierced through the sacrococcygeal ligament, the portion of the needle inside the caudal epidural space was no longer observed under sonography (fig. 2).

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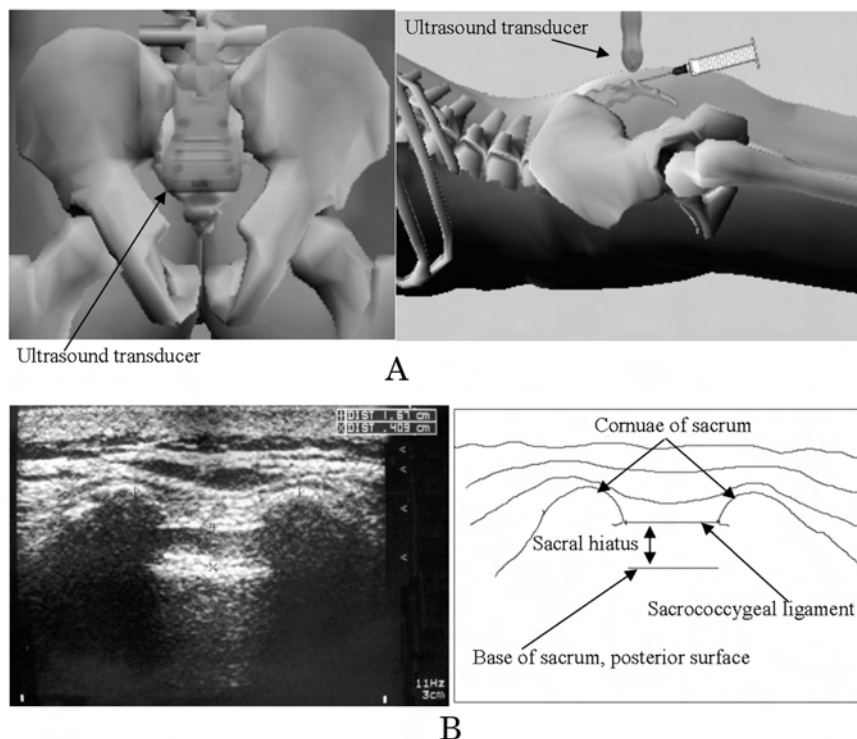


Fig. 1. (A) Transverse plane placement of the ultrasound transducer. (B) Sonographic transverse view of the sacral hiatus.

The ultrasound transducer was then adjusted in transverse and longitudinal views to make sure the spinal needle was inserted correctly into the caudal epidural space. Under the transverse view, the spinal needle appeared as a small circular hyperechoic structure, resting between the two hyperechoic cornua, and within the two hyperechoic band-like structures (fig. 3). Finally, contrast dye fluoroscopy was used to confirm the location of the caudal epidural needle (fig. 4). To prevent bias, the ultrasound-guided caudal needle insertions and the interpretation of fluoroscopy images were performed by different physicians.

Results

Seventy patients with low back pain and sciatica were recruited for this study. There were a total of 39 male and 31 female patients. The average age was 38 ± 5.6 yr. The average body height was 168 ± 8.9 cm for the male patients and 160 ± 4.3 cm for the female patients.

In all the recruited patients, the sacral hiatus was located correctly by ultrasonography in both the transverse and longitudinal views. The advancing motion of the hyperechoic caudal epidural needle to the sacral hiatus and into the caudal epidural space was observed as continuous and real-time images under the sonographic longitudinal view. The portion of the caudal epidural needle inside the caudal epidural space could not be observed under sonography (fig. 2). In all the cases, the characteristic “give” or “pop” was detected when the sacrococcygeal ligament was penetrated.

The average time span from locating the sacral hiatus to the insertion of the caudal epidural needle into the caudal epidural space was less than 2 min. Under ultrasound guidance, only one attempt was needed in guiding the caudal epidural needle into the caudal epidural space.

Fluoroscopy was then used to confirm the location of the caudal epidural needle. The caudal epidural needle was correctly placed into the caudal epidural space in all of the recruited patients as confirmed by contrast dye fluoroscopy. Christmas tree-like appearance resembling contrast dye distribution was observed in all of the patients (fig. 4).

Therefore, after fluoroscopic confirmation, the accuracy of ultrasound guidance in locating the sacral hiatus for proper placement of the caudal epidural needle into the caudal epidural space was 100%.

Discussion

Epidural injections of local anesthetic agents and corticosteroids are widely used to provide symptomatic relief in patients with low back disorders.³ Epidural steroid injections have been used since 1952.⁴ These injections can be approached by translaminar,⁵ transforaminal,⁴ and caudal routes.⁵ The caudal entry into the epidural space is preferred by many practitioners because accidental puncture of the dural sac and subsequent risk of intrathecal injection of medication is rare.^{1,3} However, even with experienced physicians, up to 25% of the injections using the caudal route do not

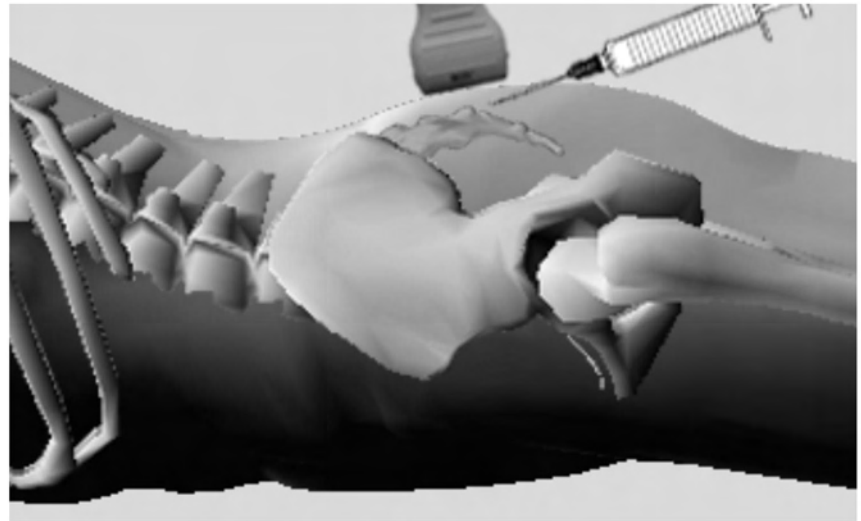
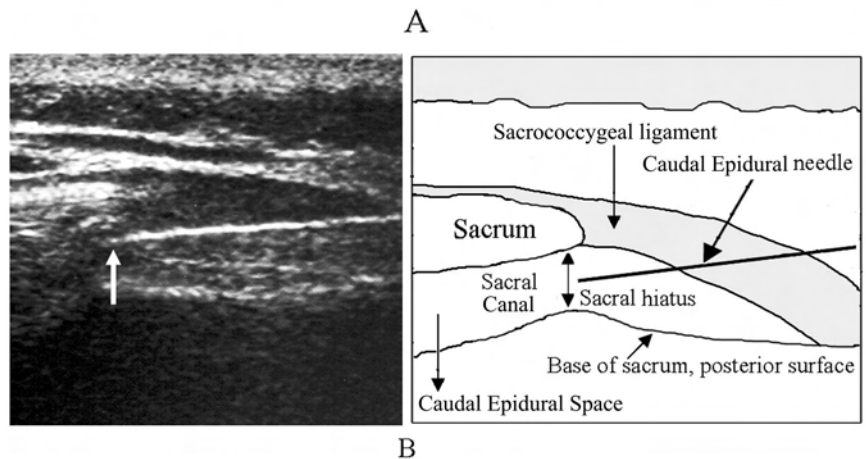


Fig. 2. (A) Longitudinal plane placement of the ultrasound transducer. (B) Caudal epidural needle is observed as a hyper-echoic structure under sonography. The portion of the needle inside the caudal epidural space cannot be observed under ultrasonography.



enter the epidural space.^{1,3} As a result, the development of an easy and reliable objective method that enables rapid confirmation of proper caudal needle placement is desirable.¹

There are several ways to identify the caudal epidural

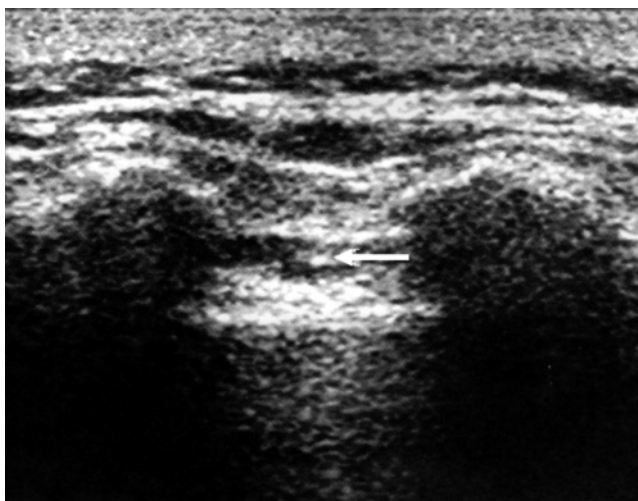


Fig. 3. The ultrasound transverse view. Arrow indicates caudal epidural needle.

space. The most common one is the detection of the characteristic “give” or “pop” on penetration of the sacrococcygeal ligament.¹ However, final confirmation of the proper needle placement can be made only after observing the clinical effect of the injected medication.¹ The lack of subcutaneous bulging or resistance on injection of local anesthetic are also important signs of proper needle placement.¹ The “whoosh” test was claimed to be more reliable than the “give” or “pop” of the sacrococcygeal ligament.⁶ However, eliciting the “whoosh” may cause venous air embolism after injection of 2.5 ml air.^{1,2} The nerve stimulation test is the other method to confirm caudal needle placement.^{1,7} The needle is classified as correctly or incorrectly placed depending on the presence or absence of anal sphincter contraction to electrical stimulation.¹

Fluoroscopy is most commonly used in interventional spine procedures⁴ and is frequently used in confirming the location of caudal epidural needle. It has been advocated that caudal epidural needle placement should be confirmed by fluoroscopy alone or by epidurography.³ Radiation exposure is the major concern when obtaining fluoroscopic images. Botwin *et al.*⁴ stated that spinal

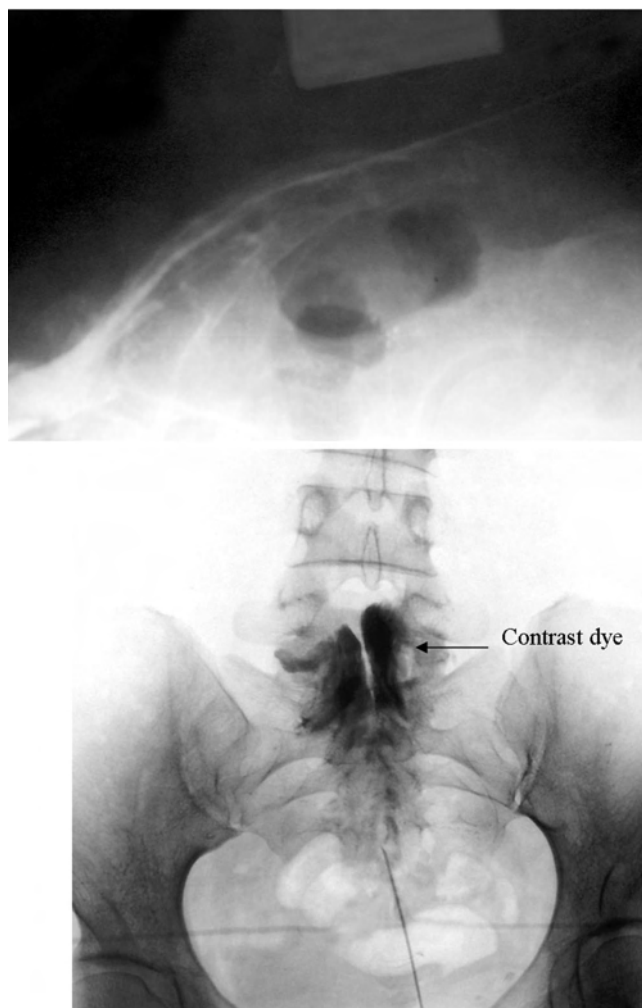


Fig. 4. Fluoroscopy confirmation with contrast dye. Christmas tree-like appearance can be observed as the contrast dye bathes the external aspect of the dura mater and nerve roots.

interventionalists should adhere to simple rules of radiation safety to minimize the cumulative radiation exposures. These rules included increasing the distance between the interventionalist and the radiation source; decreasing the overall time of exposure; shielding susceptible areas with leaded aprons, thyroid shields, leaded glasses, and leaded gloves; and being proficient in

guiding needles under the fluoroscope.⁴ Fluoroscopy can also provide real-time and continuous images, but this increases the overall time of exposure. Currently, pulsed imaging is preferred during fluoroscopy because it can reduce overall exposure by 20–75%.⁴

In this study, ultrasonography proved to be an effective tool, with 100% accuracy in locating the sacral hiatus and in guiding the caudal epidural needle into the caudal epidural space. The advantages of ultrasound are that it is easy to use, it is radiation-free, and can be used in virtually any clinical setting.⁸ Most significantly, ultrasonography can provide real-time and continuous needle-guiding images without radiation exposure. It takes approximately 2 h of training for an inexperienced physician to learn the ultrasound-guided caudal epidural injection technique. Physicians must be acquainted with skills in manipulating the ultrasound probe and interpreting the sonograms.

Perhaps the only disadvantage with ultrasound is the fact that it cannot provide us with the image information as to the depth of the inserted needle. Ultrasound waves cannot penetrate the sacral bone to observe the hyperechoic caudal epidural needle inside the caudal epidural space. Therefore, checking for the escape of cerebrospinal fluid for possible dura tear is critical before steroid injection can be pursued.

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Sonographically Guided Caudal Epidural Steroid Injections

Rainer Klocke, MRCP, Timothy Jenkinson, MB, BCh, David Glew, MB, BCh

Objective. Caudal epidural steroid injections are used for the symptomatic treatment of radicular lumbosacral pain syndromes, but incorrect injection placement has been recognized as a common problem with the routinely used unguided technique. We aimed to explore the use of sonography to facilitate this procedure. **Methods.** In patients with clinically unreliable anatomic landmarks, high-resolution real-time sonography was used to identify those landmarks and to assist in correct needle placement. **Results.** Sonography enabled localization of the sacral hiatus landmarks. We found this method particularly useful for guiding needle placement in patients with moderate obesity. **Conclusions.** Real-time sonography can facilitate caudal epidural steroid injections. **Key words:** caudal epidural injection; interventional sonography; sciatica.

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Epidural steroid injections can be helpful in the symptomatic treatment of pain due to lumbosacral root compression, such as sciatica and lumbar spinal canal stenosis.^{1,2} The caudal approach to the epidural space via the sacral hiatus is often preferred by nonanesthetists because it carries a lower risk of inadvertent thecal sac puncture and intrathecal injection. The sacral hiatus is a triangular aperture at the base of the sacrum bordered by 2 bony prominences, the sacral cornua (Fig. 1). The clinical procedure depends on the correct identification of these anatomic landmarks by palpation. However, in the technique of fluoroscopic control with contrast agent injection after unaided insertion, incorrect needle placement has been reported to occur in 25% to 38% of cases,³⁻⁵ even in the hands of experienced operators. Furthermore, even when operators were confident, incorrect placement was seen in about 1 per 7 procedures. An incorrect needle position leads predominantly to deep subcutaneous injection.⁵ Factors associated

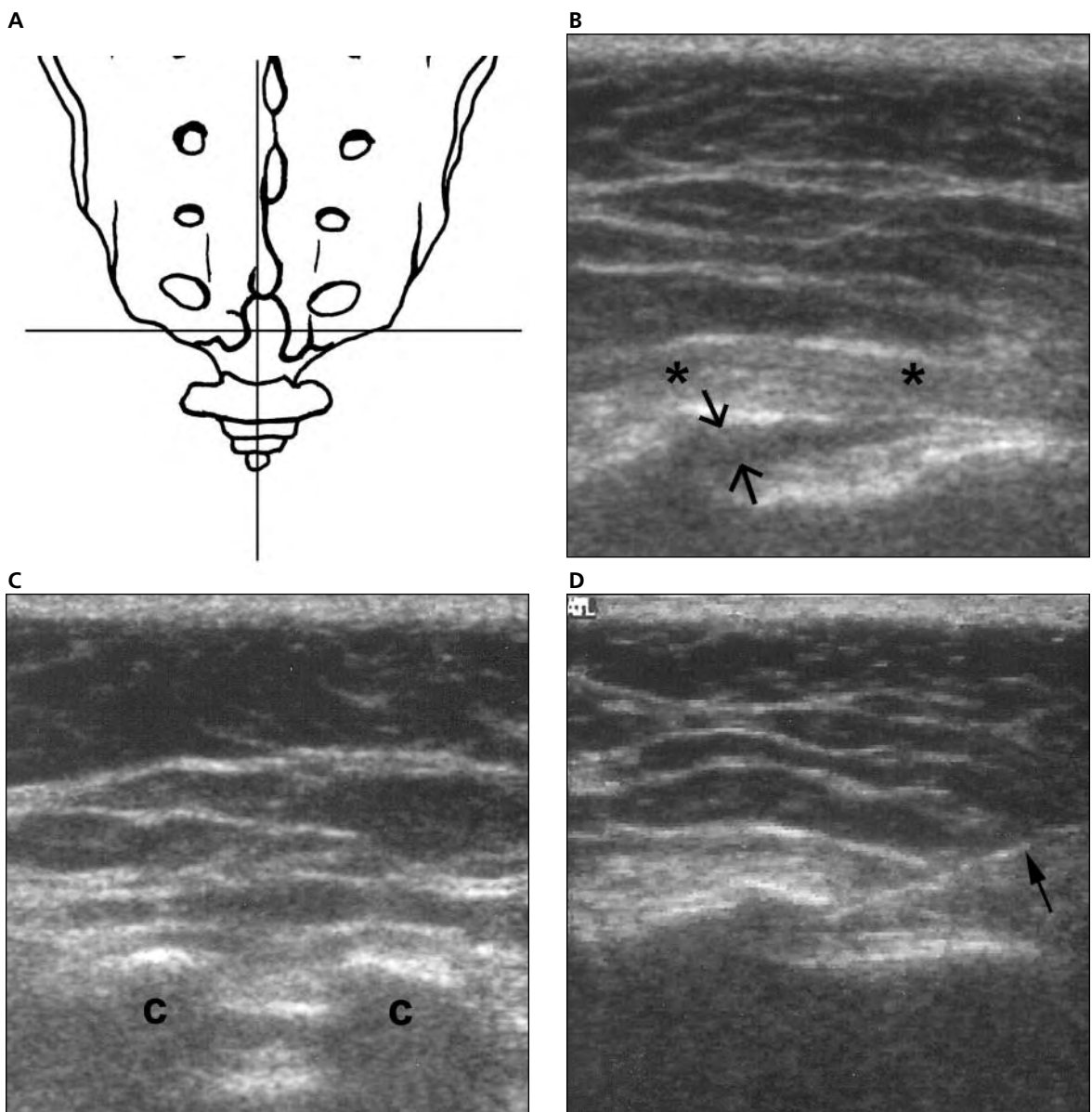
with incorrect placement include obesity, presumably because it causes impairment of correct clinical identification of the anatomic landmarks of the sacral hiatus. Finally, it has to be remembered that all aspects of the sacral canal anatomic characteristics, including the palpable landmarks, may vary.⁶

The authors of the fluoroscopically controlled studies concluded that all caudal epidural steroid injections should be performed under fluoro-

scopic guidance with contrast agent injection.³⁻⁵ Fluoroscopy, however, involves ionizing radiation close to the gonadal area, which will require careful consideration, particularly in patients of reproductive age.

We used high-resolution sonography to identify the anatomic landmarks of the sacral hiatus and then to guide the injection needle into the epidural space.

Figure 1. **A**, Schematic drawing of the posterior aspect of the bony sacral hiatus. The vertical and horizontal axes indicate the imaging planes of the sonographic images taken in case 1 (**B** and **C**, respectively). **B**, Longitudinal sonogram showing the sacrococcygeal ligament (asterisks) and the epidural space in the sacral canal (arrows). **C**, Transverse image showing the sacral cornua (c). **D**, Still image from a video recording showing the injection needle (arrow) correctly positioned in the epidural space in case 1.



Materials and Methods

Patients attending the Royal National Hospital for Rheumatic Diseases for sciatica or lumbar spinal canal stenosis who had been routinely referred for therapeutic caudal epidural steroid injections were assessed by diagnostic sonography when anatomic landmarks were unreliable by palpation.

