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The rates of lumbar spinal stenosis surgery in Norwegian public hospitals; a threefold increase from 1999 to 2013

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Abstract

Study Design

Retrospective administrative database study

Objective

To assess temporal and regional trends, and length of hospital stay, in lumbar spinal stenosis (LSS) surgery in Norwegian public hospitals from 1999 to 2013.

Summary of Background Data

Studies from several countries have reported increasing rates of LSS surgery over the last decades. No such data have been presented from Norway.

Methods

A database consisting of discharges from all Norwegian public hospitals was established. Inclusion criteria were discharges including a surgical procedure of lumbar spinal decompression and/or fusion in combination with an ICD-10 diagnosis of Spinal Stenosis (M48.0) or Other Spondylosis with Radiculopathy (M47.2), and a patient age of 18 years or older. Discharges with diagnoses indicating deformity, i.e. spondylolisthesis or scoliosis were not included.

Results

During the 15-year period, 19 543 discharges were identified. The annual rate of decompressions increased from 10.7 to 36.2 and fusions increased from 2.5 to 4.4 per 100 000 people of the general Norwegian population. The proportion of fusion surgery decreased from 19.3% to 10.9%. Among individuals older than 65 years, the annual rate of surgery per 10000, including both decompressions and fusions, more than quadrupled from 40.2 to 170.3. The regional variation was modest, differing with a factor of 1.4 between the region with the highest and the lowest surgical rates. The mean length of hospital stay decreased from 11.0 (SD 8.0) days in 1999 to 5.0 (4.6) days in 2013, but patients who received fusion surgery stayed on average 3.6 days longer than those who received decompression only.

Conclusions

The rate of LSS surgery more than tripled in Norway from 1999 to 2013. The mean length of hospital stay was reduced from 11 to 5 days.

Key Words: data linkage, decompression, fusion, hospital admission, length of stay, low back pain, retrospective studies, spinal stenosis, surgery, Norway

Level of Evidence: 4

Introduction

The term lumbar spinal stenosis (LSS) represents both an anatomical concept and a clinical syndrome. The anatomical concept is narrowing of the lumbar central spinal canal, lateral recesses or intervertebral foramen that may or may not give rise to the clinical syndrome. Most cases of anatomical LSS are caused by age related degenerative changes, i.e. facet joint hypertrophy, loss of intervertebral disc height, disc bulging, osteophyte formation, and hypertrophy of the ligamentum flavum [1]. The clinical syndrome of LSS—neurogenic claudication—includes pain in the lower back, buttocks and legs as well as sensory disturbances and weakness that are typically provoked by walking and standing [2], and relieved by lumbar flexion. Though no generally accepted criteria for diagnosis or classification exist, a diagnosis of LSS is made on a combination of symptoms, physical examination, and imaging [1,3,4]. There is no clear relationship between the severity of symptoms and the degree of stenosis seen on imaging, nor is it known why some individuals develop symptoms and others do not [5-8].

Surgical treatment of LSS has been performed for more than 100 years [9]. The traditional approach is to remove the lamina (laminectomy) and parts of the facet joint (medial facetectomy) to decompress the neural structures. Recently, less invasive techniques, such as microsurgical decompression and interspinous process spacer devices have emerged [10,11,12]. To avoid spinal instability some surgeons prefer to supplement the surgical decompression with an arthrodesis (fusion). Additional fusion is however controversial, as it is associated with increased costs and complications [13].

Information about the surgical rates for specific conditions and length of hospital stay is important for planning and allocation of health-care resources. Over the last few decades epidemiological studies in Sweden [14], the United States [15,16] and South Korea [17] have showed a strong increase in the rates of surgery for LSS. From 1979 to 1990 rates quadrupled in the United

States [15], and tripled in Sweden from 1987 to 1999 [14]. In New South Wales, Australia, rates increased by 23% from 2003 to 2013 [18]. In addition to temporal variations, the variation in degenerative spine surgery across geographical areas is among the highest of all surgical interventions [19,20]. Up to now, no such data have been presented from Norway.

