



# **MASTEROPPGAVE**

## **Treatment of patients with unilateral posterior crossbite in the student clinic in Tromsø**

– Evaluation of treatment outcome and documentation practice in Universitetsklinikken, UTK.

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# Abstract

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**OBJECTIVES:** The aim of this study was to evaluate the outcome of treatment of unilateral posterior crossbite and factors related to the treatment outcome in University student clinic. Another aim was to evaluate the adequacy and quality of documentation of the posterior crossbite treatments.

**SUBJECTS AND METHODS:-**The study population was patients who had been diagnosed and treated for unilateral posterior crossbite in the student clinic of IKO during 2008-2010. A total of 34 patients fulfilled the criteria of this study, 19 girls and 15 boys. The age of the subjects at treatment start ranged from 7 to 16.5 years, with a mean age of 10.5. Patient journals were the main source of information. Following diagnostic data on occlusion were retrieved from the journals: Overjet and overbite (mm), midline shift (mm), Angle's classification and number of teeth in crossbite. Data regarding orthodontic treatment, such as the appliance used, treatment time, availability of plaster models and clinical photos and patient cooperation were received from patient journals. The criterion for a successful treatment outcome was a total correction of the crossbite.

**RESULTS:** The treatment was successful in 88 % of the patients. The success rate was 100 % in subjects with one tooth in posterior crossbite as compared to 79 % in subjects with several teeth in crossbite. Expansion plate was the most frequently used appliance (71 %), 23 % were treated with cross elastics, and the rest (6%) with other appliances. Active treatment time varied from 1 month up to 18 months, with a mean value of 8.0 months. Good cooperation was almost significantly associated with treatment success ( $P=0.052$ ), and 3 out of 4 subjects who did not reach a successful treatment outcome showed compromised/ poor cooperation. Documentation in form of pre-treatment plaster models were found in 85 % of the patients and post-treatment in 21 %. Pre-treatment clinical photos were found for 74 % of the cases and post-treatment for 53 % of the patients, but the quality in the majority of the clinical photos was acceptable at the most or poor.

**CONCLUSIONS:** The majority of patients with unilateral posterior crossbite were successfully treated and the results at the University student clinic in Tromsø seemed comparable to results reported previously in the literature. The practice of treatment documentation, especially regarding plaster models and clinical photos, was inconsistent and calls for improvement.

# Introduction

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Crossbite is a transversal malocclusion where there is a discrepancy in the buccolingual relationship of the upper and lower teeth. Posterior crossbite is defined by the canine, premolars and molars, and can involve one or more teeth. Posterior crossbites can be divided as unilateral or bilateral, and they can be either skeletal or dentoalveolar in nature. (1) The majority of posterior crossbites are unilateral with a functional shift. When unilateral posterior crossbite is detected in children one often sees a functional shift from centric relation, CR, to intercuspal position, IP. This sliding, or displacement, of the mandible from CR to IP is caused by dental interferences. The mandible usually displaces to the side of the crossbite and a midline deviation can be seen (2) Functional shift leads to a forced bite which may have an influence on the normal growth pattern of the upper and lower jaw (3, 4). The prevalence of unilateral posterior crossbite is between 10-22% (5, 6, 7) and the great variations depend on the populations studied and diagnostic criteria.

## Etiology

There are different etiologies to how unilateral posterior crossbite can be developed. As a general rule, the greater the number of teeth in crossbite, the greater the skeletal component involved. A symmetrical narrow maxilla can result in a unilateral posterior crossbite because of differences in arch widths between the maxilla and mandible. (8,1). Skeletal class III often results in anterior crossbite and a relative posterior crossbite because a smaller part of maxilla occludes with a wider part of the mandible. Asymmetric mandibular growth is rarely a reason for unilateral posterior crossbite.

A habit of finger- or pacifier-sucking can result in low tongue position and therefore an imbalance of forces affecting the teeth which may lead to palatal tipping of the maxillary segment. (8). Chronic nasal obstruction can result in a low position of the mandible and tongue with the head tilted back to be able to breathe through the mouth. The increased pressure from the stretched cheeks can cause a narrowing of the maxilla and contribute to a unilateral posterior crossbite. (8)

Crowding can displace one or more teeth from the arch and lead to eruption into crossbite. Second premolars often erupt lingually or palatally into posterior crossbite in association with early loss of second deciduous molar (3)

Rarer causes like cleft lip and palate may restrict the transversal growth of the maxilla due to scar tissue after surgery.

### **Treatment of unilateral crossbite**

It is important to distinguish between bilateral and unilateral crossbite due to differences in treatment need and timing. Unilateral crossbite needs to be treated early to prevent adaptive remodeling of the temporomandibular joint (TMJ) and asymmetrical mandibular growth, preferably in the early mixed dentition (4, 9). Expansion of maxilla in order to increase the transversal arch width should be performed early before ossification of the midpalatal suture and eruption of the permanent canines. The gain in transversal width may provide much needed space in the dental arch for the erupting permanent incisors and canines. It is important to eliminate the habit of digit-sucking habit before crossbite treatment to help maintain stability of the corrections made. (5,8,2) Expansion plate, quad helix and cross elastics are the most common treatment alternatives used for unilateral crossbite corrections. Expansion plate is an acrylic plate with clasps on the deciduous and/or permanent molars for retention. It has a midline expansion screw for expansion of the maxilla and buccal tipping of teeth. The screw is activated by a quarter rotations twice each week until correction of the posterior crossbite is achieved. The plate is used for retention after active treatment is finished. Patient compliance is important for a successful treatment outcome.