We used an HDI 5000 sonography system (Philips Medical Systems, Bothell, WA), with a 5- to 12-MHz, 38-mm-footprint linear array transducer. The patient was usually in a prone position with the pelvis supported by a pillow. After skin disinfection and application of a sterile transducer sheath and gel, the following structures were identified: the 2 sacral cornua, the apex of the sacral hiatus, and the sacrococcygeal ligament that stretches across the sacral hiatus and separates the subcutaneous tissue layer from the epidural space underneath (Fig. 1, A–C). In obese patients, it was sometimes necessary to use a 2- to 5-MHz curvilinear array transducer to achieve adequate penetration of deeper subcutaneous tissues. A 5- to 10-MHz, small-footprint “hockey stick” transducer was used occasionally when close proximity of the needle and transducer was required, for example, in thin individuals.

After skin anesthesia with 1% lignocaine, the sacral hiatus was visualized longitudinally, and a 20-gauge (0.9 × 90-mm) spinal needle was inserted and advanced under sonographic guidance through the sacrococcygeal ligament into the epidural space of the sacral canal (Fig. 1D). Slow injection of about 2 mL of air was used as a final check of correct needle placement; in the case of the epidural needle position, no air would emerge outside the sacrococcygeal ligament as judged by real-time sonography. Forty milligrams of triamcinolone acetonide in 15 to 20 mL of 0.9% sodium chloride was then injected slowly.

Results

In our experience, the anatomic landmarks and the sacrococcygeal ligament could be readily visualized, except in cases of extreme obesity. We used and found this procedure particularly helpful in the following clinical situations.

Case 1

A 65-year-old obese woman (body mass index, 33.8 kg/m²) with sciatica underwent sonography because anatomic landmarks of the sacral hiatus were impalpable. Figure 1 shows the longitudinal and transverse sonographic sections of her sacral hiatus (Fig. 1, B and C). The injection needle was then successfully guided through the sacrococcygeal ligament into the epidural space (Fig. 1D).

Case 2

A 70-year-old woman with sciatica was unable to lie in a prone or lateral decubitus position because of coexistent advanced rheumatoid arthritis. Successful sonographically guided epidural steroid injection was achieved with the patient in an oblique lateral position.

Case 3

In a 60-year-old woman with sciatica and psoriatic spondyloarthropathy, sonography was used to guide the needle into the sacral hiatus, avoiding psoriatic skin plaques in the sacral area, which may have posed an increased risk of a septic complication from the procedure.

Discussion

Here we describe the use of sonography to facilitate correct caudal epidural injection. In addition to the examples presented above (unreliable landmarks due to obesity, unusual patient positions, and individual local factors), this method would appear to be a safer alternative to the standard method of fluoroscopic guidance in patients of reproductive age. Given the above-mentioned relative lack of agreement between operator confidence in correct needle positioning and successful epidural injection placement, one could further argue for the routine use of sonography to verify sacral hiatus landmarks before all caudal epidural injections.

There is an important limitation to this method. Inadvertent intravenous injection, which has been reported to occur in about 5% to 9% of procedures,^{3–5} cannot be avoided with this technique. This is particularly important because aspiration or return of blood does not appear to be very sensitive or specific for intravenous positioning of the needle.⁴ A local anesthetic is preferred by some operators as the diluent for the epidural steroid preparation.

However, toxic plasma concentrations of a local anesthetic may occur upon inadvertent injection into an epidural vein. Because we use 0.9% sodium chloride instead, the adverse risks associated with accidental intravenous injection become negligible.

In conclusion, we have described a sonographic method for identifying the sacral hiatus landmarks to facilitate real-time guidance of steroid injections into the caudal epidural space. This method may be a good alternative to the current standard of fluoroscopic guidance.

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Melding om bivirkninger ved bruk av legemidler (inkl. naturlegemidler)



Statens legemiddelverk
Norwegian Medicines Agency



Skjemaet er på to (2) sider.
Utfyllt skjema sendes til RELIS i din helseregion. Se baksiden for adresser.

Unntatt offentlighet jf. Offl. § 5a, jf fvl. § 13 første ledd nr. 1

PASIENTOPPLYSNINGER

Navn: _____

Kjønn: _____

Fødselsdato: _____

Vedlagt: Epikrise Obduksjonsrapport
 Labjournal Annet
 Journalnotat

Årsak til meldingen: <input type="checkbox"/> Resulterte i død <input type="checkbox"/> Livstruende <input type="checkbox"/> Sykehusinnleggelse/forlenget opphold <input type="checkbox"/> Vedvarende uførhet/nedsatt funksjons evne <input type="checkbox"/> Anomali/fødselsdefekt <input type="checkbox"/> Ikke beskrevet i preparatomtalen <input type="checkbox"/> Bivirkning(er) ved generisk bytte <input type="checkbox"/> Bivirkning(er) ved bruk av reseptfritt legemiddel/naturlegemiddel <input type="checkbox"/> Bivirkning(er) av legemidler under særlig overvåking (se liste www.legemiddelverket.no) <input type="checkbox"/> Annet _____	Konsekvenser for pasienten <input type="checkbox"/> Restituert uten ettervirkninger <input type="checkbox"/> I bedring, men ikke fullstendig restituert <input type="checkbox"/> Restituert, men med ettervirkninger <input type="checkbox"/> Ingen bedring <input type="checkbox"/> Død
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LEGEMIDLER

Navn, styrke, legemiddelform Produsentnavn - generisk bytte	Dosering	Indikasjon	Startdato evt varighet av behandling	Stoppdato	Seponert (x)
Mistenkte legemidler*					
Andre legemidler Ingen andre legemidler <input type="checkbox"/>					

Mistanke om interaksjon Hvilke legemidler? _____

Reeksponeering av mistenkte legemidler Ja Nei Evt resultat _____

BIVIRKNINGER

Bivirkningsdiagnose(r) evt symptomer	Startdato (evt varighet)	Stoppdato
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* For biologiske produkt og vaksiner bør batchnr/lotnr oppgis

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Beskrivelse av forløpet:

Pasientens sykehistorie:

Resultater av tester (inkl datoer):

Melders navn og adresse

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Farmasøyt Annet helsepersonell

Melders dato: _____

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Hva skal meldes?

Følgende bivirkninger er meldepliktige:

- Dødelige og livstruende bivirkninger
- Bivirkninger som har gitt varige alvorlige følger
- Nye eller uventede bivirkninger

Statens legemiddelverk anser det også som nyttig å få meldinger om:

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- Problemer ved seponering av legemidler
- Reaksjoner på grunn av overdosering eller feilbruk av reseptfrie legemidler
- Bivirkninger av naturlegemidler og ved generisk bytte

Mistanke om bivirkning er tilstrekkelig for å melde. Meldinger som blir vurdert å ha en årsakssammenheng blir lagt inn i den nasjonale databasen for at opplysningene skal kunne formidles videre til Verdens helseorganisasjon (WHO) og de europeiske legemiddelmyndighetene, samt brukes senere. Klassifiseringen innebærer ikke at årsakssammenheng er bevist. Vedlegg av epikriser, journalnotater eller obduksjonsrapporter gir oss verdifull tilleggsinformasjon.

Hvem skal melde?

Blir pasienten lagt inn på sykehus, bør meldingen skrives av den sykehuslege som har behandlet eller utredet pasienten. Utenfor sykehus bør meldingen sendes av legen/tannlegen som diagnostiserer reaksjonen. Apotekfarmasøyer med pasientkontakt oppfordres til å melde bivirkninger de får kunnskap om gjennom sitt arbeid.

Personvern

Alle pasientopplysninger blir behandlet strengt konfidensielt av RELIS og Statens legemiddelverk. Alle persondata blir anonymisert ved innleggelse i bivirkningsdatabasen. Identifiserbare data blir ikke gitt videre i noe tilfelle.

Tables

Causes of acute lower back pain (Modified according to Eriksen and Brage, 2000)
Divided into the three main diagnostic groups

Non-specific back pain , rarely any definite or proven relation to the diagnosis
Muscle injury
Myalgia
Spondylosis
Degenerative changes
Pelvic loosening
Osteoarthritis
Scheuermann's disease
Spondylolisthesis
Scoliosis
Kyphosis
Deformities
Radiculopathy
Disc prolapse
Recess stenosis (lateral spinal stenosis)
Spinal stenosis (medial spinal stenosis)
Benign tumour in the nerve root
Synovial cysts
Systemic/visceral/possible severe pathology
Fracture/injury
Osteoporosis
Growths (Myeloma, Metastasis, Spinal tumour)
Inflammatory disease (Ankylosing spondylitis, Polymyalgia rheumatica, Reiter's disease, psoriasis, Intestinal disease)
Metabolic bone disease (Paget's disease)
Pancreatitis
Perforated ulcer
Pyelonephritis
Prostatitis
Kidney stone
Herpes zoster
Endometriosis
Aortic aneurysm

Appendix 5 Template for radiological
evaluation of magnetic resonance or CT
images

Template for radiological evaluation of MR and CT images

Date: Us:_____ Investigation:_____

Pasient: Initials:_____ B.date:_____ Pa.no:_____ Rand.no:_____

Radiologist:_____ MR Seq._____

Disc L3/L4:

Modic: I II III Mixed type I/II II/III
_____ % of end plate Max Depth _____ mm

Facettjoint: Degeneration: No Slight Severe
Assymmetry: No Yes

Spinal stenosis: Central: 0 1 2 Foraminal: 0 1 2

Discus: Signal intensity: 0 1 2 3

Disc height: _____ % of normal disc above

HIZ (High Intensity Zone): Not present Present

Disc contour: 0 1 2 3 4 5

Herniation Size:_____ Location:_____

Nerve root: 0 1 2 3 Thickening _____

Anterolisthesis: Not present Present ___mm +Spondylolysis

Retrolisthesis: Not present Present ___mm

Disc L4/L5:

Modic: I II III Mixed type I/II II/III
_____ % of end plate Max Depth _____ mm

Facettjoint: Degeneration: No Slight Severe
Assymmetry: No Yes

Spinal stenosis: Central: 0 1 2 Foraminal: 0 1 2

Discus: Signal intensity: 0 1 2 3
Disc height: _____% of normal disc above
HIZ (High Intensity Zone): Not present Present
Disc contour: 0 1 2 3 4 5
Herniation Size: _____ Location: _____

Nerve root: 0 1 2 3 Thickening _____

Anterolisthesis: Not present Present __mm +Spondylolysis

Retrolisthesis: Not present Present __mm

Disc L5/S1:

Modic: I II III Mixed type I/II II/III
_____ % of end plate Max Depth _____ mm

Facettjoint: Degeneration: No Slight Severe
Assymetry: No Yes

Spinal stenosis: Central: 0 1 2 Foraminal: 0 1 2

Discus: Signal intensity: 0 1 2 3
Disc height: _____% of the disc above
HIZ (High Intensity Zone): Not present Present
Disc contour: 0 1 2 3 4 5
Herniation Size: _____ Location: _____

Nerve root: 0 1 2 3 Thickening _____

Anterolisthesis: Not present Present __mm +Spondylolysis

Retrolisthesis: Not present Present __mm

Modic changes in other levels:

L1/L2: _____

L2/L3: _____

Signal intensity: 0: hyperintense homogeneous
 1: hyperintense with visible intranuclear cleft
 2: intermediate
 3: hypointense

Disc height is measured in percent of the height of the nearest normal disc above the disc we are evaluating.

Disc contour:	0: normal	Herniation Size:	0: no
	1: bulging		1: <1/3
	2: focal protrusion		2: 1/3-2/3
	3: broad based protrusion		3: >2/3
	4: extrusion		of spinal
	5: sequestration		canal (axial)

Location in axial plane:

0:	left extraforaminal
1:	left foraminal
2:	left recess
3:	left central
4:	central
5:	right central
6:	right recess
7:	right foraminal
8:	right extraforaminal

Nerve root:	0: no contact	Thickening of nerve root is defined as thicker than the contralateral one in the same level
	1: in contact	
	2: dislocation	
	3: compression	

Central spinal stenosis:

0:	normal
1:	relative
2:	severe

Foraminal spinal stenosis:

0:	normal
1:	reduced fat around the nerve root
2:	no visible fat around the nerve root

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Appendix 6 Form book

Pasientnr.

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Fødselsnr.

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Sykehus

- Sykehuset Levanger (420)
- Universitetssykehuset Nord-Norge (500)
- Nordlandssykehuset Bodø (510)
- Sykehuset Buskerud (230)
- St. Olavs Hospital (400)

SKJEMABOK

Versjon 3

Epidural sacral injection study

Effect of volume and triamcinolone on chronic
lumbosacral radiculopathy?

Double blind multicentre randomised
placebo-controlled trial.

Pasientens navn/mobilnr _____

Denne skjemabok skal følge pasientens journal

Prosjektleder:

Trond Iversen

Avd. for fys med og rehabilitering, UNN

Institutt for samfunnsmedisin (ISM), Universitetet i Tromsø

Mobilnummer 95 18 69 88

Epost trondiv@online.no

OVERSIKT SKJEMA

Dato for innsending
av skjema

Signatur

Pasientinformasjon (sendes til pasienten med innkallingen)

Skriftelig informert samtykke

Skjema 1 - inklusjon - uke 0

Skjema 2 - inklusjon - uke 0

Medikamentforbruk før injeksjon

Henvisning anestesilege vedlagt

- Randomisering og injeksjon
- Pasientinformasjon etter injeksjon
- Medikamentforbruk før etterundersøkelse
- Ultralydundersøkelse
- Årsaker til at epiduralinjeksjon nr 2 ikke blir gitt

Henvisning nevrofysiologi

Svar fra nevrofysiologi

Skjema 3 - 1. etterundersøkelse - uke 6

Skjema 4 - 1. etterundersøkelse - uke 6

Skjema 3 - 2. etterundersøkelse - uke 12

Skjema 4 - 2. etterundersøkelse - uke 12

Skjema 3 - 3. etterundersøkelse - uke 52

Skjema 4 - 3. etterundersøkelse - uke 52

Epidural sacral injection study. Protocol Code Number 2137. EudraCT Number 2004-004585-32. ISRCTN Number 12574253. **Pasientinformasjon og Skriftlig informert samtykke.** 2007-10-15.

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Skriftlig informert samtykke.

Informasjon om studien er gitt skriftlig og muntlig og pasienten har lest pasientinformasjonen om studien.

Dato:

Signatur:

Tittel:

Jeg har lest pasientinformasjonen og samtykker med dette i å delta i studien hvor effekten av sakral epidural rygginjeksjon med steroider sammenlignes med sakral epidural rygginjeksjon med placebo (saltvann).

Dato:

Pasientsignatur:

Din kontaktperson på sykehuset er:

Telefon:

Originalen beholdes i skjemaboken (Pasientens journal)

Kopi 1 er pasientens eksemplar

Kopi 2 sendes til: Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge, 9030 Tromsø, merket "Epiduralstudien".

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Spørreskjema for pasienter som skal injiseres i ryggen

Skjema 1 Pasient nr.

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Sykehus nr.

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Pasientdata	
Navn	
Fødselsnr. (11 siffer)	
Adresse	
Alder (år)	<input type="text"/>
Kjønn	<input type="checkbox"/> Mann <input type="checkbox"/> Kvinne

Formålet med dette spørreskjemaet er å gi leger, sykepleiere og fysioterapeuter bedre forståelse av ryggpasienters plager og å vurdere effekter av behandling. Din utfylling av skjemaet vil være til stor nytte for å kunne gi et best mulig behandlingstilbud til ryggpasienter i fremtiden.

Spørreskjemaet har fire deler. Første del omhandler ulike sider ved din utdanning og familie samt dine smerter og plager. De neste delene består av tre ulike sett spørsmål for måling av din nåværende helse. Det første av disse (kalt Oswestryskåre) måler hvordan ryggplagene påvirker dine dagligdagse gjøremål. Det andre (kalt EQ-5D) måler din helserelaterte livskvalitet. Den siste delen er en skala der du skal merke av hvor god eller dårlig din helsetilstand er.

Dato for utfylling	<input type="text"/>	.	<input type="text"/>	.	<input type="text"/>
	Dag		Måned		År

Røyker du?	<input type="checkbox"/> Ja <input type="checkbox"/> Nei
------------	--

Høyde og vekt

1. Hvor mye veier du? kg2. Hvor høy er du? cm

Utdanning og yrke

1. Hva er din høyeste fullførte utdanning? (Sett ett kryss)

- Grunnskole 7-10 år, framhaldsskole eller folkehøyskole
- Yrkesfaglig videregående skole, yrkesskole eller realskole
- Allmennfaglig videregående skole eller gymnas
- Høyskole eller universitet (mindre enn 4 år)
- Høyskole eller universitet (4 år eller mer)

2. Hvilket yrke har du, eller hadde du tidligere (før du eventuelt ble arbeidsledig, permittert, trygdet eller pensjonert)

Familie og barn

1. Sivilstatus (sett ett kryss)

- Gift
- Samboende
- Enslig

2. Hvor mange barn har du? stk

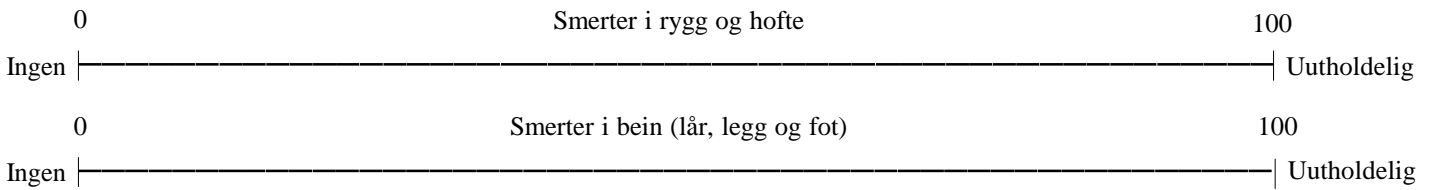
Morsmål

- Norsk
- Samisk
- Annet, angi hvilket

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Hvor sterke smerter har du nå

De vannrette linjene nedenfor viser en skala fra 0 til 100 for smertestyrke. Den begrenses på venstre side av ingen smerte (0) og på høyre side av uutholdelig smerte (100). Sett en strek på tvers av linjene svarende til din største smerte nå for tiden (den siste uken).



Funksjonsscore (Oswestry)

Disse spørsmålene er utarbeidet for å gi oss informasjon om hvordan dine smerter har påvirket dine muligheter til å klare dagliglivet ditt. Vær så snill å besvare spørsmålene ved å sette kryss (kun ett kryss for hvert avsnitt) i de rutene som passer best for deg.

1. Smerte

- Jeg har ingen smerter for øyeblikket
- Smertene er veldig svake for øyeblikket
- Smertene er moderate for øyeblikket
- Smertene er temmelig sterke for øyeblikket
- Smertene er veldig sterke for øyeblikket
- Smertene er det verste jeg kan tenke meg for øyeblikket

2. Personlig stell

- Jeg kan stelle meg selv på valig måte uten at det forårsaker ekstra smerter
- Jeg kan stelle meg selv på vanlig måte, men det er veldig smertefult
- Det er smertefult å stelle seg selv, og jeg gjør det langsomt og forsiktig
- Jeg trenger noe hjelp, men klarer det meste av mitt personlige stell
- Jeg trenger hjelp hver dag til det meste av eget stell
- Jeg kler ikke på meg, har vanskeligheter med å vaske meg og holder sengen

3. Å løfte

- Jeg kan løfte tunge ting uten å få mer smerter
- Jeg kan løfte tunge ting, men får smerter
- Smertene hindrer meg i å løfte tunge ting opp fra gulvet, men jeg greier det hvis det som skal løftes er gunstig plassert, for eksempel på et bord
- Smertene hindrer meg i å løfte tunge ting, men jeg klarer lette og middels tunge ting, hvis det er gunstig plassert
- Jeg kan bare løfte noe som er veldig lett
- Jeg kan ikke løfte eller bære noe i det hele tatt

4. Å gå

- Smerter hindrer meg ikke i å gå i det hele tatt
- Smerter hindrer meg i å gå mer enn 1 1/2 km
- Smerter hindrer meg i å gå mer enn 3/4 km
- Smerter hindrer meg i å gå mer enn 100 m
- Jeg kan bare gå med stokk eller krykker
- Jeg ligger for det meste i sengen, og jeg må krabbe til toalettet

5. Å sitte

- Jeg kan sitte så lenge jeg vil i en hvilken som helst stol
- Jeg kan sitte så lenge jeg vil i min favorittstol
- Smerter hindrer meg i å sitte mer enn en time
- Smerter hindrer meg i å sitte mer enn en halv time
- Smerter hindrer meg i å sitte mer enn ti minutter
- Smerter hindrer meg i å sitte i det hele tatt

6. Å stå

- Jeg kan stå så lenge jeg vil uten å få smerter
- Jeg kan stå så lenge jeg vil, men får mer smerter
- Smerter hindrer meg i å stå mer enn en time
- Smerter hindrer meg i å stå mer enn en halv time
- Smerter hindrer meg i å stå mer enn ti minutter
- Smerter hindrer meg i å stå i det hele tatt



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7. Å sove

- Søvnens min forstyrres aldri av smerter
- Søvnens min forstyrres av og til av smerter
- På grunn av smerter får jeg mindre enn seks timers søvn
- På grunn av smerter får jeg mindre en fire timers søvn
- På grunn av smerter får jeg mindre enn to timers søvn
- Smerter hindrer all søvn

Beskrivelse av helsetilstand (EQ-5D)

Vis hvilke utsagn som passer på din helsetilstand i dag ved å sette ett kryss i en av rutene utenfor hver av dimensjonene nedenfor.