Nearly all specialized health services in Norway are provided by public hospitals run by regional health authorities. The aim of the present study was to assess temporal and regional trends in LSS surgery as well as length of stay in public hospitals in Norway between 1999 and 2013.

Materials and Methods

Data source

Hospital patient administrative data were retrieved from a national database at the Norwegian Knowledge Centre for the Health Services. A detailed description of the methods employed for data collection is published elsewhere [21]. Patient administrative data in the period 1999—2009 were extracted directly from all Norwegian public hospitals, and in the period 2010—2013 from the Norwegian Patient Registry (NPR). Norwegian hospitals were mandated to submit data to NPR. Each hospital episode record contained a personal identifier, codes for diagnoses, medical procedures, date and time of admission and discharge, and a Charlson Comorbidity Index score. Each individual born or living in Norway is given a unique ID number, and data from the National Registry provided by Statistics Norway made it possible to link the NPR data to patients' age, sex and municipality of residence. The database did not comprise information from private hospitals.

Sample

The present sample represents all LSS surgeries performed in Norwegian public hospitals in the period 1999-2013 (population of 4.46- 5.05 million). The inclusion criteria were a surgical procedure of *decompression* and/or *fusion* (see below), an International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) diagnosis of *Spinal stenosis (caudal stenosis) (M48.0)* or *Other spondylosis with radiculopathy (M47.2),* and a patient age of 18 years or older. Discharges with a diagnosis indicating deformity, i.e. spondylolisthesis or scoliosis, cancer, trauma, spinal infection, ankylosing spondylitis or vertebral fractures were excluded. Both scheduled and emergency admissions were included.

In Norway surgical procedures are coded according to the NOMESCO Classification of Surgical Procedures (NCSP) [22]. We defined procedures including *decompression of lumbar nerve roots (ABC 36), cauda equina (ABC 40), lumbar spinal canal and nerve roots (ABC 56), lumbar spinal cord (ABC 66), other decompressive operation on spinal cord or nerve root (ABC 99) and insertion of interspinous expanding implant (ABC 28)* as decompression. The NCSP does not differentiate between laminectomy or microdecompression. Procedures including *lumbar or lumbo-sacral interbody fusion with internal fixation (NAG 44,46), with external fixation (NAG 54,56) or with no fixation (NAG 34,36),* and *interlaminary fusion with fixation (NAG 74,76) or without fixation (NAG 64,66)* were defined as fusion. Fusions were further categorized according to whether a concurrent decompression was performed or not. The NCSP does not enable coding of the number of spinal disc levels fused.

Comorbidity

The Charlson Comorbidity Index (0-12) scoring was based on the diagnosis codes occurring in hospital admissions from the last three years (prior to but not including the current episode) using the revised ICD-10 implementation of Quan et al. [23].

Complications

Complications were identified by diagnoses indicating bleeding (T81.0), accidental perforation of blood vessel/nerve/organ during a procedure (T81.2), and procedure related postoperative infection (T81.4). We recorded complications occurring in the course of the initial surgical stay and readmissions within 30 days.

Statistical analysis

Annual surgical rates were calculated per 100 000 inhabitants based on the size of the total Norwegian population on Jan 1 of each year, retrieved from Statistics Norway [24]. Additionally, annual rates in patients aged > 65 years were calculated per 100 000 using the population > 65 years as denominator. Regional rates were calculated based on patients' residence according to the health authority; *East, South, West, Central* or *North.* Age differences in those who received decompression alone and those who received fusion was analysed by t-test, and proportions of discharges with fusion and decompression surgery were compared with $\chi 2$ tests. The association between year of discharge and number of surgeries was analysed by Kendall's tau-b correlation. Differences in length of stay according to type of surgical procedure (decompression or fusion) were analyzed by linear regression using age, sex, Charlson Comorbidity Index score and the year of discharge as covariates. P-values <0.05 were considered statistically significant. Data analyses were performed using SPSS version 25.0 (IBM, Armonk, NY, USA).

Ethics

The study was approved by the Norwegian Data Inspectorate (2014/14413) and the Norwegian Regional Ethics Committee (2013/1662, REC south-east D).