1. Gange

- Jeg har ingen problemer med å gå omkring
- Jeg har litt problemer med å gå omkring
- Jeg er sengeliggende

8. Seksualliv

- Seksuallivet mitt er normalt og forårsaker ikke mer smerter
- Seksuallivet mitt er normalt, men forårsaker noe mer smerter
- Seksuallivet mitt er normalt, men svært smertefullt
- Seksuallivet mitt er svært begrenset av smerter
- Seksuallivet mitt er nesten borte på grunn av smerter
- Smerter forhindrer alt seksualliv

2. Personlig stell

- Jeg har ingen problemer med personlig stell
- Jeg har litt problemer med å vaske meg eller kle meg
- Jeg er ute av stand til å vaske meg eller kle meg

9. Sosialt liv (omgang med venner og bekjente)

- Det sosiale livet mitt er normalt og forårsaker ikke mer smerter
- Det sosiale livet mitt er normalt, men øker graden av smerter
- Smerter har ingen betydelig innvirkning på mitt sosiale liv, bortsett fra at de begrenser mine mer fysiske aktive sider, som sport osv.
- Smerter har begrenset mitt sosiale liv, og jeg går ikke så ofte ut
- Smerter har begrenset mitt sosiale liv til hjemmet
- På grunn av smerter har jeg ikke noe sosialt liv

3. Vanlige gjøremål (f.eks. arbeid, studier, husarbeid, familie- eller fritidsaktiviteter)

- Jeg har ingen problemer med å utføre mine vanlige gjøremål
- Jeg har litt problemer med å utføre mine vanlige gjøremål
- Jeg er ute av stand til å utføre mine vanlige gjøremål

4. Smerte og ubehag

- Jeg har verken smerte eller ubehag
- Jeg har moderat smerte og ubehag
- Jeg har sterk smerte og ubehag

5. Angst og depresjon

- Jeg er hverken engstelig eller depriment
- Jeg er noe engstelig og depriment
- Jeg er svært engstelig og depriment

10. Å reise

- Jeg kan reise hvor som helst uten smerter
- Jeg kan reise hvor som helst, men det gir mer smerter
- Smertene er ille, men jeg klarer reiser på to timer
- Smerter begrenser meg til korte reiser på under en time
- Smerter begrenser meg til korte, nødvendige reiser på under 30 minutter
- Smerter forhindrer meg fra å reise, unntatt for å få behandling

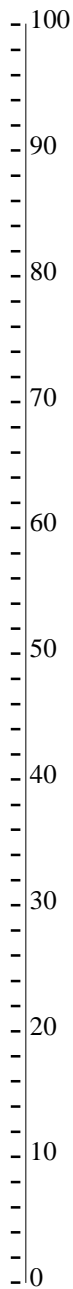
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Helsetilstand

For at du skal kunne vise oss hvor god eller dårlig din helsetilstand er, har vi laget en skala (nesten som et termometer), hvor den beste helsetilstanden du kan tenke deg er markert med 100 og den dårligste med 0.

Vi ber deg om at du viser din helsetilstand ved å trekke ei linje fra boksen nedenfor til det punkt på skalaen som passer best med din helsetilstand.

Best tenkelige
helsetilstand



Nåværende
helsetilstand

Verst tenkelige
helsetilstand

Har du søkt om uføretrygd?

- Ja
- Nei
- Planlegger å søke
- Er allerede innvilget

Har du søkt om erstatning fra forsikringsselskap eller folketrygden (evt. yrkesskadeerstatning)?

- Ja
- Nei
- Planlegger å søke
- Er allerede innvilget



SMERTE, FYSISK AKTIVITET OG JOBB

(Fear-Avoidance Beliefs Questionnaire,
Waddell et al 1993)

Her er noe av det som andre har fortalt oss om ryggsmertene sine. Kryss av for ett tall fra 0 (helt uenig) til 6 (helt enig) for hvert utsagn for å si hvor mye fysiske aktiviteter som å bøye seg, løfte, gå eller kjøre vil påvirke ryggen din.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
1	Smertene mine ble forårsaket av fysisk aktivitet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Fysisk aktivitet forverrer smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3	Fysisk aktivitet kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4	Jeg burde ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5	Jeg kan ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Følgende utsagn handler om hvordan det vanlige arbeidet ditt påvirker eller kan påvirke ryggsmertene dine.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
6	Smertene mine ble forårsaket av arbeidet mitt eller et uhell på jobben	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7	Arbeidet mitt forverret smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8	Jeg har framsatt erstatningskrav for smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9	Arbeidet mitt er for tungt for meg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10	Arbeidet mitt forverrer eller kan forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
11	Arbeidet mitt kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
12	Jeg burde ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
13	Jeg kan ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
14	Jeg kan ikke utføre det vanlige arbeidet mitt før smertene er behandlet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
15	Jeg tror ikke jeg vil være tilbake på det vanlige arbeidet mitt innen tre måneder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
16	Jeg tror ikke jeg noen gang vil være i stand til å komme tilbake til det arbeidet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



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Registrerings skjema for pasienter som injiseres i ryggen

<p>Pasientdata</p> <p>Navn</p> <p>Fødselsnr. (11 siffer) <table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table></p> <p>Adresse</p> <p>Alder (år) <table border="1"><tr><td> </td><td> </td></tr></table></p> <p>Kjønn <input type="checkbox"/> Mann <input type="checkbox"/> Kvinne</p> <p>Dato for utfylling <table border="1"><tr><td> </td><td> </td><td>.</td><td> </td><td> </td><td>.</td><td> </td><td> </td></tr><tr><td colspan="2">Dag</td><td></td><td colspan="2">Måned</td><td></td><td colspan="2">År</td></tr></table></p> <p>Arbeidsstatus</p> <p><input type="checkbox"/> I arbeid <input type="checkbox"/> Student/skoleelev</p> <p><input type="checkbox"/> Sykemeldt <input type="checkbox"/> Pensjonist</p> <p><input type="checkbox"/> Aktiv sykemeldt <input type="checkbox"/> Arbeidsledig</p> <p><input type="checkbox"/> Delvis sykemeldt <input type="checkbox"/> Attføring/rehabilitering</p> <p><table border="1"><tr><td> </td><td> </td></tr></table> % sykemeldt <input type="checkbox"/> Uføretrygdet</p> <p><input type="checkbox"/> Hjemneværende</p> <p>Symptomvarighet</p> <p>Ryggsmerter <table border="1"><tr><td> </td><td> </td><td> </td></tr></table> (uker)</p> <p>Utrålende smerter <table border="1"><tr><td> </td><td> </td><td> </td></tr></table> (uker)</p> <p>Varighet sykemelding og/eller attføring pga. disse smertene <table border="1"><tr><td> </td><td> </td><td> </td></tr></table> (uker)</p>																.			.			Dag			Måned			År													<p>Radiologisk vurdering (Kryss av for flere alternativer når det er aktuelt)</p> <p>1. Undersøkelse</p> <p><input type="checkbox"/> MR Dato <table border="1"><tr><td> </td><td> </td><td>.</td><td> </td><td> </td><td>.</td><td> </td><td> </td></tr><tr><td colspan="2">Dag</td><td></td><td colspan="2">Måned</td><td></td><td colspan="2">År</td></tr></table></p> <p>Sykehus/institutt.....</p> <p>2. Funn</p> <p><input type="checkbox"/> Normal</p> <p><input type="checkbox"/> Signalforandringer</p> <p><input type="checkbox"/> Skive bukning/dekket prolaps</p> <p><input type="checkbox"/> Fritt/Sekvestrert prolaps</p> <p><input type="checkbox"/> Fortykket nerverot</p> <p><input type="checkbox"/> Lateral resesstenose med dislosert nerverot</p>			.			.			Dag			Måned			År	
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Dag			Måned			År																																																			



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Kliniske funn
1. SLR

 Gradtall positiv test

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 Hø Ve

 2. Omvendt Lasegue positiv
(sett kryss)
 Hø Ve

3. Muskelkraft (tall 0-5)

 Tågåing
 Hø Ve

 Fleksjon, hofte
 Hø Ve

 Abduksjon, hofte
 Hø Ve

 Dorsalfleksjon, ankel
 Hø Ve

 Dorsalfleksjon , stortå
 Hø Ve

 Eversjon ankel
 Hø Ve

 Fleksjon kne
 Hø Ve

 Ekstensjon kne
 Hø Ve

 Kontraksjon rompeballer

 Hø Ve

4. Reflekser

(sett kryss)

 Kne Hø 0 + ++ +++ ++++
 Ve 0 + ++ +++ ++++

 Plantar Hø Normal Invertert
 Ve Normal Invertert

 Achilles Hø 0 + ++ +++ ++++
 Ve 0 + ++ +++ ++++

5. Sensibilitetstap

(sett kryss)

 L3 Hø Ve

 L4 Hø Ve

 L5 Hø Ve

 S1 Hø Ve

Nerverotsutfall og side(r).
Konklusjon basert på klinisk us.

(Sett om nødvendig flere kryss)

 L3 Hø. Ve.

 L4 Hø. Ve.

 L5 Hø. Ve.

 S1 Hø. Ve.

 Flere nivåer, spesifiser:



Medikamentbruk før injeksjon

Pasient nr.

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Sykehus nr.

--	--	--

Pasientdata

Navn

Fødselsnr. (11 siffer)

--	--	--	--	--	--	--	--	--	--	--

Du deltar i en studie for å undersøke effekten av rygginjeksjon ved isjias.

Det er svært viktig for oss å vite hvor mye medikamenter/tabletter du tener for å dempe smerter.

Vi ber deg om å registrere (navn, antall) på alle medikamenter du bruker i en uke før den første rygginjeksjonen skal gies.

Bruk dette arket til å notere ned ditt medikamentforbruk.

Ta med notatene dine til sykehuset og lever det til den legen som skal sette injeksjonen. Legen vil videresende ditt skjema til Klinisk forskningssenter.

Medisin	Mandag	Tirsdag	Onsdag	Torsdag	Fredag	Lørdag	Søndag

Skjema sendes til:

Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

Epidural sacral injection study, Henvisning anestesilege

Til anestesilege

Olaf Sivertsen og/eller Just Thoner, UNN

Jørgen Hansen, Nordlandssykehuset Bodø

Gunnar Engesnes, Sykehuset Levanger

Tarjei Rygnestad, St. Olavs Hospital

Niels Becker, Sykehuset Buskerud

Vedr pasient (Navn/Adresse/Telefon):

Dato henvist:

HENVISNING FOR INKLUSJON I EPIDURALSTUDIEN OG INJEKSJON

Pasienten er inkludert i epiduralstudien. Det foreligger ingen kontraindikasjoner mot injeksjon.

Pasienten henvises med dette til to injeksjoner ut fra resultat av randomisering.

Med vennlig hilsen

Henvisende lege

Randomisation and Treatment of subjects.

Pasient nr.

Sykehus nr.

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

After the inclusion check, back consultation and MR investigation have been performed, the doctor refers the patient to the anaesthesiologist for random allocation and injections according to the randomisation outcome. The referral to the anaesthesiologist is standardised, and include important information on cardiac and pulmonary status, medication and any allergies (Referral for injection). The referrals do not include information on the patient's clinical back details at the time of inclusion. As a rule, no more than 2 weeks should elapse between the inclusion check and randomisation to intervention.

The patients included are given either two epidural sacral injections (ESI) with volume plus steroid (Group I) or volume alone (Group II), or two placebo saline subcutaneous (SC) injections (Group III). The two injections are administrated at two-week intervals. Tick the result of randomisation in the table, note the date for injection 1 and 2 estimate technical success of injections on VAS scale where 0 (= failure) - 100(=success).

Group	Inervention with two injections	Randomisation Tick and date	Date Inj. 1 Success 0 -100	Date Inj. 2 Success 0 -100
I Volume + Steroid ESI	1 ml Triamcinolone 40 mg/ml + 29 ml NaCl 0.9 %			
II Volume ESI	30 ml NaCl 0.9 %			
III Placebo SC	2 ml NaCl 0.9 %			

For randomisering vennligst ring til Klinisk forskningscenter
Tlf 77 66 91 17 eller Fax 77 66 90 74

Skjema sendes til:

Klinisk forskningscenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

Ultrasound examination technique.

Pasient nr.	<input type="text"/>	<input type="text"/>	<input type="text"/>
Sykehus nr.	<input type="text"/>	<input type="text"/>	<input type="text"/>

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	<input type="text"/>

The injection technique is checked before and after the procedure by means of an ultrasound scan of the sacrum (Klocke et al, 2003, Chen et al 2004). The anaesthetists who are to administer the injections are trained in this standardised examination (longitudinal and transverse sections over the sacrum). All examinations are recorded with images. The anaesthetists at the various hospitals have access to ultrasound equipment. If the ultrasound examination reveals the presence of fluid over the sacrum, indication that the injection was given subcutaneously without this having been detected by palpatory inspection, this is recorded as a complication of the procedure. Subcutaneous injection is considered a non-hazardous complication and the patient is not excluded from the study if there is a complication of this kind with one or more of the injections.

Injection number	Ultrasound sacrum Subcutaneously fluid? Yes/No
1	
2	

Chen, CP ; Tang, SF ; Hsu, TC ; Tsai, WC ; Liu, HP ; Chen, MJ ; Date, E ; Lew, HL (2004) Ultrasound guidance in caudal epidural needle placement. *Anesthesiology*. Jul; 101(1):181-4

Klocke, R ; Jenkinson, T ; Glew, D (2003) Sonographically guided caudal epidural steroid injections. *J Ultrasound Med*. Nov; 22(11) : 1229-32

Skjema sendes til:

Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

Pasientinformasjon etter injeksjon.

Injeksjonen settes inn via det såkalte hiatus sakralis, en liten åpning i ryggraden like over halebeinet. Injeksjonen tar vanligvis 10-15 minutter. Medikamentet legger seg i det såkalte epiduralrommet som er det rommet som ligger rundt nervene i ryggen. Du vil under injeksjonen kunne kjenne et press over lenderyggen og noen ganger nedover i benet.

Etter injeksjonen ligger du 10 minutter på magen og deretter 15 minutter på ryggen. Det blir gjort en kontrollundersøkelse før du forlater legekantoret for å påse at det ikke har oppstått noen komplikasjoner.

Det første døgnet etter injeksjonen anbefales sengeleie, og du bør unngå langvarig sittende stilling. De fleste vil oppleve en bedring i ryggsmertene etter injeksjonen, men noen vil kunne kjenne en forbigående forverring i smertene to tre dager etter at injeksjonen er gitt. Etter et par dager kan du gjenoppta vanlig aktivitet.

Den første uka etter injeksjonen ber vi deg være spesielt oppmerksom på følgende plager; Sterk lokal smerte der sprøyten er satt, feber og sykdomsfølelse. Dersom du merker slike plager må du ta kontakt med din fastlege, legevakta i din kommune eller ta direkte kontakt med det sykehuset hvor du fikk injeksjonen.

Medikamentbruk før etterundersøkelse

Pasient nr.	<input type="text"/>	<input type="text"/>	<input type="text"/>
Sykehus nr.	<input type="text"/>	<input type="text"/>	<input type="text"/>

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	<input type="text"/>

Du deltar i en studie for å undersøke effekten av rygginjeksjon ved isjias.
Det er svært viktig for oss å vite hvor mye medikamenter/tabletter du tener for å dempe smerter.

Vi ber deg om å registrere (navn, antall) på alle medikamenter du bruker i en uke før den første etterkontrollen.

Bruk dette arket til å notere ned ditt medikamentforbruk.
Ta med notatene dine til sykehuset og lever det til den legen som skal utfører etterundersøkelsen.
Legen vil videresende ditt skjema til Klinisk forskningssenter.

Medisin	Mandag	Tirsdag	Onsdag	Torsdag	Fredag	Lørdag	Søndag

Årsak til at epiduralinjeksjon nr 2 ikke blir gitt

Pasient nr.

--	--	--

Sykehus nr.

--	--	--

Pasientdata											
Navn											
Fødselsnr. (11 siffer) <table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>											

Erkjent eller mistenkt infeksjon

Pasienten ønsker ikke ny injeksjon

Betydelig bedring etter første injeksjon

Mye smerter i forb. med første injeksjon

Andre årsaker

Angi grunn

Skjema sendes til:

Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

2784



Epidural sacral injection study, Henvisning nevrofysiologi

Til nevrolog/nevrofysiologisk undersøkelse

UNN

Nordlandssykehuset Bodø

Sykehuset Levanger

St. Olavs Hospital

Buskerud sykehus

Vedr pasient (Navn/Adresse/Telefon)

Dato henvist:

HENVISNING TIL NEVROFYSIOLOGISK UNDERSØKELSE

Pasienten er inkludert i epiduralstudien. Det er påvist kliniske tegn til nerverotaffeksjon med kraftsvikt ved isometriske tester. Det er ønskelig med nevrofysiologisk undersøkelse for å kartlegge om det er objektive nevrologiske tegn til svekket funksjon i aktuelle muskel/muskelgruppe.

Isometrisk muskeltest	Hø (0-5 muskelkraft)	Ve (0-5 muskelkraft)
Tågang		
Fleksjon hofte		
Abduksjon hofte		
Dorsalfleksjon ankel		
Dorsalfleksjon stortå		
Eversjon ankel		
Fleksjon kne		
Ekstensjon kne		
Kontraksjon rompeballer		

Med vennlig hilsen

Henvisende lege

Svar på EMG undersøkelse ved klinisk påvist kraftsvikt i muskulatur

Pasient nr.

Sykehus nr.

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

Muskel	EMG resultat			
1. Gastrocnemius (tågang):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
2. Psoas (fleksjon hofte):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
3. Gluteus medius (abduksjon hofte):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
4. Tibialis anterior (dorsalfleksjon ankel):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
5. Ext hallucis longus (dorsalfleksjon stortå):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
6. Peroneus (eversjon ankel):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
7. Hamstrings (fleksjon kne):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
8. Quadriceps (ekstensjon kne):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet
9. Gluteus maximus (kontraksjon rompeballer):	<input type="checkbox"/> Normalt	<input type="checkbox"/> Nevrogenombygning	<input type="checkbox"/> Denervasjon	<input type="checkbox"/> Annet



Spørreskjema for pasienter etter rygginjeksjon

Skjema 3

Pasient nr.

Sykehus nr.

Etterkontroll nr

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	
Adresse	
Alder (år)	<input type="text"/> <input type="text"/>
Kjønn	<input type="checkbox"/> Mann <input type="checkbox"/> Kvinne

Formålet med dette spørreskjemaet er å gi leger, sykepleiere og fysioterapeuter bedre forståelse av ryggpasienters plager og å vurdere effekter av behandling. Din utfylling av skjemaet vil være til stor nytte for å kunne gi et best mulig behandlingstilbud til ryggpasienter i fremtiden.

Spørreskjemaet har fem deler. Første del omhandler ulike sider ved din utdanning og familie samt dine smerter og plager. De neste delene består av tre ulike sett spørsmål for måling av din nåværende helse. Det første av disse (kalt Oswestryskåre) måler hvordan ryggplagene påvirker dine dagligdagse gjøremål. Det andre (kalt EQ-5D) måler din helserelaterte livskvalitet. Den siste delen er en skala der du skal merke av hvor god eller dårlig din helsetilstand er.