Results

During the 15 year period, there were 19 543 discharges with a relevant surgical procedure and a concurrent diagnosis of spinal stenosis (n=18 105, 92.6%) or spondylosis (n=1438, 7.4 %). Patients' mean age (SD) was 66.3 (11.6) years, increasing from 62.6 (12.3) years in 1999 to 67.2 (11.1) years in 2013. Fifty-four percent of the patients were females.

Surgical procedures

The majority of all operations were coded as decompressions only (87.4%), with the remaining coded as either a combination of decompression and fusion surgery (10.5%) or fusion surgery only (2.1%) (Table 1). Of those treated with decompression only, 392 patients (2.0% of total) received an interspinous distraction device between 2006 and 2010. After 2010 only 9 patients received this device.

The proportion of fusions decreased from 19.3% in 1999 to 10.9% in 2013, χ^2 (1, N=2638) = 28.8, $p<0.001$. Patients treated with fusion surgery were 4.5 (95% CI 4.0-5.0, $p<0.001$) years younger than patients treated with decompression alone.

Temporal trends

From 1999 to 2013, the annual rate of LSS surgery more than tripled. Decompressions increased from 10.7 to 36.2 and fusions from 2.5 to 4.4 per 100 000 (Figure 1). Among individuals aged >65 years, the total number of procedures more than quadrupled from 40.2 in 1999 to 170.3 in 2013. There was a strong, positive correlation between year of discharge and the number of surgeries ($\tau b = 0.91$, $p< 0.001$).

Regional variation

The annual rates of surgical procedures in the different geographical regions are shown in Figure 2. For the whole period (1999-2013) there were only modest differences in rates between the regions; Central had the highest mean annual rate with 32 procedures per 100 000 and North the lowest with 23 per 100 000 people. However, the use of the diagnosis *Other spondylosis with radiculopathy (M47.2)* versus *Spinal stenosis (M48.0)* did vary. In four of the five regions, the diagnosis *Other spondylosis with radiculopathy* constituted from 1.9% to 4.6% of the discharges, whereas in North this diagnosis was used in 53.2% of all discharges.

Length of hospital stay

The mean length of stay decreased from 11.0 (8.0) days in 1999 to 5.0 (4.6) days in 2013. Length of stay according to age group and sex is shown in Table 1. On average, the length of stay was more than 3 days longer in patients aged ≥ 80 years than in those aged ≤ 70 years, and females stayed about 1 day longer than men. Fusion surgery required a longer hospital stay than decompression surgery, 10.4 (10.3) versus 6.9 (7.3) days. In a multiple linear regression model, including the Charlson Comorbidity Index, the adjusted difference between fusion and decompression was 3.6 (95 % CI 3.3–3.9) days, see Table 2. The regression model showed that males stayed 22% shorter time in hospital than females.

Complications

The number of complications was generally low. Bleeding or hematoma was recorded in 1.0% of all operations, accidental puncture or laceration was recorded in 2.8%, and infections in 0.3%. Further, 0.7% of patients were readmitted within 30 days of discharge with a postoperative infection and 0.1% with a postoperative bleeding.

Discussion

This population-based study showed that surgery for LSS more than tripled from 1999 to 2013. In total, decompressions constituted 87.4% and fusions 12.6%, but the proportion of fusions decreased from 19.3% in 1999 to 10.9% in 2013.

As with the general unexplained increase in lumbar surgery rates internationally [19,25,26], there are also no obvious explanations to the increase observed in Norway. To our best knowledge, there was no increase in the prevalence, severity or surgical efficacy in LSS prior to or during the study period. Since rates in those older than 65 years quadrupled during the study period, the rise cannot merely be explained by an aging population. Improved diagnostic assessment, increased treatment capacity, as well as increased awareness among physicians and rising patient expectations [27] are possible explanations. Variation in imaging rates has previously been shown to explain some of the variation in lumbar stenosis surgery rates [28]. From 1993 to 2002, the examination frequency of spine MRI in Norway increased by 1292% whereas the frequency of spine CT increased by 92% [29]. MRI provides better visualization of soft tissue pathology than CT, and a survey indicated that spinal surgeons rely more on the morphological appearance of the dural sac than on surface measurements in deciding which patients are suitable for surgery [30]. Furthermore, in the course of the study, the number of surgeons (in all specialities) in Norwegian public hospitals increased by 16% [31].

Our findings regarding fusion and decompression surgery rates are generally similar to what was previously reported in Sweden and Australia. In Norway, the proportion of fusion of all surgeries for LSS was 11.6%, while it was 12.8% in New South Wales in the years 2003- 2013, and 11.1% in Sweden in the years 1987-1999 [14,18]. However, the rates in Norway were substantially lower than those reported in the United States and South Korea during the 2000s

[13,16,17]. This noticeable difference was supported in a recent study which found that 51% of patients undergoing LSS surgery in Boston received fusion compared to only 19% of matched Norwegian patients [32]. Further, and contrary to what is found in the United States [13,15,20], the present study demonstrated a decrease in the use of fusion relative to decompression surgery. Yet, the efficacy of fusion as an adjunct to decompression in LSS is unclear; a recent randomized controlled trial showed no difference in clinical outcomes of decompression surgery plus fusion compared to decompression alone [33].

We emphasize that we did not include discharges with a primary diagnosis of spondylolisthesis or scoliosis with secondary LSS. However, varying degrees of olisthesis and scoliosis are common manifestations of spinal degeneration, and frequently accompany LSS [34,35]. Hence, we cannot rule out unintentional inclusion of patients with these conditions, especially in the subgroup operated with fusion surgery. Since data in our study were de-identified, a chart review in order to confirm diagnoses or procedures was not possible.

Our observation of a substantial reduction in the length of hospital stay is in line with findings in England; that showed the length of stay for patients undergoing degenerative spine surgery between 1999 and 2013 shortened from 8.3 to 3.6 days [26]. Previous literature found fusion, particularly complex fusion (i.e. of three or more disc levels), to be associated with a longer hospital stay than single decompression, implying higher costs [13,18]. In our study, admissions including fusion lasted on average 3.5 days longer. Due to limitations in the NCSP, we were not able to differentiate between complex and simple fusion.

We found that interspinous spacers were predominantly used in a short period between 2006 and 2010. After 2010, the abrupt decline of usage was presumably influenced by a Norwegian randomized controlled trial which was stopped due to a high re-operation rate in the spacer group [36].

Strengths and limitations

The strength of the current data set is that all surgeries performed in public hospitals were represented. The most important limitations are those inherent to large administrative databases, i.e. the risk of misclassification of diagnoses and procedures [37]. The accuracy of diagnoses is particularly challenging for conditions without a clear definition with observable signs and symptoms such as LSS [38]. However, in this study discharges were included based on a combination of relevant surgical procedures and diagnoses, reducing the risk of misclassification.

In Norway diagnoses are typically coded by junior doctors with variable coding training and variable involvement in the assessment and treatment of each patient, whereas procedures are coded by the surgeons immediately after the operation. Data from the UK suggest procedure coding to be more accurate than diagnosis coding [39]. However, we consider the 2.1% of procedure codes in the present study indicating fusion surgery only, i.e. without a simultaneous decompression, to be a result of incomplete coding.

In order to avoid missing relevant cases, we also included discharges diagnosed with *Other spondylosis with radiculopathy (M47.2).* Somewhat surprisingly, there were regional differences in the use of this diagnosis. In North, the occurrence of *Other spondylosis with radiculopathy* was much higher than expected, indicating a systematic difference regarding how to code LSS. Including the discharges with *M47.2* inflated the total number of cases by 7.4%.

Another limitation is that the present study did not include surgeries performed in private hospitals. In Norway private for-profit hospitals provide some services, in particular day surgery, and they perform about 7% of the total number of elective surgeries [40]. The Norwegian Registry for Spine Surgery (NORspine), which is a voluntary registry for quality control and research, recorded 1007 LSS surgeries in private hospitals from 2007 to 2013 [41]. NORspine has an estimated coverage ratio of private spine surgery of 80%. In the same period of time there were 11929 surgeries in the public hospitals. These figures indicate that in the years 2007-2013, 9.7% of all LSS surgeries in Norway were performed by private institutions, thus about 90% were performed by public hospitals.