Dato for utfylling	<input type="text"/> <input type="text"/>	.	<input type="text"/> <input type="text"/>	.	<input type="text"/> <input type="text"/>
	Dag		Måned		År
Tidspunkt etter injeksjon	<input type="text"/> <input type="text"/>	(måned)			

Er skjemaet besvart per brev?

 Ja Nei

Hvor stor nytte mener du at du har hatt av injeksjon?

 Stor nytte Litt nytte Ingen nytte Er blitt verre

Hvor fornøyd er du med behandlingen du har fått på sykehuset?

 Fornøyd Litt fornøyd Hverken fornøyd eller misfornøyd Litt misfornøyd Misfornøyd

Skjema sendes til:

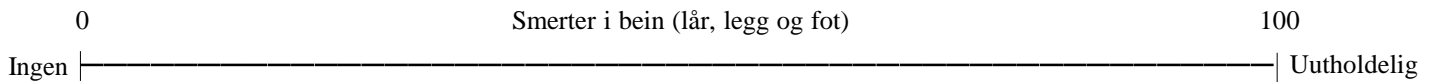
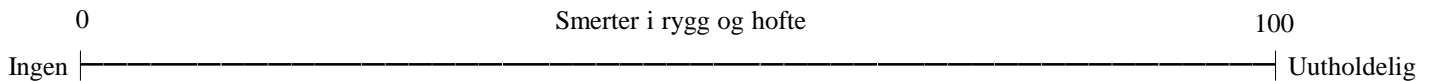
Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

29341



Hvor sterke smerter har du nå

De vannrette linjene nedenfor viser en skala fra 0 til 100 for smertestyrke. Den begrenses på venstre side av ingen smerte (0) og på høyre side av uutholdelig smerte (100). Sett en strek på tvers av linjene svarende til din største smerte nå for tiden (den siste uken).

**Funksjonsscore (Oswestry)**

Disse spørsmålene er utarbeidet for å gi oss informasjon om hvordan dine smerter har påvirket dine muligheter til å klare dagliglivet ditt. Vær så snill å besvare spørsmålene ved å sette kryss (kun ett kryss for hvert avsnitt) i de rutene som passer best for deg.

1. Smerte

- Jeg har ingen smerter for øyeblikket
- Smertene er veldig svake for øyeblikket
- Smertene er moderate for øyeblikket
- Smertene er temmelig sterke for øyeblikket
- Smertene er veldig sterke for øyeblikket
- Smertene er det verste jeg kan tenke meg for øyeblikket

2. Personlig stell

- Jeg kan stelle meg selv på valig måte uten at det forårsaker ekstra smerter
- Jeg kan stelle meg selv på vanlig måte, men det er veldig smertefult
- Det er smertefult å stelle seg selv, og jeg gjør det langsomt og forsiktig
- Jeg trenger noe hjelp, men klarer det meste av mitt personlige stell
- Jeg trenger hjelp hver dag til det meste av eget stell
- Jeg kler ikke på meg, har vanskeligheter med å vaske meg og holder sengen

3. Å løfte

- Jeg kan løfte tunge ting uten å få mer smerter
- Jeg kan løfte tunge ting, men får smerter
- Smertene hindrer meg i å løfte tunge ting opp fra gulvet, men jeg greier det hvis det som skal løftes er gunstig plassert, for eksempel på et bord
- Smertene hindrer meg i å løfte tunge ting, men jeg klarer lette og middels tunge ting, hvis det er gunstig plassert
- Jeg kan bare løfte noe som er veldig lett
- Jeg kan ikke løfte eller bære noe i det hele tatt

4. Å gå

- Smerter hindrer meg ikke i å gå i det hele tatt
- Smerter hindrer meg i å gå mer enn 1 1/2 km
- Smerter hindrer meg i å gå mer enn 3/4 km
- Smerter hindrer meg i å gå mer enn 100 m
- Jeg kan bare gå med stokk eller krykker
- Jeg ligger for det meste i sengen, og jeg må krabbe til toalettet

5. Å sitte

- Jeg kan sitte så lenge jeg vil i en hvilken som helst stol
- Jeg kan sitte så lenge jeg vil i min favorittstol
- Smerter hindrer meg i å sitte mer enn en time
- Smerter hindrer meg i å sitte mer enn en halv time
- Smerter hindrer meg i å sitte mer enn ti minutter
- Smerter hindrer meg i å sitte i det hele tatt

6. Å stå

- Jeg kan stå så lenge jeg vil uten å få smerter
- Jeg kan stå så lenge jeg vil, men får mer smerter
- Smerter hindrer meg i å stå mer enn en time
- Smerter hindrer meg i å stå mer enn en halv time
- Smerter hindrer meg i å stå mer enn ti minutter
- Smerter hindrer meg i å stå i det hele tatt



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7. Å sove

- Søvnens min forstyrres aldri av smerter
- Søvnens min forstyrres av og til av smerter
- På grunn av smerter får jeg mindre enn seks timers søvn
- På grunn av smerter får jeg mindre en fire timers søvn
- På grunn av smerter får jeg mindre enn to timers søvn
- Smerter hindre all søvn

8. Seksualliv

- Seksuallivet mitt er normalt og forårsaker ikke mer smerter
- Seksuallivet mitt er normalt, men forårsaker noe mer smerter
- Seksuallivet mitt er normalt, men svært smertefullt
- Seksuallivet mitt er svært begrenset av smerter
- Seksuallivet mitt er nesten borte på grunn av smerter
- Smerter forhindrer alt seksualliv

9. Sosialt liv (omgang med venner og bekjente)

- Det sosiale livet mitt er normalt og forårsaker ikke mer smerter
- Det sosiale livet mitt er normalt, men øker graden av smerter
- Smerter har ingen betydelig innvirkning på mitt sosiale liv, bortsett fra at de begrenser mine mer fysiske aktive sider, som sport osv.
- Smerter har begrenset mitt sosiale liv, og jeg går ikke så ofte ut
- Smerter har begrenset mitt sosiale liv til hjemmet
- På grunn av smerter har jeg ikke noe sosialt liv

10. Å reise

- Jeg kan reise hvor som helst uten smerter
- Jeg kan reise hvor som helst, men det gir mer smerter
- Smertene er ille, men jeg klarer reiser på to timer
- Smerter begrenser meg til korte reiser på under en time
- Smerter begrenser meg til korte, nødvendige reiser på under 30 minutter
- Smerter forhindrer meg fra å reise, unntatt for å få behandling

Beskrivelse av helsetilstand (EQ-5D)

Vis hvilke utsagn som passer på din helsetilstand i dag ved å sette ett kryss i en av rutene utenfor hver av dimensjonene nedenfor.

1. Gange

- Jeg har ingen problemer med å gå omkring
- Jeg har litt problemer med å gå omkring
- Jeg er sengeliggende

2. Personlig stell

- Jeg har ingen problemer med personlig stell
- Jeg har litt problemer med å vaske meg eller kle meg
- Jeg er ute av stand til å vaske meg eller kle meg

3. Vanlige gjøremål (f.eks. arbeid, studier, husarbeid, familie- eller fritidsaktiviteter)

- Jeg har ingen problemer med å utføre mine vanlige gjøremål
- Jeg har litt problemer med å utføre mine vanlige gjøremål
- Jeg er ute av stand til å utføre mine vanlige gjøremål

4. Smerte og ubehag

- Jeg har verken smerte eller ubehag
- Jeg har moderat smerte og ubehag
- Jeg har sterk smerte og ubehag

5. Angst og depresjon

- Jeg er hverken engstelig eller deprimert
- Jeg er noe engstelig og deprimert
- Jeg er svært engstelig og deprimert

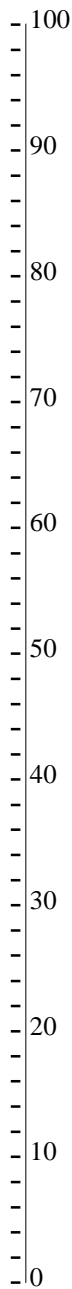


Helsetilstand

For at du skal kunne vise oss hvor god eller dårlig din helsetilstand er, har vi laget en skala (nesten som et termometer), hvor den beste helsetilstanden du kan tenke deg er markert med 100 og den dårligste med 0.

Vi ber deg om at du viser din helsetilstand ved å trekke ei linje fra boksen nedenfor til det punkt på skalaen som passer best med din helsetilstand.

Best tenkelige
helsetilstand



Nåværende
helsetilstand

Verst tenkelige
helsetilstand

Arbeidsstatus (Fylles ut hvis besvarelsen er per brev)

- I arbeid Student/skoleelev
 Sykemeldt Pensjonist
 Aktiv sykemeldt Arbeidsledig
 Delvis sykemeldt Attføring/rehabilitering
 % sykemeldt Uføretrygdet
 Hjemmeværende

Friskmeldt? (Fylles ut hvis besvarelsen er per brev)

Hvis ja, angi dato . .
Dag Måned År

Varighet av sykemelding etter injeksjon (uker)

Komplikasjoner til injeksjon? (Fylles ut hvis besvarelsen er per brev)

- Uventet skade
 Blødning
 Infeksjon i huden etter injeksjon
 Allergiske reaksjoner
 Annet (spesifiser)

Har du søkt om uføretrygd?

- Ja
 Nei
 Planlegger å søke
 Er allerede innvilget

Har du søkt om erstatning fra forsikrings-selskap eller folketrygden (evt. yrkesskadeerstatning)?

- Ja
 Nei
 Planlegger å søke
 Er allerede innvilget



SMERTE, FYSISK AKTIVITET OG JOBB

(Fear-Avoidance Beliefs Questionnaire,
Waddell et al 1993)

Her er noe av det som andre har fortalt oss om ryggsmertene sine. Kryss av for ett tall fra 0 (helt uenig) til 6 (helt enig) for hvert utsagn for å si hvor mye fysiske aktiviteter som å bøye seg, løfte, gå eller kjøre vil påvirke ryggen din.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
1	Smertene mine ble forårsaket av fysisk aktivitet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Fysisk aktivitet forverrer smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3	Fysisk aktivitet kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4	Jeg burde ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5	Jeg kan ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Følgende utsagn handler om hvordan det vanlige arbeidet ditt påvirker eller kan påvirke ryggsmertene dine.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
6	Smertene mine ble forårsaket av arbeidet mitt eller et uhell på jobben	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7	Arbeidet mitt forverret smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8	Jeg har framsatt erstatningskrav for smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9	Arbeidet mitt er for tungt for meg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10	Arbeidet mitt forverrer eller kan forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
11	Arbeidet mitt kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
12	Jeg burde ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
13	Jeg kan ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
14	Jeg kan ikke utføre det vanlige arbeidet mitt før smertene er behandlet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
15	Jeg tror ikke jeg vil være tilbake på det vanlige arbeidet mitt innen tre måneder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
16	Jeg tror ikke jeg noen gang vil være i stand til å komme tilbake til det arbeidet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



Registrerings skjema ved kontroll etter rygginjeksjon

Pasientdata	Friskmeldt?
Navn	Hvis ja, angi dato <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> Dag Måned År
Fødselsnr. (11 siffer)	Varighet av sykemelding etter injeksjon <input type="text"/> <input type="text"/> <input type="text"/> (uker)
Adresse	Komplikasjoner til injeksjonen?
Alder (år) <input type="text"/> <input type="text"/>	<input type="checkbox"/> Nerveskade, spesifiser
Kjønn <input type="checkbox"/> Mann <input type="checkbox"/> Kvinne	-----
Etterundersøkelse dato <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> Dag Måned År	<input type="checkbox"/> Blødning
Tidspunkt etter injeksjon <input type="text"/> <input type="text"/> (måneder)	<input type="checkbox"/> Infeksjon <input type="checkbox"/> Overfladisk sårinfeksjon
Har pasienten møtt personlig til etterkontroll?	<input type="checkbox"/> Dyp sårinfeksjon/spondylitt
<input type="checkbox"/> Ja	<input type="checkbox"/> Allergisk reaksjon
<input type="checkbox"/> Nei	<input type="checkbox"/> Durapunksjon
Hvis nei, er skjemaet besvart per brev?	<input type="checkbox"/> Annet (spesifiser)
<input type="checkbox"/> Ja	-----
<input type="checkbox"/> Nei	Får du for tiden annen behandling for ryggplager
Arbeidsstatus	<input type="checkbox"/> Fysioterapi
<input type="checkbox"/> I arbeid <input type="checkbox"/> Student/skoleelev	<input type="checkbox"/> Kiropraktor
<input type="checkbox"/> Sykemeldt <input type="checkbox"/> Pensjonist	<input type="checkbox"/> Annen type behandling
<input type="checkbox"/> Aktiv sykemeldt <input type="checkbox"/> Arbeidsledig	Ja, spesifiser.....
<input type="checkbox"/> Delvis sykemeldt <input type="checkbox"/> Attføring/rehabilitering	Andre relevante sykdommer, skader eller plager
<input type="text"/> <input type="text"/> % sykemeldt <input type="checkbox"/> Uføretrygdet	<input type="checkbox"/> Nei
<input type="checkbox"/> Hjemmeværende	<input type="checkbox"/> Ja, spesifiser



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Kliniske funn

1. SLR

Gradtall positiv test

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 Hø Ve

2. Omvendt Lasegue positiv (sett kryss) Hø Ve

3. Muskelkraft (tall 0-5)

Tågåing	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Fleksjon, hofte	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Abduksjon, hofte	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Dorsalfleksjon, ankel	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Dorsalfleksjon , stortå	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Eversjon ankel	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Fleksjon kne	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Ekstensjon kne	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Kontraksjon rompeballer	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve

4. Reflekser (sett kryss)

Kne Hø 0 + ++ +++ ++++
 Ve 0 + ++ +++ ++++

Plantar Hø Normal Invertert
 Ve Normal Invertert

Achilles Hø 0 + ++ +++ ++++
 Ve 0 + ++ +++ ++++

5. Sensibilitetstap (sett kryss)

L3	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
L4	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
L5	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
S1	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve

**Nerverotsutfall og side(r).
 Konklusjon basert på klinisk us.
 (Sett om nødvendig flere kryss)**

<input type="checkbox"/> L3	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> L4	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> L5	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> S1	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.

Flere nivåer, spesifiser:



Spørreskjema for pasienter etter rygginjeksjon

Skjema 3

Pasient nr.

Sykehus nr.

Etterkontroll nr

2

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	
Adresse	
Alder (år)	<input type="text"/> <input type="text"/>
Kjønn	<input type="checkbox"/> Mann <input type="checkbox"/> Kvinne

Formålet med dette spørreskjemaet er å gi leger, sykepleiere og fysioterapeuter bedre forståelse av ryggpasienters plager og å vurdere effekter av behandling. Din utfylling av skjemaet vil være til stor nytte for å kunne gi et best mulig behandlingstilbud til ryggpasienter i fremtiden.

Spørreskjemaet har fem deler. Første del omhandler ulike sider ved din utdanning og familie samt dine smerter og plager. De neste delene består av tre ulike sett spørsmål for måling av din nåværende helse. Det første av disse (kalt Oswestryskåre) måler hvordan ryggplagene påvirker dine dagligdagsgjøremål. Det andre (kalt EQ-5D) måler din helserelaterte livskvalitet. Den siste delen er en skala der du skal merke av hvor god eller dårlig din helsetilstand er.

Dato for utfylling	<input type="text"/> <input type="text"/>	.	<input type="text"/> <input type="text"/>	.	<input type="text"/> <input type="text"/>
	Dag		Måned		År
Tidspunkt etter injeksjon	<input type="text"/> <input type="text"/>	(måned)			

Er skjemaet besvart per brev?

 Ja Nei

Hvor stor nytte mener du at du har hatt av injeksjon?

 Stor nytte Litt nytte Ingen nytte Er blitt verre

Hvor fornøyd er du med behandlingen du har fått på sykehuset?

 Fornøyd Litt fornøyd Hverken fornøyd eller misfornøyd Litt misfornøyd Misfornøyd

Skjema sendes til:

Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

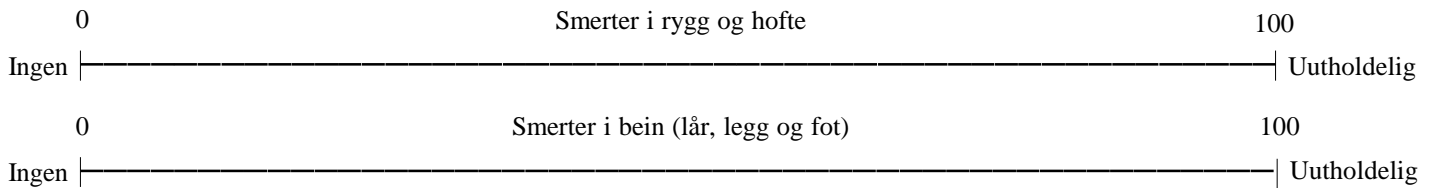
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Hvor sterke smerter har du nå

De vannrette linjene nedenfor viser en skala fra 0 til 100 for smertestyrke. Den begrenses på venstre side av ingen smerte (0) og på høyre side av uutholdelig smerte (100). Sett en strek på tvers av linjene svarende til din største smerte nå for tiden (den siste uken).



Funksjonsscore (Oswestry)

Disse spørsmålene er utarbeidet for å gi oss informasjon om hvordan dine smerter har påvirket dine muligheter til å klare dagliglivet ditt. Vær så snill å besvare spørsmålene ved å sette kryss (kun ett kryss for hvert avsnitt) i de rutene som passer best for deg.

1. Smerte

- Jeg har ingen smerter for øyeblikket
- Smertene er veldig svake for øyeblikket
- Smertene er moderate for øyeblikket
- Smertene er temmelig sterke for øyeblikket
- Smertene er veldig sterke for øyeblikket
- Smertene er det verste jeg kan tenke meg for øyeblikket

2. Personlig stell

- Jeg kan stelle meg selv på valig måte uten at det forårsaker ekstra smerter
- Jeg kan stelle meg selv på vanlig måte, men det er veldig smertefult
- Det er smertefult å stelle seg selv, og jeg gjør det langsomt og forsiktig
- Jeg trenger noe hjelp, men klarer det meste av mitt personlige stell
- Jeg trenger hjelp hver dag til det meste av eget stell
- Jeg kler ikke på meg, har vanskeligheter med å vaske meg og holder sengen

3. Å løfte

- Jeg kan løfte tunge ting uten å få mer smerter
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- Smertene hindrer meg i å løfte tunge ting opp fra gulvet, men jeg greier det hvis det som skal løftes er gunstig plassert, for eksempel på et bord
- Smertene hindrer meg i å løfte tunge ting, men jeg klarer lette og middels tunge ting, hvis det er gunstig plassert
- Jeg kan bare løfte noe som er veldig lett
- Jeg kan ikke løfte eller bære noe i det hele tatt

4. Å gå

- Smerter hindrer meg ikke i å gå i det hele tatt
- Smerter hindrer meg i å gå mer enn 1 1/2 km
- Smerter hindrer meg i å gå mer enn 3/4 km
- Smerter hindrer meg i å gå mer enn 100 m
- Jeg kan bare gå med stokk eller krykker
- Jeg ligger for det meste i sengen, og jeg må krabbe til toalettet

5. Å sitte

- Jeg kan sitte så lenge jeg vil i en hvilken som helst stol
- Jeg kan sitte så lenge jeg vil i min favorittstol
- Smerter hindrer meg i å sitte mer enn en time
- Smerter hindrer meg i å sitte mer enn en halv time
- Smerter hindrer meg i å sitte mer enn ti minutter
- Smerter hindrer meg i å sitte i det hele tatt

6. Å stå

- Jeg kan stå så lenge jeg vil uten å få smerter
- Jeg kan stå så lenge jeg vil, men får mer smerter
- Smerter hindrer meg i å stå mer enn en time
- Smerter hindrer meg i å stå mer enn en halv time
- Smerter hindrer meg i å stå mer enn ti minutter
- Smerter hindrer meg i å stå i det hele tatt



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7. Å sove

- Søvnens min forstyrres aldri av smerter
- Søvnens min forstyrres av og til av smerter
- På grunn av smerter får jeg mindre enn seks timers søvn
- På grunn av smerter får jeg mindre en fire timers søvn
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Vis hvilke utsagn som passer på din helsetilstand i dag ved å sette ett kryss i en av rutene utenfor hver av dimensjonene nedenfor.