With these limitations in mind, the Norwegian population-based surgical rates were comparable to those in Sweden in 1999 [14], somewhat higher than in Australia in 2013 [18], but lower than the United States' Medicare population between 2002 and 2007 [13]. In contrast to what has been reported for spine surgery in the United States [19,42], there was only a modest regional variation in surgical rates for LSS in Norway. Our findings of regional variation in LSS surgery are about the same as in hip arthroplasty in Norway [43].

In conclusion, the rate of LSS surgery more than tripled in Norway from 1999 to 2013. The reason for this increase remains obscure. The mean length of hospital stay was reduced from 11 to 5 days. Patients who received fusion surgery stayed on average 3.6 days longer than those who received decompression only.

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Legands

Figure 1. Annual rates of surgery for lumbar spinal stenosis adjusted for the total population on Jan 1 of each year.

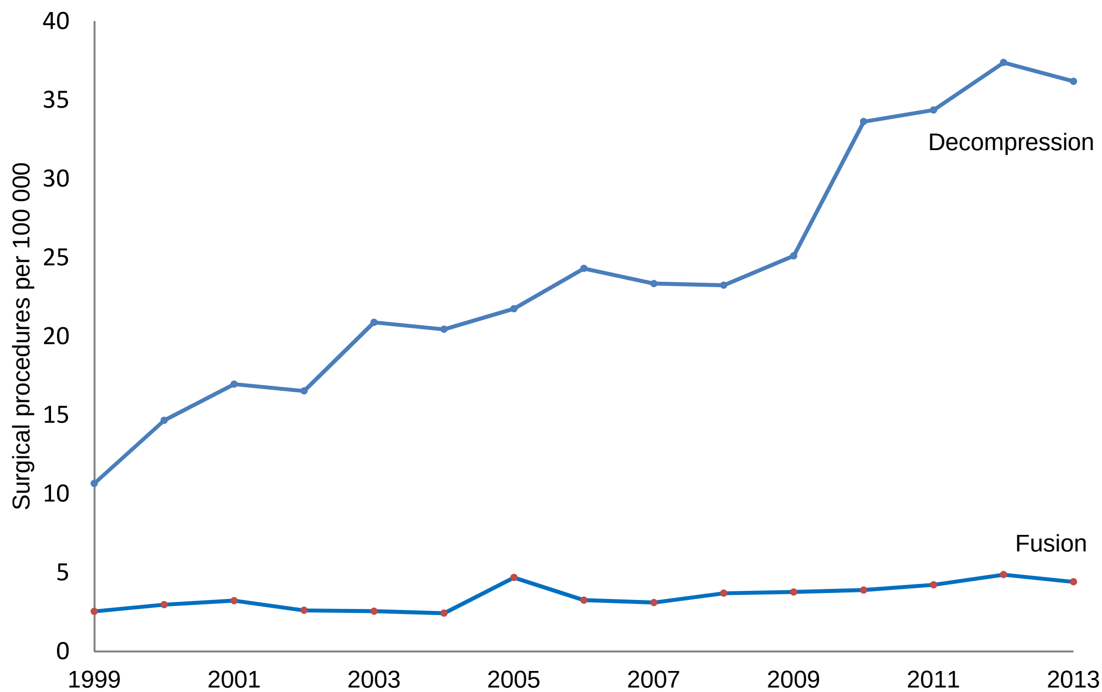

Figure 2. Annual rates of surgery for lumbar spinal stenosis according to Norwegian regions, adjusted for the total populations on Jan 1 of each year.