1. Gange

- Jeg har ingen problemer med å gå omkring
- Jeg har litt problemer med å gå omkring
- Jeg er sengeliggende

8. Seksualliv

- Seksuallivet mitt er normalt og forårsaker ikke mer smerter
- Seksuallivet mitt er normalt, men forårsaker noe mer smerter
- Seksuallivet mitt er normalt, men svært smertefullt
- Seksuallivet mitt er svært begrenset av smerter
- Seksuallivet mitt er nesten borte på grunn av smerter
- Smerter forhindrer alt seksualliv

2. Personlig stell

- Jeg har ingen problemer med personlig stell
- Jeg har litt problemer med å vaske meg eller kle meg
- Jeg er ute av stand til å vaske meg eller kle meg

9. Sosialt liv (omgang med venner og bekjente)

- Det sosiale livet mitt er normalt og forårsaker ikke mer smerter
- Det sosiale livet mitt er normalt, men øker graden av smerter
- Smerter har ingen betydelig innvirkning på mitt sosiale liv, bortsett fra at de begrenser mine mer fysiske aktive sider, som sport osv.
- Smerter har begrenset mitt sosiale liv, og jeg går ikke så ofte ut
- Smerter har begrenset mitt sosiale liv til hjemmet
- På grunn av smerter har jeg ikke noe sosialt liv

3. Vanlige gjøremål (f.eks. arbeid, studier, husarbeid, familie- eller fritidsaktiviteter)

- Jeg har ingen problemer med å utføre mine vanlige gjøremål
- Jeg har litt problemer med å utføre mine vanlige gjøremål
- Jeg er ute av stand til å utføre mine vanlige gjøremål

4. Smerte og ubehag

- Jeg har verken smerte eller ubehag
- Jeg har moderat smerte og ubehag
- Jeg har sterk smerte og ubehag

5. Angst og depresjon

- Jeg er hverken engstelig eller deprimert
- Jeg er noe engstelig og deprimert
- Jeg er svært engstelig og deprimert

10. Å reise

- Jeg kan reise hvor som helst uten smerter
- Jeg kan reise hvor som helst, men det gir mer smerter
- Smertene er ille, men jeg klarer reiser på to timer
- Smerter begrenser meg til korte reiser på under en time
- Smerter begrenser meg til korte, nødvendige reiser på under 30 minutter
- Smerter forhindrer meg fra å reise, unntatt for å få behandling

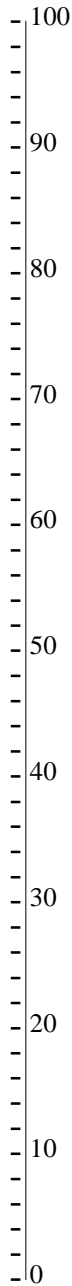


Helsetilstand

For at du skal kunne vise oss hvor god eller dårlig din helsetilstand er, har vi laget en skala (nesten som et termometer), hvor den beste helsetilstanden du kan tenke deg er markert med 100 og den dårligste med 0.

Vi ber deg om at du viser din helsetilstand ved å trekke ei linje fra boksen nedenfor til det punkt på skalaen som passer best med din helsetilstand.

Best tenkelige
helsetilstand



Nåværende
helsetilstand

Verst tenkelige
helsetilstand

Arbeidsstatus (Fylles ut hvis besvarelsen er per brev)

- | | |
|--|---|
| <input type="checkbox"/> I arbeid | <input type="checkbox"/> Student/skoleelev |
| <input type="checkbox"/> Sykemeldt | <input type="checkbox"/> Pensjonist |
| <input type="checkbox"/> Aktiv sykemeldt | <input type="checkbox"/> Arbeidsledig |
| <input type="checkbox"/> Delvis sykemeldt | <input type="checkbox"/> Attføring/rehabilitering |
| % sykemeldt | <input type="checkbox"/> Uføretrygdet |
| <input type="checkbox"/> Hjemmeværende | |

Friskmeldt? (Fylles ut hvis besvarelsen er per brev)

Hvis ja, angi dato . .
 Dag Måned År

Varighet av sykemelding etter injeksjon (uker)

Komplikasjoner til injeksjon? (Fylles ut hvis besvarelsen er per brev)

- Uventet skade
- Blødning
- Infeksjon i huden etter injeksjon
- Allergiske reaksjoner
- Annet (spesifiser)

Har du søkt om uføretrygd?

- Ja
- Nei
- Planlegger å søke
- Er allerede innvilget

Har du søkt om erstatning fra forsikringselskap eller folketrygden (evt. yrkesskadeerstatning)?

- Ja
- Nei
- Planlegger å søke
- Er allerede innvilget



SMERTE, FYSISK AKTIVITET OG JOBB

(Fear-Avoidance Beliefs Questionnaire,
Waddell et al 1993)

Her er noe av det som andre har fortalt oss om ryggsmertene sine. Kryss av for ett tall fra 0 (helt uenig) til 6 (helt enig) for hvert utsagn for å si hvor mye fysiske aktiviteter som å bøye seg, løfte, gå eller kjøre vil påvirke ryggen din.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
1	Smertene mine ble forårsaket av fysisk aktivitet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Fysisk aktivitet forverrer smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3	Fysisk aktivitet kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4	Jeg burde ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5	Jeg kan ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Følgende utsagn handler om hvordan det vanlige arbeidet ditt påvirker eller kan påvirke ryggsmertene dine.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
6	Smertene mine ble forårsaket av arbeidet mitt eller et uhell på jobben	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7	Arbeidet mitt forverrer smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8	Jeg har framsatt erstatningskrav for smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9	Arbeidet mitt er for tungt for meg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10	Arbeidet mitt forverrer eller kan forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
11	Arbeidet mitt kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
12	Jeg burde ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
13	Jeg kan ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
14	Jeg kan ikke utføre det vanlige arbeidet mitt før smertene er behandlet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
15	Jeg tror ikke jeg vil være tilbake på det vanlige arbeidet mitt innen tre måneder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
16	Jeg tror ikke jeg noen gang vil være i stand til å komme tilbake til det arbeidet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



Registrerings skjema ved kontroll etter rygginjeksjon

Pasientdata	Friskmeldt?
Navn	Hvis ja, angi dato <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> Dag Måned År
Fødselsnr. (11 siffer)	Varighet av sykemelding etter injeksjon <input type="text"/> <input type="text"/> <input type="text"/> (uker)
Adresse	Komplikasjoner til injeksjonen?
Alder (år) <input type="text"/> <input type="text"/>	<input type="checkbox"/> Nerveskade, spesifiser
Kjønn <input type="checkbox"/> Mann <input type="checkbox"/> Kvinne	-----
Etterundersøkelse dato <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> Dag Måned År	<input type="checkbox"/> Blødning
Tidspunkt etter injeksjon <input type="text"/> <input type="text"/> (måned)	<input type="checkbox"/> Infeksjon <input type="checkbox"/> Overfladisk sårinfeksjon
Har pasienten møtt personlig til etterkontroll?	<input type="checkbox"/> Dyp sårinfeksjon/spondylitt
<input type="checkbox"/> Ja	<input type="checkbox"/> Allergisk reaksjon
<input type="checkbox"/> Nei	<input type="checkbox"/> Durapunksjon
Hvis nei, er skjemaet besvart per brev?	<input type="checkbox"/> Annet (spesifiser)
<input type="checkbox"/> Ja	-----
<input type="checkbox"/> Nei	Får du for tiden annen behandling for ryggplager
Arbeidsstatus	<input type="checkbox"/> Fysioterapi
<input type="checkbox"/> I arbeid <input type="checkbox"/> Student/skoleelev	<input type="checkbox"/> Kiropraktor
<input type="checkbox"/> Sykemeldt <input type="checkbox"/> Pensjonist	<input type="checkbox"/> Annen type behandling
<input type="checkbox"/> Aktiv sykemeldt <input type="checkbox"/> Arbeidsledig	Ja, spesifiser.....
<input type="checkbox"/> Delvis sykemeldt <input type="checkbox"/> Attføring/rehabilitering	Andre relevante sykdommer, skader eller plager
<input type="text"/> <input type="text"/> % sykemeldt <input type="checkbox"/> Uføretrygdet	<input type="checkbox"/> Nei
<input type="checkbox"/> Hjemneværende	<input type="checkbox"/> Ja, spesifiser



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Kliniske funn
1. SLR

 Gradtall positiv test

--	--

 Hø Ve

 2. Omvendt Lasegue positiv
(sett kryss) Hø Ve

3. Muskelkraft (tall 0-5)

Tågåing	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Fleksjon, hofte	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Abduksjon, hofte	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Dorsalfleksjon, ankel	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Dorsalfleksjon , stortå	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Eversjon ankel	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Fleksjon kne	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Ekstensjon kne	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Kontraksjon rompeballer	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve

4. Reflekser

(sett kryss)

 Kne Hø 0 + ++ +++ ++++
 Ve 0 + ++ +++ ++++

 Plantar Hø Normal Invertert
 Ve Normal Invertert

 Achilles Hø 0 + ++ +++ ++++
 Ve 0 + ++ +++ ++++

5. Sensibilitetstap

(sett kryss)

L3	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
L4	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
L5	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
S1	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve

Nerverotsutfall og side(r).

Konklusjon basert på klinisk us.

(Sett om nødvendig flere kryss)

<input type="checkbox"/> L3	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> L4	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> L5	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> S1	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.

Flere nivåer, spesifiser:



Spørreskjema for pasienter etter rygginjeksjon

Skjema 3

Pasient nr.

Sykehus nr.

Etterkontroll nr

3

Pasientdata	
Navn	
Fødselsnr. (11 siffer)	
Adresse	
Alder (år)	<input type="text"/> <input type="text"/>
Kjønn	<input type="checkbox"/> Mann <input type="checkbox"/> Kvinne

Formålet med dette spørreskjemaet er å gi leger, sykepleiere og fysioterapeuter bedre forståelse av ryggpasienters plager og å vurdere effekter av behandling. Din utfylling av skjemaet vil være til stor nytte for å kunne gi et best mulig behandlingstilbud til ryggpasienter i fremtiden.

Spørreskjemaet har fem deler. Første del omhandler ulike sider ved din utdanning og familie samt dine smerter og plager. De neste delene består av tre ulike sett spørsmål for måling av din nåværende helse. Det første av disse (kalt Oswestryskåre) måler hvordan ryggplagene påvirker dine dagligdage gjøremål. Det andre (kalt EQ-5D) måler din helserelaterte livskvalitet. Den siste delen er en skala der du skal merke av hvor god eller dårlig din helsetilstand er.

Dato for utfylling	<input type="text"/> <input type="text"/>	.	<input type="text"/> <input type="text"/>	.	<input type="text"/> <input type="text"/>
	Dag		Måned		År
Tidspunkt etter injeksjon	<input type="text"/> <input type="text"/>	(måned)			

Er skjemaet besvart per brev?

 Ja Nei

Hvor stor nytte mener du at du har hatt av injeksjon?

- Stor nytte
- Litt nytte
- Ingen nytte
- Er blitt verre

Hvor fornøyd er du med behandlingen du har fått på sykehuset?

- Fornøyd
- Litt fornøyd
- Hverken fornøyd eller misfornøyd
- Litt misfornøyd
- Misfornøyd

Skjema sendes til:

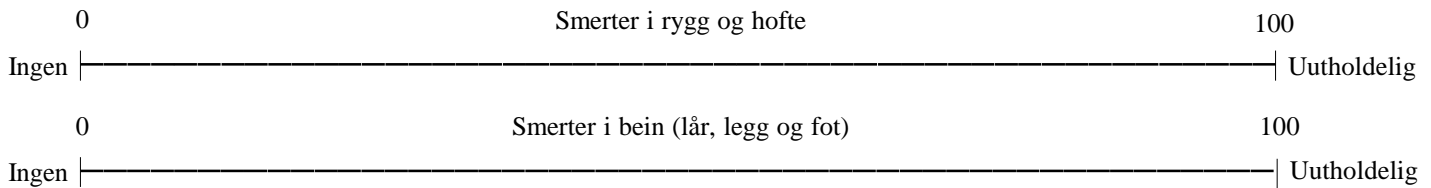
Klinisk forskningssenter, Postboks 78, Universitetssykehuset Nord-Norge,
9038 Tromsø, merket "Epidural studien"

18444



Hvor sterke smerter har du nå

De vannrette linjene nedenfor viser en skala fra 0 til 100 for smertestyrke. Den begrenses på venstre side av ingen smerte (0) og på høyre side av utholdelig smerte (100). Sett en strek på tvers av linjene svarende til din største smerte nå for tiden (den siste uken).



Funksjonsscore (Oswestry)

Disse spørsmålene er utarbeidet for å gi oss informasjon om hvordan dine smerter har påvirket dine muligheter til å klare dagliglivet ditt. Vær så snill å besvare spørsmålene ved å sette kryss (kun ett kryss for hvert avsnitt) i de rutene som passer best for deg.

1. Smerte

- Jeg har ingen smerter for øyeblikket
- Smertene er veldig svake for øyeblikket
- Smertene er moderate for øyeblikket
- Smertene er temmelig sterke for øyeblikket
- Smertene er veldig sterke for øyeblikket
- Smertene er det verste jeg kan tenke meg for øyeblikket

2. Personlig stell

- Jeg kan stelle meg selv på valig måte uten at det forårsaker ekstra smerter
- Jeg kan stelle meg selv på vanlig måte, men det er veldig smertefult
- Det er smertefult å stelle seg selv, og jeg gjør det langsomt og forsiktig
- Jeg trenger noe hjelp, men klarer det meste av mitt personlige stell
- Jeg trenger hjelp hver dag til det meste av eget stell
- Jeg kler ikke på meg, har vanskeligheter med å vaske meg og holder sengen

4. Å gå

- Smerter hindrer meg ikke i å gå i det hele tatt
- Smerter hindrer meg i å gå mer enn 1 1/2 km
- Smerter hindrer meg i å gå mer enn 3/4 km
- Smerter hindrer meg i å gå mer enn 100 m
- Jeg kan bare gå med stokk eller krykker
- Jeg ligger for det meste i sengen, og jeg må krabbe til toalettet

5. Å sitte

- Jeg kan sitte så lenge jeg vil i en hvilken som helst stol
- Jeg kan sitte så lenge jeg vil i min favorittstol
- Smerter hindrer meg i å sitte mer enn en time
- Smerter hindrer meg i å sitte mer enn en halv time
- Smerter hindrer meg i å sitte mer enn ti minutter
- Smerter hindrer meg i å sitte i det hele tatt

3. Å løfte

- Jeg kan løfte tunge ting uten å få mer smerter
- Jeg kan løfte tunge ting, men får smerter
- Smertene hindrer meg i å løfte tunge ting opp fra gulvet, men jeg greier det hvis det som skal løftes er gunstig plassert, for eksempel på et bord
- Smertene hindrer meg i å løfte tunge ting, men jeg klarer lette og middels tunge ting, hvis det er gunstig plassert
- Jeg kan bare løfte noe som er veldig lett
- Jeg kan ikke løfte eller bære noe i det hele tatt

6. Å stå

- Jeg kan stå så lenge jeg vil uten å få smerter
- Jeg kan stå så lenge jeg vil, men får mer smerter
- Smerter hindrer meg i å stå mer enn en time
- Smerter hindrer meg i å stå mer enn en halv time
- Smerter hindrer meg i å stå mer enn ti minutter
- Smerter hindrer meg i å stå i det hele tatt



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7. Å sove

- Søvnens min forstyrres aldri av smerter
- Søvnens min forstyrres av og til av smerter
- På grunn av smerter får jeg mindre enn seks timers søvn
- På grunn av smerter får jeg mindre en fire timers søvn
- På grunn av smerter får jeg mindre enn to timers søvn
- Smerter hindre all søvn

8. Seksualliv

- Seksuallivet mitt er normalt og forårsaker ikke mer smerter
- Seksuallivet mitt er normalt, men forårsaker noe mer smerter
- Seksuallivet mitt er normalt, men svært smertefullt
- Seksuallivet mitt er svært begrenset av smerter
- Seksuallivet mitt er nesten borte på grunn av smerter
- Smerter forhindrer alt seksualliv

9. Sosialt liv (omgang med venner og bekjente)

- Det sosiale livet mitt er normalt og forårsaker ikke mer smerter
- Det sosiale livet mitt er normalt, men øker graden av smerter
- Smerter har ingen betydelig innvirkning på mitt sosiale liv, bortsett fra at de begrenser mine mer fysiske aktive sider, som sport osv.
- Smerter har begrenset mitt sosiale liv, og jeg går ikke så ofte ut
- Smerter har begrenset mitt sosiale liv til hjemmet
- På grunn av smerter har jeg ikke noe sosialt liv

10. Å reise

- Jeg kan reise hvor som helst uten smerter
- Jeg kan reise hvor som helst, men det gir mer smerter
- Smertene er ille, men jeg klarer reiser på to timer
- Smerter begrenser meg til korte reiser på under en time
- Smerter begrenser meg til korte, nødvendige reiser på under 30 minutter
- Smerter forhindrer meg fra å reise, unntatt for å få behandling

Beskrivelse av helsetilstand (EQ-5D)

Vis hvilke utsagn som passer på din helsetilstand i dag ved å sette ett kryss i en av rutene utenfor hver av dimensjonene nedenfor.

1. Gange

- Jeg har ingen problemer med å gå omkring
- Jeg har litt problemer med å gå omkring
- Jeg er sengeliggende

2. Personlig stell

- Jeg har ingen problemer med personlig stell
- Jeg har litt problemer med å vaske meg eller kle meg
- Jeg er ute av stand til å vaske meg eller kle meg

3. Vanlige gjøremål (f.eks. arbeid, studier, husarbeid, familie- eller fritidsaktiviteter)

- Jeg har ingen problemer med å utføre mine vanlige gjøremål
- Jeg har litt problemer med å utføre mine vanlige gjøremål
- Jeg er ute av stand til å utføre mine vanlige gjøremål

4. Smerte og ubehag

- Jeg har verken smerte eller ubehag
- Jeg har moderat smerte og ubehag
- Jeg har sterk smerte og ubehag

5. Angst og depresjon

- Jeg er hverken engstelig eller depriment
- Jeg er noe engstelig og depriment
- Jeg er svært engstelig og depriment



SMERTE, FYSISK AKTIVITET OG JOBB

(Fear-Avoidance Beliefs Questionnaire,
Waddell et al 1993)

Her er noe av det som andre har fortalt oss om ryggsmertene sine. Kryss av for ett tall fra 0 (helt uenig) til 6 (helt enig) for hvert utsagn for å si hvor mye fysiske aktiviteter som å bøye seg, løfte, gå eller kjøre vil påvirke ryggen din.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
1	Smertene mine ble forårsaket av fysisk aktivitet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Fysisk aktivitet forverrer smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3	Fysisk aktivitet kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4	Jeg burde ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5	Jeg kan ikke utføre fysiske aktiviteter som (kan) forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Følgende utsagn handler om hvordan det vanlige arbeidet ditt påvirker eller kan påvirke ryggsmertene dine.