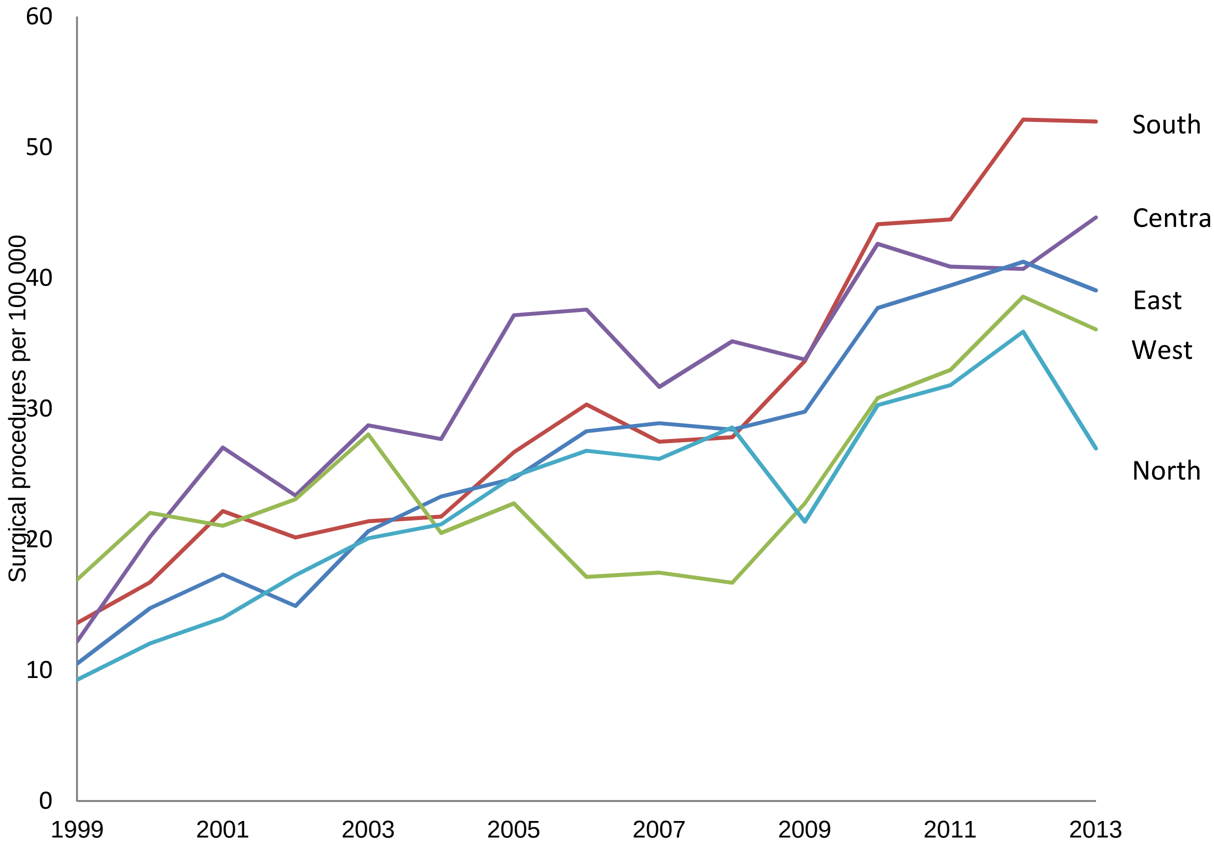

Table 1. Patient characteristics

	Surgical procedure				Length of stay (days)	
	Decompression*		Fusion†			
	n	%	n	%	mean	SD
Overall	17076		2467		7.4	(7.8)
Age, years						
<50	1275	(7.5)	379	(15.4)	6.7	(5.4)
50-59	2975	(17.4)	561	(22.7)	6.4	(8.4)
60-69	5149	(30.2)	758	(30.7)	6.5	(6.5)
70-79	5542	(32.5)	627	(25.4)	8.1	(8.1)
≥80	2135	(12.5)	142	(5.8)	9.7	(9.7)
Sex						
Men	8063	(47.2)	922	(37.4)	6.8	(7.1)
Women	9013	(52.8)	1545	(62.6)	7.9	(8.3)

*Including insertion of expanding implant between spinous processes (n=392)

†Including simultaneous decompression (n=2049)

Table 2. Multiple linear regression model for length of stay (days), (N=19543)

	Coefficient (B)*	95%CI
Age (1 year)	0.10	0.09, 0.11
Male (female)	0.78	0.58, 0.99
Charlson Comorbidity Index (0-12)	0.57	0.43, 0.70
Year of discharge (1999-2013)	-0.49	-0.51, -0.46
Fusion (decompression)	3.56	3.25, 3.87

*All coefficients $p < 0.001$