		HELT UENIG		USIKKER				HELT ENIG	
		0	1	2	3	4	5	6	
6	Smertene mine ble forårsaket av arbeidet mitt eller et uhell på jobben	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7	Arbeidet mitt forverrer smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8	Jeg har framsatt erstatningskrav for smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9	Arbeidet mitt er for tungt for meg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10	Arbeidet mitt forverrer eller kan forverre smertene mine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
11	Arbeidet mitt kan skade ryggen min	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
12	Jeg burde ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
13	Jeg kan ikke utføre det vanlige arbeidet mitt med mine nåværende smerter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
14	Jeg kan ikke utføre det vanlige arbeidet mitt før smertene er behandlet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
15	Jeg tror ikke jeg vil være tilbake på det vanlige arbeidet mitt innen tre måneder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
16	Jeg tror ikke jeg noen gang vil være i stand til å komme tilbake til det arbeidet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



Registrerings skjema ved kontroll etter rygginjeksjon

Pasientdata	Friskmeldt?
Navn	Hvis ja, angi dato <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> Dag Måned År
Fødselsnr. (11 siffer)	Varighet av sykemelding etter injeksjon <input type="text"/> <input type="text"/> <input type="text"/> (uker)
Adresse	Komplikasjoner til injeksjonen?
Alder (år) <input type="text"/> <input type="text"/>	<input type="checkbox"/> Nerveskade, spesifiser
Kjønn <input type="checkbox"/> Mann <input type="checkbox"/> Kvinne	-----
Etterundersøkelse dato <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> Dag Måned År	<input type="checkbox"/> Blødning
Tidspunkt etter injeksjon <input type="text"/> <input type="text"/> (måneder)	<input type="checkbox"/> Infeksjon <input type="checkbox"/> Overfladisk sårinfeksjon
Har pasienten møtt personlig til etterkontroll?	<input type="checkbox"/> Dyp sårinfeksjon/spondylitt
<input type="checkbox"/> Ja	<input type="checkbox"/> Allergisk reaksjon
<input type="checkbox"/> Nei	<input type="checkbox"/> Durapunksjon
Hvis nei, er skjemaet besvart per brev?	<input type="checkbox"/> Annet (spesifiser)
<input type="checkbox"/> Ja	-----
<input type="checkbox"/> Nei	Får du for tiden annen behandling for ryggplager
Arbeidsstatus	<input type="checkbox"/> Fysioterapi
<input type="checkbox"/> I arbeid <input type="checkbox"/> Student/skoleelev	<input type="checkbox"/> Kiropraktor
<input type="checkbox"/> Sykemeldt <input type="checkbox"/> Pensjonist	<input type="checkbox"/> Annen type behandling
<input type="checkbox"/> Aktiv sykemeldt <input type="checkbox"/> Arbeidsledig	Ja, spesifiser.....
<input type="checkbox"/> Delvis sykemeldt <input type="checkbox"/> Attføring/rehabilitering	Andre relevante sykdommer, skader eller plager
<input type="text"/> <input type="text"/> % sykemeldt <input type="checkbox"/> Uføretrygdet	<input type="checkbox"/> Nei
<input type="checkbox"/> Hjemmeværende	<input type="checkbox"/> Ja, spesifiser

--	--	--

Kliniske funn

1. SLR

Gradtall positiv test

--	--

 Hø Ve

2. Omvendt Lasegue positiv (sett kryss) Hø Ve

3. Muskelkraft (tall 0-5)

Tågåing	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Fleksjon, hofte	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Abduksjon, hofte	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Dorsalfleksjon, ankel	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Dorsalfleksjon , stortå	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Eversjon ankel	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Fleksjon kne	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Ekstensjon kne	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
Kontraksjon rompeballer	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve

4. Reflekser (sett kryss)

Kne Hø 0 + ++ +++ +++++
 Ve 0 + ++ +++ +++++

Plantar Hø Normal Invertert
 Ve Normal Invertert

Achilles Hø 0 + ++ +++ +++++
 Ve 0 + ++ +++ +++++

5. Sensibilitetstap (sett kryss)

L3	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
L4	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
L5	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve
S1	<input type="checkbox"/>	Hø	<input type="checkbox"/>	Ve

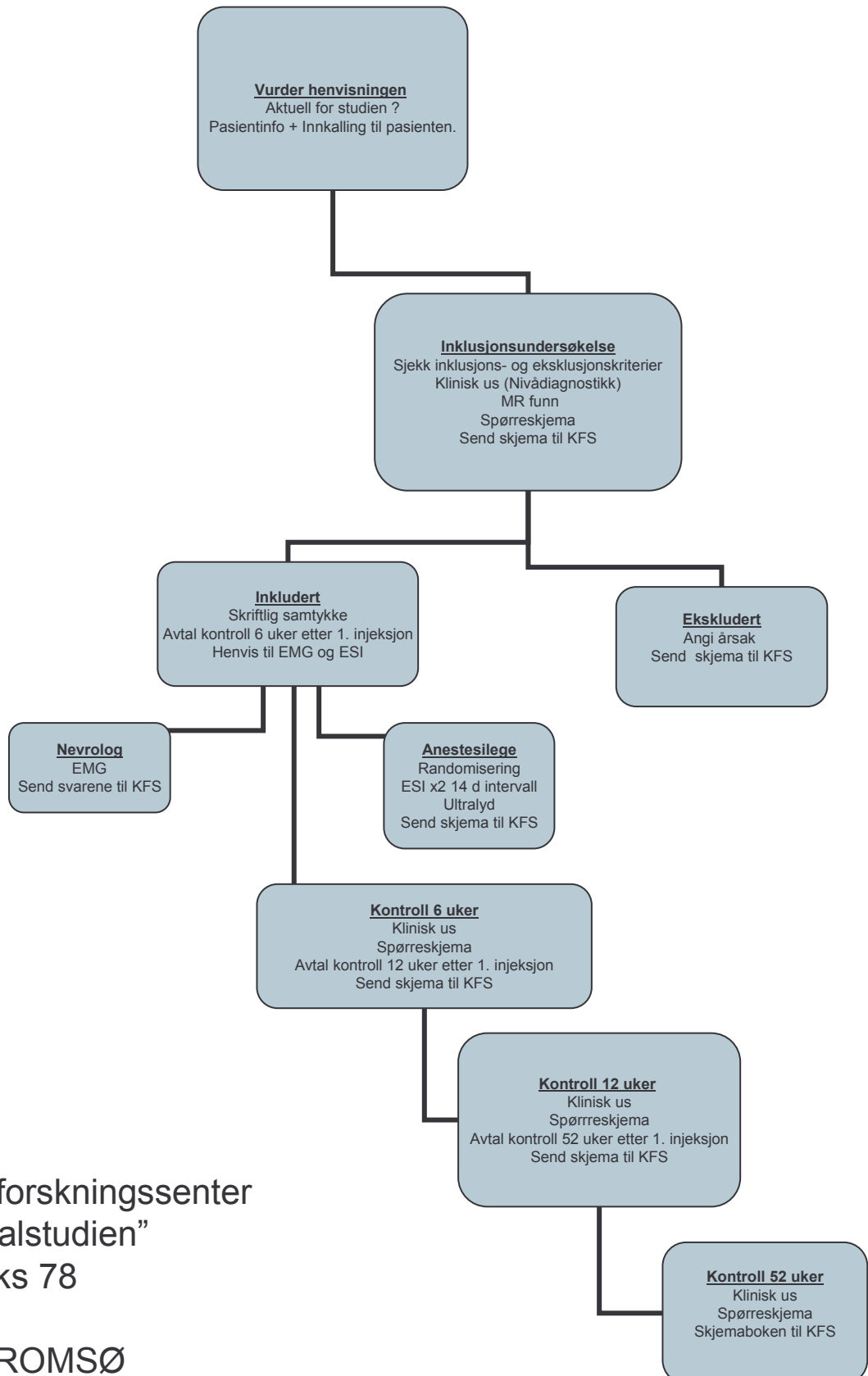
**Nerverotsutfall og side(r).
 Konklusjon basert på klinisk us.
 (Sett om nødvendig flere kryss)**

<input type="checkbox"/> L3	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> L4	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> L5	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.
<input type="checkbox"/> S1	<input type="checkbox"/> Hø.	<input type="checkbox"/> Ve.

Flere nivåer, spesifiser:



Epidural sacral injection study



KFS =
Klinisk forskningscenter
"Epiduralstudien"
Postboks 78
UNN
9038 TROMSØ

Inklusjonskriterier

1. 20 - 60 år
2. Smertevarighet \geq 12 uker
3. Nerverotaffeksjon/radikulopati L3, L4, L5, S1
4. Body mass index \leq 30

Eksklusjonskriterier

1. Tidligere ryggoperert
2. Tidligere rygginjisert
3. Røde flagg
4. Gule flagg
5. Gravide
6. Marevanbruker
7. Amming

Appendix 7 Study protocol

**Epidural steroid injection. Effect of saline solution and triamcinolone
acetonide (Kenacort-T[®]) on chronic lumbosacral radiculopathy. Blinded
multicentre randomized placebo-controlled trial.**

Protocol Code Number 2137

EudraCT Number 2004-004585-32

ISRCTN Number 12574253

Recommendation of trial amendments by the Norwegian Medicines Agency 20 January 2009

Trial amendments approved by the Privacy Issues Unit, Norwegian Social Science Data Services (NSD)

4 May 2007 and Privacy Issues Unit, University Hospital of North Norway, 16 January 2009

Recommendation of trial amendments issued by the Regional Committee for Medical and Health

Research Ethics, North Norway (REK nord) 18 December 2003, 1 April 2005, 9 May 2007 and 19

December 2008

St. Olavs Hospital, Trondheim University Hospital. New centre from 8 May 2007

Approved as a Clinical Trial by the Norwegian Medicines Agency 20 June 2005

Approved by the Privacy Issues Unit, NSD 26 November 2003

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Principles and guidelines for this study protocol

The content of this trial protocol follows the principles and guidelines in these documents

- The European Union Directive 2001/20/EC, April 2001 (The Clinical Trials Directive).
- Note for Guidance on Good Clinical Practice, September 1997 (CPMP/ICH/135/95).
- Detailed Guidelines on the principles of good clinical practice in the conduct in the EU of clinical trials on medicinal products for human use, July 2002 (ENTR/6416/01).
- Detailed guidance on the European database of Suspected Unexpected Serious Adverse Reactions (Eudravigilance-Clinical Trial Module), April 2004 (ENTR/CT 4).
- Detailed guidance on the collection, verification and presentation of adverse reaction reports arising from clinical trials on medicinal products for human use, April 2004 (ENTR/CT 3).
- The rules governing medicinal products in the European Union, volume 4 – Medicinal products for human and veterinary use: Good manufacturing practices, Annex 13 – Manufacture of investigational medicinal products, July 2003 (2003/94/EC 6).
- Declaration of Helsinki, 2000 version with note of clarification on paragraph 29 of the World Medical Association (WMA) on placebo-controlled trial.

- Statens legemiddelverk (Norwegian Medicines Agency) Melding om bivirkninger ved bruk av legemidler (inkl. naturlegemidler), September 2004.
- Forskrift om klinisk utprøving av legemidler til mennesker (FOR 2003-09-24 nr 1202).

Name, title and addresses of the investigators who are responsible for conducting the trial

University Hospital of North Norway, Tromsø

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Responsible for inclusion and follow-up of patients: Trond Iversen (Senior Physician, Department of Physical Medicine and Rehabilitation) and Jan Inge Letto (Physiotherapist, Department for Physical Medicine and Rehabilitation).

Responsible for epidural injections: Olaf Sivertsen (Senior Physician, Anaesthesiology Department) and Just Thoner (Senior Physician, Anaesthesiology Department).

Nordland Hospital, Bodø

Project leader in charge: Rolf Salvesen (Departmental Senior Physician / Professor II, Neurology Department).

Responsible for inclusion and follow-up of patients: Svetlana Rasic (Senior Physician, Neurology Department) and Anne Sofie Broback (Physiotherapist, The Outpatient Pain Clinic).

Responsible for epidural injections: Jørgen Hansen (Departmental Senior Physician, Anaesthesiology Department).

Levanger Hospital, Levanger

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Responsible for epidural injections: Gunnar Engesnes (Departmental Senior Physician, Anaesthesiology Department).

Buskerud Hospital, Drammen

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Responsible for epidural injections: Niels Becker (Departmental Senior Physician, Anaesthesiology Department).

St. Olavs Hospital, Trondheim University Hospital

Project leader in charge: Bjørn Skogstad (Senior Physician, Physical Medicine and Rehabilitation).

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Responsible for epidural injections: Tarjei Rygnestad (Professor and Senior Physician, Anaesthesiology Department, Pain Clinic).

The Coordinating Committee

Franz Hintringer (Senior Physician, Department of Physical Medicine and Rehabilitation, University Hospital of North Norway).

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The Independent Data-Monitoring Committee

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Holger Ursin (Professor, The Norwegian Back Pain Network, The Research Unit, Bergen).

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Radiologists for independent assessment of magnetic resonance scans

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Toralf Hasvold, Professor, Institute of Community Medicine, University of Tromsø.

Abstract

Background

Epidural steroid injection for lumbar radiculopathy has been used since 1953. Along with mechanical compression of nerve roots, lumbar radiculopathy can be triggered by different pro-inflammatory chemical agents, causing ectopic neuron firing. It has been hypothesized that steroids injected into the epidural space or around the affected nerve root inhibit these inflammatory mediators. However, there is conflicting evidence for a potential benefit of epidural steroid injections. Some studies have shown a moderate short-term benefit, while others show no difference between epidural steroid and placebo injections. Studies of epidural steroid injections compared to epidural saline or local anaesthetic injections show less benefit from steroids than studies comparing epidural steroid injections with sham or soft tissue injections. Furthermore, recent studies conclude that epidural local anaesthetics or saline alone may have a positive effect by themselves.

Methods/Design

The objective is to evaluate the short (6-week), intermediate (12-week), and long-term (52-week) efficacy of caudal epidural steroid and caudal epidural saline injection in the treatment of chronic (duration >12 weeks) lumbar radiculopathy.

The study is designed as a multicentre blinded randomized controlled trial.

The setting is outpatient multidisciplinary back clinics of five Norwegian hospitals.

Inclusion of patients with lumbar radiculopathy for more than 12 weeks.

There are three intervention groups. Each group receives two injections with a 2-week interval. Group one is given subcutaneous sham injections superficial to the sacral hiatus and not into the spinal canal, Group two is given caudal epidural injections with saline alone, and Group three is given caudal epidural injections with a combination of saline and triamcinolone acetonide (Kenacort-T[®]). There are three follow-up measurements: 6, 12 and 52 weeks after the intervention.

The primary outcome measure is the Oswestry Disability Index. The secondary outcome measures are the European Quality of Life measure, the visual analogue scale score for low back pain, and the visual analogue scale score for leg pain.

Discussion

This randomized controlled trial will compare caudal epidural steroid injections and caudal epidural saline injections with subcutaneous sham injections. The null hypothesis is that treatment of chronic lumbar radiculopathy with caudal epidural injection with steroids or isotonic saline has no clinically important effect.

Trial registration

Current Controlled Trials ISRCTN12574253. Registered 18 May 2005.

Keywords

Back pain; Epidural steroid; European Quality of Life; Leg pain; Lumbar nerve root impingement; Lumbar radiculopathy; Oswestry Disability Index; Physical examination; Randomized controlled trial; Sciatica

Background

Back pain, social costs

The risk of developing back pain in the course of one's life is put at about 60–80% [1-3]. Every year, one-third of all adults are afflicted by severe back pain [4]. Back pain causes considerable suffering, and the social costs are high [5]. Among Norwegians in their forties, about 6% report that their capacity for work is reduced to a greater or lesser extent by back pain [6]. Two per cent of Norwegians of working age, about 50,000 people, have such a reduced work capacity owing to back pain that they report sick, retrain or take early retirement [1]. The duration that they are off sick (more than 2 weeks) depends on whether or not the back complaints are associated with radiating pain. Hagen and Thune (1998) found that the median duration was 59 days for those with radiating pain, and 38 days for those without radiating pain [7]. Low levels of physical activity, a lack of energy, work involving heavy loads on the back, and low expectations of getting back into work are shown to

be predictors for not being back at work one year after taking time off sick for low back complaints [8]. The total cost associated with bad backs in Norway is between 13 and 15 billion Norwegian kroner per annum. In 2002, 14.1% of all disabled people were diagnosed as having a back disorder, and this diagnosis accounted for 15.7% of all new disabled pensioners in the same year [9].

Back pain, classification based on type of disease

Low back pain can roughly be divided into three types [10]. The largest group (80–90%) is ‘Non-specific low back pain’. Patients experience the spread of pain in their lower backs, buttocks and thighs. They experience variable pain intensity, are in good general health and experience an improvement at rest. The patient group with ‘Nerve root disease’ accounts for around 5–10% of all low back pain sufferers. In this group, the pain is radiating in nature, and there can be a variable degree of neurological effects in the form of loss of sensitivity, strength or reflexes. Usually, the radiation of pain is reproduced by Lasegue’s test. A spontaneous improvement in this type of back pain usually occurs within 8–12 months in about 70% of patients [11,12]. The last group is made up of patients with ‘Possibly severe underlying disease’. Around 1–5% of all patients with low back pain can prove to have fractures/damage, cancer or inflammation. The typical feature of this patient group is that patients experience constant pain, pain at rest and often a general sensation of illness. The multidisciplinary guidelines for the treatment of acute low back pain [10] describe the causes of acute low back pain based on these three main diagnostic groups [13].

Back pain, classification based on duration of symptoms

Bogduk and McGuirk (2002) and Ihlebæk and Lærum (2004) classify low back pain, regardless of cause, as acute (<6 weeks), subacute (6–12 weeks) and chronic pain (duration >12 weeks) [3,14].

Back pain, traditional treatment

Traditionally, low back pain is treated by reporting sick, resting, taking painkilling medication and receiving physiotherapy [15]. The treatment of lumbago and sciatica is a controversial issue [16]. Many guidelines have been issued for treating back pain [17-19]. The main message is that physical exercise and activity help [20]. In many cases, a combination of expensive painkilling and anti-inflammatory drugs are often used. These therapeutic approaches are not shown to have a proven effect [21]. The prospects of improvement for patients with inoperable low back pain, and who have tried various types of conservative treatment to no effect, are poor [22]. Traction therapy [23,24], bed rest [25] and non-steroidal anti-inflammatory drugs (NSAIDs) [26] have not been shown to have any effect on chronic lumbar back pain. NSAIDs can have a symptomatic effect on acute back pain [27]. There is some evidence that electrotherapy [28], cognitive therapy [29], McKenzie exercises [30] and physical exercise [31] can have an effect, but randomized clinical studies are needed [15].

Back pain, surgery

Major disc prolapses with neurological deficits and pain are usually treated by surgery. The results of microdiscectomy and macrodiscectomy are good [32,33]. Most clinics operating on back patients have clear guidelines for when surgical treatment is indicated [34]. A lot of patients with sciatica are offered an operation. This treatment is considered a 'gold-standard'. However, the long-term results following operation for sciatica are not convincing, with a high frequency of recurrence [35]. It will, for these reasons, also be important to investigate whether epidural sacral injection (ESI) can postpone or reduce the frequency of back operations. However, the steroid ESI treatment has yet to be established as an effective method compared to placebo.

Methods/Design

ESI is a method of treating low back pain and radiculopathy that is the subject of considerable discussion [36]. Although the method with steroid epidural injection has been in use from 1953, there are only a few good randomized controlled studies [37,38]. In Nelemans et al (2000), evidence for the method is given as weak, and studies of a high scientific quality are sought [39]. Randomized controlled studies are needed to clarify the effect of the volume of the epidural injection and steroids versus placebo. Many patients with chronic low back pain and sciatica feel that they have few therapeutic options besides surgery. Only a few patients with sciatica are suitable for surgical treatment. The surgeon needs a correspondence between the clinical level of radiculopathy and magnetic resonance (MR) diagnosis of disc protrusion [40]. Many patients lack this correspondence. We therefore want to conduct the study on patients with clinical signs of lumbosacral radiculopathy, where the pain has lasted for more than 12 weeks (chronic) and where surgical treatment is not indicated at the time of inclusion due either to lack of correspondence between clinical and MR finding or low Oswestry Disability Index (ODI). In our study, we wish to use a corticosteroid preparation with a weak anti-inflammatory effect. Triamcinolone acetonide (Kenacort-T[®]) in a strength of 40 mg/ml and a quantity of 1 ml diluted with 29 ml NaCl 0.9% in the epidural space meets this requirement. The effect is to be compared with placebo/sham injection (2 ml NaCl 0.9% subcutaneously) and 30 ml NaCl 0.9% without steroid in the epidural space. In many studies, injections have been used with a small volume (<10 ml). We will use a volume of 30 ml to be sure that the medicinal product is distributed throughout the epidural space in the lumbosacral column up to level L2.

If our study can demonstrate a significant therapeutic effect for ESI of steroid, the method could become an important tool in the treatment of patients with low back pain and radiculopathy. We could also clarify in the study whether there are special subgroups of patients with radiculopathy (e.g. signal changes in the disc; covered prolapse; free prolapse; thickened nerve root; disclosed nerve root) that respond better to steroid injection. If the method can also be proven to be easy to perform, and is associated with few serious complications and adverse drug reactions (ADRs), it could

become useful in both the treatment and rehabilitation of sciatica patients. At present, we do not know enough about the risk associated with use of the method, the incidence of side effects, and what should be regarded as adequate follow-up of patients. Hopefully, a study could yield valuable information on this. Given a good effect from the treatment and a low incidence of side effects, we will probably be able to substantiate a positive gain in the form of reduced suffering for the individual in addition to a socioeconomic gain from patients recovering their health and being able to return to work more quickly.

Trial design

The study can be classified as a blinded, placebo-controlled, explanatory, effectiveness, multicentre, randomized controlled trial (RCT) [41]. Blinding is ensured by keeping the subjects and investigators responsible for the follow-ups at the different hospitals unaware of the treatment assignment. The study is a placebo-controlled explanatory trial because it addresses whether or not the intervention with steroid has a better effect compared to placebo injections [41]. The effectiveness of the intervention is measured on primary and secondary outcome measures.

Randomized controlled trial, patient selection

Patients with clinically suspected lumbosacral radiculopathy who are referred in the course of 2005–2008 from the general practitioners to the Outpatient Back Department at the University Hospital of North Norway (UNN) in Tromsø, the Outpatient Neurology Department at Nordland Hospital in Bodø, the Outpatient Back Department at Levanger Hospital and to the Outpatient Back Department at Buskerud Hospital in Drammen will be continuously assessed for possible inclusion in the study (Figure 1). Referred patients who may be suitable for inclusion in the study are given, together with the invitation to a consultation at the appropriate outpatient department, an information letter on

the study indicating that, if they meet special criteria in terms of their back complaints, they will be invited to take part in the study (Figure 2).

Inclusion, clinical examination

The inclusion examination and follow-up is conducted by a physician on an outpatient basis. The examination follows a study template that has been drawn up, and the aim is to decide whether the patient clinically suffers from a lumbosacral radiculopathy and at which level (Figure 3). Based on the standardized clinical back examination, the doctor must determine which of the levels from L3 to S1 the radiculopathy affects.

Definition of the term 'lumbosacral radiculopathy'

The term 'lumbosacral radiculopathy' should be understood to mean that a patient with or without low back pain has either radicular radiating pain in the leg below the knee joint, reduced strength, impaired sensitivity or attenuated tendon reflexes, or possibly a combination of several clinical findings of this kind.

Magnetic resonance diagnosis. Investigation procedure and assessment

All patients included must have undergone an MR scan of their lumbosacral column. The scans are taken and described at the time of inclusion at the MR departments at UNN, Nordland Hospital in Bodø, Levanger Hospital or at Buskerud Hospital. Scans taken and described at other hospitals or private radiography bodies are accepted. The scans should as a rule be taken within 8 weeks before the inclusion check. An important condition for the use of scans taken before the time of inclusion is that the patient's clinical findings have not changed from when the MR scans were taken. The MR

scans are taken in accordance with a standardized protocol (Sagittal T1/T2, Axial T1/T2) with a view to prolapse diagnosis.

Magnetic resonance diagnosis, based on Modic [42]

Based on the radiologist's MR description of the individual patient, it must be recorded whether one or more of the specified findings are present and their level and side.

- Normal
- Signal changes/Degenerative changes in the disc (Yes/No?, Level/Side?)
- Disc bending/Covered prolapse (Yes/No?, Level/Side?)
- Free/Sequestered prolapse (Yes/No?, Level/Side?)
- Thickened nerve root (Yes/No?, Level/Side?)
- Lateral recess stenosis with disclosed nerve root (Yes/No?, Level/Side?)

Each patient's scans are stored on CD-ROM. This is labelled with the patient ID and sent to the Clinical Research Centre, the Unit for Research Methodology, UNN. The CD-ROMs are then later sent for review by two independent experienced radiologists.

Treatment groups

1. We want to investigate whether ESI with 30 ml saline (Volume intervention group), has a positive effect on patients with clinical signs of chronic lumbosacral radiculopathy.
2. We want to investigate whether the use of ESI with 29 ml saline plus 1 ml 40 mg triamcinolone (Volume plus Steroid intervention group) has a positive additional effect

compared to volume alone on patients with clinical signs of chronic lumbosacral radiculopathy.

3. We want to investigate whether a possible effect of volume or triamcinolone depends on which subgroups of patients with chronic lumbosacral radiculopathy we treat [43].

Subgroups are classified on the basis of the clinical level of the radiculopathy, and what MR diagnosis the patient is given.

Blinding of treatment

The patient being given the injection is not informed whether ESI treatment or placebo is being given. The anaesthesiologist and the patient do not discuss the patient's medical history. The anaesthesiologist does not inform the doctor or physiotherapist who included the patient as to which injection has been given.

Randomization process

1. The randomization process is performed at a central randomization unit (Clinical research centre, Unit for Research Methodology, UNN) by personnel who have nothing to do with the patients.
2. Patients included are randomized ('Random Allocation') to receive placebo or one of the two treatments. Stratified block randomization is used. As this is a multicentre RCT, the hospital where the treatment is administered forms a stratification factor [44]. The anaesthesiologist, who is to administer the injection, telephones the randomization unit. He is told to which group (steroid, volume or placebo) the patient has been randomized.

3. The anaesthesiologist administering the injection has nothing to do with the study, nor does he find out about the patient's medical history or clinical findings made during the inclusion check.

Selection and withdrawal of subjects

Inclusion criteria based on medical history and clinical examination

1. Patients aged 20–60 years old, of both sexes.
2. Duration of radicular symptoms ≥ 12 weeks (chronic pain).
3. Clinically proven radiculopathy at nerve root L3, L4, L5 or S1. The radiculopathy may be unilateral/bilateral on the same level, or unilateral/bilateral on one or more levels at the same time.

Exclusion criteria based on medical history and clinical examination

1. Indication of acute back surgery at the time of inclusion. To determine whether acute surgery is indicated, the guidelines drawn up by the Neurosurgery Department, UNN, are followed [34].
2. Previous back surgery.
3. Previous epidural or nerve root injection for low back pain or sciatica.
4. Body mass index (BMI) >30 .
5. Red flags (rheumatic inflammatory disease; malignant disease; diabetes mellitus; severe and uncompensated cardiovascular disease; known autoimmune disease; currently known infection; haemophilia; some other type of disease that affects the coagulation system).

6. Yellow flags (known severe mental disease; known problems with alcohol or substance abuse).

7. The patient must not have noticed an improvement in symptoms for the previous 2 weeks before inclusion. The person investigating the patient for the first time asks the following question:

Have you got better over the past 2 weeks? (Yes/No)

If the patient answers *Yes* to this question, the individual is excluded.

8. Nor must the patient have experienced centralization of the pain, i.e. the pain has moved from the lower extremity towards the middle of the back, as this is regarded as a clinical sign of an already ongoing spontaneous improvement in the patient's condition [45]. The person investigating the patient for the first time asks the following question:

Over the past 2 weeks, have you experienced a shift in the pain from severe leg pain to severe pain in your back? (Yes/No)

If the patient answers *Yes* to this question, the individual in question is excluded.

9. Women of childbearing age are asked about pregnancy. The person investigating the patient for the first time asks the following question:

Are you pregnant? (Yes/No)

If the patient answers *Yes* to this question, the individual in question is excluded. All women of childbearing age are tested for HCG in urine.

10. Women who are breastfeeding.

11. Anticlotting therapy. The person investigating the patient for the first time asks the following question:

Are you taking warfarin (Marevan)? (Yes/No)

If the patient answers *Yes* to this question, the person is excluded. Use of Acetyl Salicylic Acid is not an exclusion criterion [46].

12. Ongoing drug treatment with NSAID. The person investigating the patient for the first time asks the following question:

Can you come off the NSAID? (Yes/No)

If the patient answers *No* to this question, the individual in question is excluded.

Exclusion criteria based on magnetic resonance findings

The physician who conducts the inclusion check must, after the clinical examination is completed, assess the MR response provided by the radiologist for the patient. If, based on the radiologist's description, a *Yes* answer is given to one or more of the findings listed below, the patient must be excluded. If the MR description does not provide a basis for answering *Yes* or *No* to the questions, the radiologist who has described the scans must be contacted and asked to clarify his description.

- Lateral recess stenosis of osteogenic aetiology (Yes/No?)

- Tumour (Yes/No?)

- Bleeding (Yes/No?)

- Dural fistula (Yes/No?)

- Synovial cyst (Yes/No?)

- Dysraphia conditions (Yes/No?)

Written informed consent

The patients in question, who it is demonstrated have a lumbosacral radiculopathy and fulfil the inclusion criteria and no exclusion criteria, provide written informed consent if they wish to take part in the study (Figure 4).

Back information for patients included. The good back consultation

All patients included who have given written informed consent to take part in the study are given standardized oral information on back anatomy and back function with the emphasis on management and encouragement to engage in activity [47-52]. The information is given by the doctor and physiotherapist conducting the inclusion check. A recently published study shows that back information alone can be just as effective in treating low back pain as standard physiotherapy treatment [53]. In the back consultation that the doctor conducts with the patient, the Norwegian national guidelines as set out in 'Acute low back pain. Interdisciplinary clinical guidelines' [10] and the 'European guidelines for the management of chronic nonspecific low back pain' [19] are followed, with a special focus on the recommendations concerning 'The good back consultation'. All patients included also receive the brochure 'Worth knowing about bad backs. What experts agree on' [10] after the inclusion check and back consultation have been conducted.

Recording use of medication

1. The patient records his consumption of medication over one week before the first injection is performed. The names of the medicinal products, their strength and the number of tablets taken are recorded by the patient.

2. After the second injection is administered, the patient is asked to record his consumption of painkilling medication in the same way over one week before the agreed check-ups.
3. The consumption of each drug will be calculated with defined daily doses as a measurement unit and classified and presented by therapeutic group according to the anatomical therapeutic chemical system [50].

Treatment of subjects

After the inclusion check, back consultation and MR investigation have been performed, the doctor refers the patient to the anaesthesiologist for random allocation and injections according to the randomization outcome. The referral to the anaesthesiologist is standardized, and includes important information on cardiac and pulmonary status, medication and any allergies (Figure 5). The referrals do not include information on the patient's clinical back details at the time of inclusion. As a rule, no more than 2 weeks should elapse between the inclusion check and randomization to intervention.

The intervention

The patients included are given either two ESIs with volume plus steroid (Group I) or volume alone (Group II), or two placebo saline subcutaneous injections (Group III). The two injections are administered at 2-week intervals. The injections are administered by an anaesthesiologist with competence in spine injections. The injections follow a set template for injections of this kind (Figure 6). Ultrasound is used to localize the hiatus sacralis and increase the precision of the ESI.

Intervention groups

The following three intervention groups are established.

Group	Intervention with two injections
I Volume + Steroid ESI	1 ml triamcinolone 40 mg/ml + 29 ml NaCl 0.9%
II Volume ESI	30 ml NaCl 0.9%
III Placebo subcutaneous	2 ml NaCl 0.9%

Assessment of efficacy

The patients are examined by a physician at the time of inclusion and after 6 weeks. The follow-up checks by a physiotherapist are done after 12 and 52 weeks. The inclusion and follow-up checks include completing the standardized registration form and questionnaire and a clinical examination with focus on radicular pain, muscle power, sensibility and reflexes [54-58].

Primary outcome

Oswestry Disability Index

The ODI measure consists of 10 questions about pain, pain-related disability in daily life, and social participation [59,60]. The total score ranges from 0 (no pain or disability) to 100 (worst possible pain

and disability). The Norwegian version of the original ODI (version 2.0) will be used in this study. The Norwegian version of the ODI has been found to be reliable and valid for Norwegian patients with low back pain [61,62]. The scores (0–5) from all 10 sections are summarized, divided by the number of sections answered and multiplied by 20% [63].

Secondary outcomes

European Quality of Life measure

Fear-Avoidance Beliefs Questionnaire

Visual analogue scale back pain, leg pain and general health

Number of patients referred to all types of back surgery during follow-up

European Quality of Life measure (EQ-5D) is a generic (aims to capture physical, mental, and social functioning) measure of health-related quality of life (HRQL) in which health status is defined in terms of five dimensions: Mobility, Self-Care, Usual Activities, Pain/Discomfort, Anxiety/Depression [64,65]. Each dimension has three qualifying levels of response roughly corresponding to ‘no problems’, ‘some difficulties/problems’ and ‘extreme difficulties’. Information collected using EQ-5D can be reported in terms of its individual dimensions and as a single index score (EQ-5D) [66,67].

Fear-avoidance beliefs are measured by the Fear-Avoidance Beliefs Questionnaire (FABQ) [68]. The FABQ consists of 16 items and is divided into two subscales: fear-avoidance beliefs for work (FABQ-Work) and fear-avoidance beliefs for physical activity (FABQ-PA). The items are scored from 0 to 6, with higher numbers indicating increased levels of fear-avoidance beliefs. According to the paper by Waddell et al [68], seven of the 11 items in the FABQ-Work and four of the five items in the FABQ-PA are summarized in one score. The FABQ-Work scores range from 0 to 42, and the FABQ-PA from 0 to 24. Previous studies have found the FABQ to be a reliable and valid instrument [69].

The patients score their current pain intensity in the lower back and lower limb on visual analogue scale back pain and leg pain (VAS_{BP}, VAS_{LP}) ranging from 0 to 100, where 0 reflects no pain and 100 the worst possible pain. In addition, the patients are invited to state how good or bad their general health state is on visual analogue scale general health (VAS_{GH}), in which the best state is marked by 100 and the worst state that they can imagine is marked by 0.

The last of the secondary outcome measurements, need for back surgery, is registered as type of surgery done in the follow-up period.

Assessment of safety

No harmful effects have been demonstrated on the dura mater or nerve tissue after a series of steroid ESIs [70,71]. Following reported cases of arachnoiditis after epidural injection of the steroid preparation Depo-Medrol, the indications for the use of this medicinal product were restricted, and the manufacturer stated in its product information in 1981 that 'we would advise against the epidural/extradural routes of administration because of possible adverse reactions'. This warning was removed from later product information [72].

Nelson and Landau (2001) have also reviewed the complications and adverse reactions following epidural injections (both lumbar and sacral) reported to the US Food and Drug Administration (FDA) in the period 1930 to 1994 [72]. Their aim was to clarify effectiveness, side effects, complications and what information should be given to patients who are given epidural steroid injections. They conclude as follows: (1) Intraspinal steroid therapy is not effective therapy for back pain or radicular syndromes because steroid formulations, placebos, and sham injections have similar outcomes. (2) When injected, epidural medications may not remain confined to the epidural space and some inaccuracies of placement approach 40% [73-75]. (3) The additives of steroid formulations – polyethylene glycol, benzyl alcohol, and benzalkonium chloride – can be neurotoxic when injected

intrathecally. Further research may disclose that the steroid formulations and mixtures themselves may be neurotoxic because of high osmolalities. (4) Epidural steroid infusion may result in increased pain, early or late. There may also be serious complications of arachnoiditis, spinal infection [76-79], or permanent neurological deficits [80,81]. (5) Patients should be informed that there is no evidence that epidural steroid injections provide permanent relief of pain. Serious permanent complications to the spinal cord, nerve roots, or peripheral nerves are a rare but certain risk [82,83].

Despite this negative evaluation of what we know so far concerning problems associated with steroid ESI primarily on the lumbar level, not the sacral/caudal level, a search is being started for good randomized placebo-controlled studies in order to get some answers to many of the questions and uncertainties relating to this form of treatment [84]. Most recently, in an editorial in the *BMJ* dated June 2004 [85], it was claimed that ‘a need exists for well-designed trials of adequate size to determine the effectiveness of epidural injection in back pain’. Epidural injection therapy may provide a useful adjunct to recovery in patients whose symptoms have extended beyond 3 months in the absence of recognized indicators of chronicity (‘yellow flags’) and who may have radicular symptoms. In a review article about steroid ESI, Ogoke (2000) concludes that it is ‘essential that further meticulously controlled, randomized studies are conducted to prove the rational and unequivocal efficiency of steroid ESI’ [86].

The intervention, safety rules

1. In the interests of patient safety, the anaesthesiologist who is to administer the injections is not blinded for the injections given.
2. The sacral route (ESI) is used.
3. If serious complications arise from the injection, every patient must be treated as if there has been given active treatment (steroid). The anaesthesiologist records every injection given,

and this record with information concerning medication and batch number may be opened if necessary.

4. Use of ultrasound to enhance ESI safety and precision.

Serious complications ('Serious adverse events'). Procedure for recording and notification

1. The patients are given a list of which serious complications may arise after the injections, and which call for immediate contact with the doctor. Patients are told to contact the duty medical officer in their place of residence if suspected serious complications arise (Figure 7).
2. Doctors who are invited to refer patients to the study are informed in a separate letter about the study, possible serious complications after the injections, and about recommended therapeutic measures (Figure 8). If a serious complication arises before the two planned injections are administered, the patient will not receive the injections, but will be followed up as planned ('intention to treat').
3. The risk of serious complications as a result of sacral epidural injection is generally low. *Infection, haemorrhage, nerve damage and dural puncture* are possible serious complications.
 - *Infection* is characterized by high temperature, discomfort and significant local pain, possibly in combination with redness, heat and swelling at the injection site on the sacrum. The estimated incidence of infection is 0.01 to 0.1%. Most frequently this involves superficial skin infection, and very rarely epidural abscesses.
 - *Haemorrhaging* is a very rare complication of the sacral epidural injection technique. During the procedure, aspiration is regularly performed to check for the effusion of

blood. Superficial bleeding from the skin at the injection site may occur, but the risk is reduced by light compression of the injection site when the needle is removed.

- *Nerve damage and dural puncture* are very rare in connection with sacral epidural injection. Normally there is around 6 cm from the sacral hiatus to the lower limit of the dura (the lower limit is at S2 level). In the injection technique, the needle is inserted about 2 cm from the sacral hiatus and is consequently about 4 cm from the dura. Anomalies can, however, arise from the lower limit of the dura being nearer the sacral hiatus than normal. During the injection, particular attention is therefore paid to preventing the presence of spinal fluid in the spinal needle before the injection starts. In the case of dural puncture, what is known as a 'spinal headache' can arise. Most individuals who experience a complication of this kind spontaneously get better after a few days. In isolated cases of persistent headache, treatment with so-called 'blood patches' can be necessary. Spinal nerves at level S2 to S5 start, in normal anatomy, at a level cranially before the upper limit of the spinal needle. The sacral epidural technique is therefore associated with very little danger of direct damage to spinal nerves.

4. In the event of a serious complication (infection, haemorrhage, nerve damage, dural puncture) from an injection, this is recorded and reported by the coordinating investigator to the chairman of the Independent Data-Monitoring Committee (IDMC). Based on an overall assessment of the individual event, it will then be decided whether the event is of such a nature and severity that the study should be discontinued.

Adverse drug reactions ('Minor adverse events'). Procedure for recording and notification

1. Corticosteroids administered orally, used for local injection or for spinal injection, may induce a range of side effects of variable severity in the patient. If the side effects are significant, and are considered to be harmful to health, the doctor refers the patient to the doctor who included the patient at the hospital in question. The case is assessed and discussed by the Coordinating Committee, and a decision will be taken on whether the patient should drop out of the study owing to the side effects.
2. The assumed frequency of ADRs from the use of corticosteroids for injections is about 2%, and the commonest ADRs are:
 - Transient flushing and heat in the skin
 - Menstruation-like bleeding
 - Fluid retention
 - Weight gain. Increased appetite
 - Increased blood pressure
 - Mood swings
 - Irritability
 - Anxiety
 - Sleeping problems
 - Elevated blood sugar
 - Transient impairment of immune defence

- In long-term use (dose-dependent), corticosteroids can contribute to the development of cataracts, avascular osteonecrosis and osteoporosis
3. Corticosteroid side effects reported by the patient or doctor are recorded and reported by the coordinating investigator to the chairman of the IDMC if the side effect is considered to be abnormally marked or if it has resulted in damage to health. It will then be decided whether the side effect is of such a nature and severity that the study must be discontinued.

Notification to the Norwegian Medicines Agency

All serious complications, ADRs and serious unexpected severe adverse reactions (SUSARs) are reported to the Norwegian Medicines Agency, regionale legemiddelinformasjonssentre (RELIS) and the Regional Committee for Medical and Health Research Ethics, Nordland, Troms og Finnmark (North Norway) (REK nord / REKNOR) in accordance with defined procedures.

All SUSARs will also be electronically reported to the European Medicines Agency's (EMA's) EudraVigilance database.

Independent Data-Monitoring Committee, interim analysis

The main functions of the IDMC are to perform continuous monitoring during the study for the occurrence of serious complications ('Serious adverse events'), serious ADRs ('Minor adverse events') or unexpected serious side effects ('Serious unexpected events'), and for the occurrence of statistically significant more serious side effects in the treatment group. We adopt a sequential design in which we assume five interim analyses in the course of the study. The difference in the proportion of serious adverse events between the groups is tested at a total significance level of 5%. The interim analyses are performed with the aid of the program EaSt-2000. The advantage of a sequential design is that we can monitor the study for early termination on ethical grounds. If

significantly ($P < 0.05$) more serious complications or significant side effects that are harmful to health are recorded in the treatment group (the corticosteroid group), the Coordinating Committee must be immediately informed. As the disease that is being studied in this study is not a life-threatening one, and as a rule spontaneously improves over time, a statistically significant greater therapeutic effect in the group receiving active treatment than with the group receiving placebo alone will in itself not be a reason to terminate the study. Any decision to terminate the study must be taken by the Coordinating Committee on the advice of the IDMC.

Data analysis

1. Analysis is performed by the 'intention to treat' method.
2. Change in the primary outcome variable (ODI) and the secondary outcome variables (EQ-5D, VAS leg and back pain) will be calculated.
3. The results of the MR investigation and clinical examination will cover the following subgroups (in different combinations) of patients with nerve root disease.
 - MR signal changes in the disc (Yes/No)
 - MR covered prolapse (Yes/No)
 - MR free prolapse (Yes/No)
 - MR thickened nerve root (Yes/No)
 - MR disclosed nerve root (Yes/No)
 - CLINICAL L3 root radiculopathy (Yes/No)
 - CLINICAL L4 root radiculopathy (Yes/No)

- CLINICAL L5 root radiculopathy (Yes/No)
- CLINICAL S1 root radiculopathy (Yes/No)

An important part of the study is comparison of the effect of sacral epidural injection on these different combinations of clinical and MR findings. A one-way ANOVA (for normally distributed data) or Kruskal-Wallis test (for non-normally distributed data) are used here.

4. The statistical program SPSS is used to analyse the results. The statistical analyses are performed at the Institutt for Samfunns Medisin (ISM), Universitetet i Tromsø, by personnel who do not know the patients' clinical details or which patients have received placebo or treatment.

Calculation of sample size

Many studies have been conducted that can provide a basis for calculating the sample size of the trial. In the case of the primary outcome measure, the ODI, a clinically significant difference between the groups can be set at $\Delta = 10$ [50]. Based on this, and by using a quantitative method where $f(\alpha = 0.05, \beta = 0.10) = 10.5$ [87], we can calculate the necessary sample size for each randomization group: $n = 69 \{n = 2 (\sigma/\Delta)^2 \times f(\alpha, \beta)\}$ patients in each group if the standard deviation (σ) = 18, strength (β) = 90% and significance level (α) = 5%. With three groups we therefore need a total of 207 patients included in the study. We want to have five interim analyses performed during the study, and therefore need to increase the number of patients to 72 in each group. If we add a few more to take account of lost-to-follow-up, non-compliance, etc., we will probably have to increase the size of the groups to 80 patients. Based on this, we aim to include a total of 240 patients.

Direct access to source data/documents

All data from the standardized questionnaires are input in anonymized form in a database established at the Clinical Research Centre, the Unit for Research Methodology, UNN. Data input is carried out by optical scanning of the questionnaires.

Quality control and quality assurance

Monitoring of the quality of data recording and record keeping may be performed unannounced by personnel from the Clinical Research Centre, the Unit for Research Methodology, UNN.

The Coordinating Committee

The Coordinating Committee's tasks are, via its members, to ensure that the study progresses and that it is performed as intended at each hospital. The Coordinating Committee must also take a view on serious complications and ADRs recorded and, in consultation with the IDMC, decide to terminate the study if appropriate.

Ethics

Placebo is traditionally regarded as inactive treatment. In experimental studies, treatment is often compared with placebo to determine whether or not treatment using an active medicine has any effect [88]. In studies on the effect of ESI, steroid treatment is often compared with placebo treatment using saline. The reason for this is that so far there is still no standard treatment for ESI for back pain. In some studies a positive effect has been recorded for epidural saline on its own. One possible interpretation of this could be that an inactive substance can have an effect via mechanisms other than the purely pharmacological action, for example due to a volume or pressure effect. The

inclusion and randomization of patients with nerve root disease for ESI is basically associated with a number of ethical problems. The use of ESI is widespread. This method has been used both inside and outside hospitals. There is, however, no evidence that the method is effective. It is therefore important that a high-quality randomized controlled study is carried out in order to document any effect of steroid and volume versus placebo in patients with chronic lumbosacral radiculopathy. Since there is some uncertainty and lack of evidence associated with most methods for treating lower back pain and sciatica, testing the effect of ESI would be ethically defensible. Good patient information, informed consent, the principles of good clinical practice in clinical trials, the Declaration of Helsinki and ethical approval are fundamental requirements for conducting a study of this kind.

Data handling

All questionnaires and clinical record forms in the study are collected in a dedicated 'Form book' that tracks the patient until the study has been completed (Figure 9). All procedures and recorded information about the patients will be saved and accessible at each involved clinical trial hospital (in the electronic patient journal) for at least 15 years after the study report has been completed.

Insurance

Section 3 of the Product Liability Act no. 104 of 23 December 1988 contains special rules governing liability for compensation in respect of harm caused by medicinal products. Under these rules, manufacturers, importers and testers of medicinal products must take out special insurance known as Medicinal Product Insurance. This insurance will, under the detailed rules of the Act, compensate any injured party in an objective manner, i.e. regardless of whether blame is established. The Product Liability Act requires manufacturers, importers and testers to take out insurance via membership of a

special association known as the Drug Liability Association. The epidural project is insured under the Medicinal Product Insurance scheme via membership of the Drug Liability Association.

Own risk

The project covers health insurance for the patients for the inclusion check, two injections and three follow-up check-ups.

Trial plan

- Start of trial: October 2005.
- End of study: December 2009 (or when inclusion of 240 patients is completed).
- Actual inclusion rate from 2005 to 2007: 2 per month.
- Estimated inclusion rate all hospitals at start of RCT was 16 per month. This gap between expected and current inclusion rate has initiated a rerun of the information letter concerning the study to the doctors, chiropractors and physiotherapists referring patients to the study and stronger internal logistics in coadjutant hospitals. All departments will give priority to the RCT and increase the inclusion rate. By the end of 2007 it is estimated that 100 patients are included, by the end of 2008, 170 patients, and by the end of 2009, 240 patients.
- Presentation of results: 2010.

Discussion

Back pain, injections

Ever since the beginning of the 20th century, ESI has been used as a method of treating lumbago and sciatica [89]. Clinical findings for sacral epidural injection for back pain were reported as long ago as 1925 [90]. In one clinical study from 1930, full and permanent improvement was reported for 61% of a group of sciatica patients who were treated with ESI of the local anaesthetic procaine [91]. The English physician James Cyriax used ESI regularly in the treatment of his back patients. Over the period 1937–1980, he probably used more than 50,000 such injections [92].

Bogduk (2004) has in a clinical update concerning management of chronic low back pain argued in defence of a so-called reductionism [93]. Reductionism describes the pursuit of a pathoanatomical diagnosis for chronic low back pain with the view to implementing a target-specific treatment. Bogduk describes diagnostic joint blocks, discography, intradiscal electrothermal therapy as examples of target-specific treatment. It is possible that the use of ESI can be classified as both reductionism and target-specific treatment.

Back injections, evidence from Cochrane

ESI for low back pain was described as a potentially effective method of treatment in a Cochrane report [39] dealing with evidence for injection treatment for back pain. Injections, according to this systematic review, should not be seen as an alternative to the surgical treatment of sciatica, but more as a supplement. Injections can in some cases have the effect of postponing surgery and in this way enable the patient to train his or her back muscles in a pain-free period before any subsequent surgery. In some cases, the injections can provide an effective therapeutic option for the large group of back patients for whom surgery is not indicated and for whom exercise and other conservative treatment has been unsuccessful [21,85]. Some American clinics are increasingly using ESI preoperatively, both as a diagnostic aid and for treatment purposes [94]. Used in this way, the injections may perhaps also postpone, or prevent, surgery [95-98].

Back injections, effect on radiculopathy

The effect of ESI is not well elucidated [70,99-102]. The use of ESI in disc prolapse with radiculopathy is based on the hypothesis that inflammation develops as a result of compression either against the dura or against the nerve root [103]. Compression against the dura gives rise to multisegmental pain via an effect on sensory nerve fibres in the dura, or segmental pain on compression against the nerve root [104]. In theory, it is conceivable that the volume used in ESI may be important for the painkilling effect in multisegmental pain, either via a pressure effect on the dura in which the dura is pressed away from the disc, or via a tensile effect in which the fluid breaks or loosens inflammatory-induced adhesions between the disc and dura [105-107]. In two recently published studies [108,109], it has been documented in animal experiments that material from the pulpy nucleus that comes into contact with nerve tissue can trigger pain without there being mechanical pressure against the nerve. This may help explain how significant problems with back pain and sciatica can be experienced even if a definitely free prolapse with an effect on the dura mater or nerve root cannot be demonstrated by MR diagnosis [110-112]. In a study using gadolinium-enhanced lumbar spine MRI, Saifuddin et al (1999) found that patients with annular tears may experience low back pain with radiation into the lower limb in the absence of nerve root compression [113]. Inflammation of nerve roots from leak of degenerative nuclear material through full-thickness annular tears was the proposed mechanism for such leg pain.

Back injections, effect of volume in the epidural space

Variable volumes have been used for ESI in various studies. Cuckler et al (1985) used 7 ml [114], Klenerman et al (1984) 20 ml [115], Beliveau (1971) 42 ml [116] and Evans (1930) 98 ml [91]. Klenerman et al (1984) injected a volume of 20 ml for three different treatment groups [115]. One group received corticosteroid and saline, another group received only saline and the third was given

only local anaesthetic. Klenerman recorded an effect from the injections on pain but was unable to establish a significant difference between the treatment groups. One possible interpretation of this result is that neither corticosteroid nor local anaesthesia has an effect. Another possible interpretation of this result is that the injected volume of 20 ml has an effect in itself [117]. Fluoroscopic studies of ESI have shown that, by using a volume of 8 ml, it is possible to reach disc level L4/L5. Epidural injections of preparations show that a volume of 30 ml reaches L2 level, and is distributed throughout the epidural space (Professor in anatomy University of Oslo, Norway, Eric Rinvik, personal communication from 2003). A study published by Valat et al (2003) reports that ESI of 2 ml saline alone yields a reduction in pain, but no additional effect from the injection of 2 ml prednisolone acetate (50 mg) was demonstrable [118].

Back injections, evidence from clinical studies, systematic reviews and randomized controlled trials

ESI has been used as treatment for lumbago and sciatica for many years, but the method is still not established as good clinical practice. It is documented in one review that ESI was recommended to as many as 12.6% of all patients with lumbago and sciatica [119]. Despite this, there are few randomized controlled studies documenting the therapeutic effect [120]. The weakness of the studies that exist in this field is that they have generally been conducted on small patient populations, often without the use of control groups [102,121-127]. In addition, inclusion criteria and diagnosis groups have been poorly explained [128].

Two of the studies mentioned above [122,123] comprise more than 200 patients, but the studies lack control groups. The findings therefore become difficult to interpret. Variable results have been reported for ESI with a one-year success rate ranging from 25% [129] to 65% [122]. In other studies with patient populations comprising 30–70 patients and with control groups, no statistically significant improvement is reported after epidural injection [114,115,130-134]. Many of these

studies conclude that ESI of corticosteroids has no effect either on relieving symptoms or on the duration of disease in the case of sciatica [131,133]. In one of the studies, epidural injection of corticosteroid was compared with NSAID, without any significant difference in reduction of symptoms and duration of disease being demonstrable [130]. In four of the studies, corticosteroids are compared with local anaesthesia and saline, without it having been possible to demonstrate significant differences in therapeutic effect [114,115,132,134].

In five randomized controlled studies, improvement in back complaints has been documented following ESI of corticosteroids. Breivik et al (1976) report a significant improvement in pain and objective neurological signs after injection of corticosteroid and bupivacaine compared with injection of saline and bupivacaine [135]. Mathews et al (1987) and Bush and Hillier (1991) report significantly more pain-free patients, and an improvement in Lasegue's test, 3 months after ESI of corticosteroid and procaine compared with saline [136,137]. Ridley et al (1988) found that the effect of epidural injection of corticosteroid was better than placebo injection of saline in the spinous ligament [138]. Carrette et al (1997) found that epidural injection of corticosteroid and saline yielded better results on pain than injection of saline alone [139].

Some of the randomized controlled studies in this area lend support to the use of ESI for low back pain and sciatica [140,141], whereas others reject the method [142]. This uncertainty concerning the findings of the studies that have been conducted means that evidence for use of the method is weak [143]. The method has therefore not been generally accepted as good clinical practice. However, the method is inexpensive, easy to use and has few reported side effects [144,145].

Accuracy of the method

There are a number of more recent reports indicating that accuracy of the ESI method is lower than previously assumed [146-151]. It is indicated in one study that clinical perception of a properly

performed technique has a sensitivity rate of 94%, and a specificity rate of 20% [152]. In another study, in which 304 ESIs were administered by experienced clinicians, it turned out that 25% of the injections were performed incorrectly [153]. Another important aspect of not using fluoroscopic guided epidural injection is the uncertainty concerning the likelihood of placing the injection intravasally in the venous plexus in the epidural space. Sensitivity when using aspiration for sacral epidural injection has not been described in the literature.

Side effects

In around 15% of patients, less serious side effects can be experienced from epidural injection. Sleeping problems, headache, flushing and temporarily increased back pain have been reported for the first 24 hours after the injection has been administered [154]. There is no systematic summary of the incidence of side effects and complications associated with corticosteroid ESI.

Need for further investigations

There are currently no studies that have systematically investigated the importance of mechanical volume effects in the epidural space as a result of ESI. We also lack evidence-based knowledge of which patient groups with lumbar back pain may benefit from sacral epidural injection. It is assumed that patients with an element of local inflammation, for example in association with radiculopathy as a result of disc prolapse or radiculitis of different aetiology, may respond best to steroid injection [39].

The anti-inflammatory effects of steroids in the epidural space

The body's own steroids are produced in the reticular region of the adrenal cortex. Steroids affect protein metabolism (nitrogen catabolism) and glucose metabolism (increasing gluconeogenesis) [155]. Corticosteroids for joint injection have been used since 1951 [156]. Caudal epidural hydrocortisone therapy gained wide popularity after Lievre et al (1953) reported improvement in five of 20 patients with sciatica [157]. The mechanisms of action and local effect in inflammatory tissue have still not been fully elucidated [158]. The anti-inflammatory effect of steroids (the glucocorticoid effect) is first and foremost regarded as being mediated via a reduction in prostaglandin synthesis [155]. The mechanism behind this is not fully understood, but most probably glucocorticosteroids work intracellularly and bind to specific receptor proteins in the cell nucleus [155]. This steroid receptor complex is thought to affect the transcription of genes, inhibiting formation of the enzyme cyclo-oxygenase 2 (cox-2). This enzyme is responsible for formation of the prostaglandins involved in the inflammation process [155]. Corticosteroids also suppress the immunological response to lymphocytes, reduce oedema formation in inflammatory tissue and stimulate production of the anti-inflammatory mediator lipocortin [155].

The medicinal product triamcinolone has a relative anti-inflammatory effect of 4 (by way of comparison, hydrocortisone = cortisol has an anti-inflammatory effect = 1 in a dosage of 20 mg). The biological action time of triamcinolone is estimated to be between 15 and 48 hours; the local effect in tissue is more uncertain, but may probably be up to 14 days. The reason for this long local action time is thought to be that steroid preparations are barely soluble, and are therefore absorbed slowly in the systemic circulation for metabolization [159]. Steroids have for many years been used for spinal injections [160,161], but clinical documentation concerning the action and effect of the medicinal product on nerve tissue is limited [162]. More recent studies indicate that corticosteroids can have a direct impact on pain via an effect on the pain mediator, substance P [163]. Nygaard et al (1997) found that inflammatory mechanisms are involved in sciatica and that different types of disc herniation have different inflammatory properties [164]. Muramoto et al (1997) found that

triamcinolone suppressed the firing induced by prostaglandin suggesting that steroids may be effective in the treatment of root symptoms [165]. In the studies conducted, corticosteroid preparations of differing anti-inflammatory effect have been used. There is therefore uncertainty as to whether the effect depends on which corticosteroid preparation is used. In a comparative study of the effect of epidural injections on low back pain, triamcinolone has been found to be more efficacious than betamethasone [166]. Triamcinolone is regarded as a safe preparation in spinal injections. A regression of the hernia disc material following corticosteroid ESI has been reported in one paper [167]. The mechanisms behind the spontaneous regression of pulpy nucleus prolapse are still not fully understood [168-170].

What this study emphasizes

- Use of strict inclusion and exclusion criteria, template for clinical back examination and high level of competence on the part of physicians and physiotherapists investigating the patients ensuring a homogeneous patient population (lumbosacral nerve root disease).
- Study design as a blinded RCT with good randomization and calculation of strength.
- Multicentre study.
- The treatment consists of two injections at 14-day intervals, which conforms to good clinical practice.
- Use of a volume of 30 ml for the epidurals, which ensures that the entire epidural space in the lumbosacral column is covered up to level L2.
- The injections are performed by well-qualified personnel with the same technical background (anaesthesiologists).

- To follow internationally accepted and validated outcome measures (ODI, EQ-5D, VAS leg and back pain), which means that the results from the study can be compared with other back research.
- Use of MRI makes it possible to identify subgroups of the disease and compare clinical findings and MRI findings.
- Use of diagnostic ultrasound to increase the accuracy of the epidural injections.

Planned publications based on this study

- Placebo-controlled study of the effect of sacral epidural injection with triamcinolone versus volume on patients with lumbosacral radiculopathy in which ODI is the primary outcome variable and EQ-5D, VAS low back pain and VAS leg pain are the secondary outcome variables.
- Appraisal of whether the effect differs in patients with clinical radiculopathy and whether MR showed either signal changes in the disc, covered prolapse, free prolapse, thickened nerve root or disclosed nerve root.
- Description of the relationship between clinical findings of the level and side of the radiculopathy in connection with back examination and corresponding MR findings.
- Description of the correspondence between clinical finding, MR and electromyography (EMG) in those cases where there is clinical loss of muscle strength.
- The benefit of ultrasound in identifying sacral hiatus and thus improving the accuracy of sacral epidural injection.

List of abbreviations

ADR	adverse drug reaction
BMI	Body mass index
EMA	European Medicines Agency
EMG	Electromyography
EQ-5D	European Quality of Life measure
ESI	Epidural Steroid Injection
FABQ	Fear-Avoidance Beliefs Questionnaire
FABQ-Work	Fear-Avoidance Beliefs Questionnaire for work
FABQ-PA	Fear-Avoidance Beliefs Questionnaire for physical activity
FDA	Food and Drug Administration
HRQL	Health-related quality of life
ISM	Institutt for Samfunns Medisin
MR	Magnetic resonance
MRI	Magnetic resonance imaging
NSAID	Non-steroidal anti-inflammatory drug
NSD	Norwegian Social Science Data Services
RCT	Randomized controlled trial
REK nord / REKNOR	Regionale komiteer for medisinsk og helsefaglig forskningsetikk Nordland, Troms og Finnmark

RELIS	Regionale legemiddelinformasjonssentre
SUSAR	Serious unexpected severe adverse reaction
UNN	University Hospital of North Norway
VAS _{BP}	Visual analogue scale back pain
VAS _{LP}	Visual analogue scale leg pain
VAS _{GH}	Visual analogue scale general health
WMA	World Medical Association

Competing interests

The author declare that they have no competing interests.

Authors' contributions

The author contributed to the study design and writing of the manuscript.

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Figure 1 Flow diagram of the study (p. 46 in Epidural Skjemabok v3)

Figure 2 Information letter to patients concerning the study (p. 3-4 in Epidural Skjemabok v3)

Figure 3 Template for clinical examination (p. 11-47 in Prosedyrebok)

Figure 4 Written informed consent (p. 5 in Epidural Skjemabok v3)

Figure 5 Referral for injection (p. 17 in Epidural Skjemabok v3)

Figure 6 Template for ESI (p. 18-19 in Epidural Skjemabok v3)

Figure 7 Patient information after sacral epidural injection (p. 20 in Epidural Skjemabok v3)

Figure 8 Information for doctors concerning the study

Figure 9 Form book