Quad helix is a fixed appliance with bands cemented to first maxillary molars and soldered to a stainless steel expansion arch. The activation of the quad helix provides efficient slow expansion of the maxilla that does not require patient cooperation, and with few visits. After active treatment the quad helix can serve as passive retention appliance to maintain the expansion.

Cross elastics is generally used only when single permanent premolar or molar tooth pairs are in crossbite. The patient places elastic rubber bands to buttons on opposite sides of the involved tooth pair and tipping occurs simultaneously which brings both teeth in correct position.

Selective grinding is also an option to correct posterior crossbite in the primary dentition. Premature contacts that lead to a functional shift are generally most pronounced in primary

canines. If the intercuspitation is not too locked grinding is performed on the tips of primary canines, and sometimes also primary molars.

Rapid maxillary expansion (RME) is especially used in bilateral posterior crossbite correction. Rapid maxillary expansion aims to opening the midpalatal suture using a cemented or bonded appliance with an expansion screw. The opening of the midpalatal suture occurs when the forces applied to the teeth and maxillary alveolar process exceeds the limit needed for orthodontic tooth movement.(10)

The stability of unilateral posterior crossbite correction depends on the degree of posterior cuspal interdigitation, the degree of tipping of the teeth, and on transversal and anteroposterior growth to be favorable. (11,3)

### **Treatment practices of posterior crossbite in the student clinic in IKO:**

During the screening process at the student clinic (UTK) children presenting with unilateral crossbite are prioritized to receive early treatment. Expansion plate, cross elastics and selective grinding are most commonly used for early treatment. These are all treatment methods suitable for the general practitioner and therefore important for the students to learn. Although according to evidence quad helix has the highest success rate (12), it is not much used in Norway.

### **Aims of the study**

The aim of this study was to evaluate the outcome of treatment of unilateral posterior crossbite and factors related to the treatment outcome in patients treated in the University student clinic.

Another aim was to evaluate the adequacy and quality of documentation of the posterior crossbite treatments.

## **Subjects and methods**

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### ***Subjects***

The subjects were all patients who had been diagnosed with unilateral posterior crossbite and treated in the student clinic of IKO during 2008-2010.

After the authors (LMB and EMH) had manually gone through patient journals of every orthodontic patient treated at UTK during 2008-2010 a total of 74 patients were found with a diagnosis of unilateral posterior crossbite. Additional inclusion criteria in the study were that the treatment had to be finished by the end of 2010, and no other major malocclusions existed in combination with the posterior crossbite. Of the original 74 subjects found from journals 40 had to be excluded because of various reasons. (Table 1)

**Table 1.**

<b>Patients diagnosed with unilateral posterior crossbite</b>	<b>74</b>
Excluded because the treatment was not finished within the given time period	21
Excluded because of anterior crossbite in addition to posterior crossbite	12
Miscellaneous reasons (system drop-outs, no show to treatment, transfer to other clinics, missing documentation of treatment success in the journal, treatment postponed)	7
<b>Total included patients</b>	<b>34</b>

A total of 34 subjects, 19 girls and 15 boys, fulfilled the study criteria and were included in the study.

## *Methods*

Data for the study was collected from patient journals, plaster models and clinical photos.

### *Data from patient records*

Patient journals were the main source of information. Following diagnostic data on occlusion were retrieved from the journals: Overjet and overbite (mm), midline shift (mm) and Angle's classification on first molars. If Angle classification on left and right side were different, the combination of A I and AII with an overjet of 5 millimeters or more was classified as AII, and the combination of AI and AIII with a positive overjet was classified as AI. Number of teeth in posterior crossbite was recorded in tooth pairs. If one jaw had more teeth in crossbite than the opposite jaw, the one with the most teeth was registered. Crossbite was categorized into 3 groups (1= 1 tooth in crossbite, 2=2 teeth in crossbite and 3=  $\geq 3$  teeth in crossbite). Dental stage at treatment start was recorded as early mixed, late mixed or permanent dentition.

The patient's age at treatment start was recorded in years and rounded to the nearest half year. Co-operation of the patient was assessed in three categories: good, compromised or poor. To

be evaluated as a good cooperation the patient had to show regularly for the appointments and use the appliances according to instructions. The assessments of cooperation were done by the authors (LMB, EMH) on the basis of the recordings in the patient journals.

Data regarding orthodontic treatment, such as the appliance used, active treatment time, retention period and total treatment time (in months), number of operators, number of visits (included screening and appointments during active treatment and retention) were received from patient journals. For the analyses active treatment time was divided into two groups: 1=  $\leq 8$  months, 2= more than 8 months.

#### Evaluation of treatment outcome

Every case was assessed either successful or unsuccessful based on information from the patient journals. The criterion for a successful treatment outcome was total correction of the crossbite.

#### *Data from plaster models*

Plaster models and clinical photos were used to complement the journals when information was lacking and to study the reliability of the records from patient journals. When information from the journals did not correspond with the findings in plaster models and clinical photos, data from journals were used.

The same occlusal data as retrieved from the patient journals were recorded from the plaster models when available: Angle's classification, overjet, overbite, midline shift, number of teeth in posterior crossbite, and dental stage.

Plaster models were divided into three groups based on the diagnostic quality. 1: Trimmed models with index. 2: Trimmed models without index and with minor flaws. 3: Poorly trimmed models and/or models with major flaws which cannot be used for diagnostic purposes.

#### *Data from clinical photos*

The documentation value of clinical photos was evaluated as good, acceptable or poor. For documentation to be evaluated as good all the standard photos had to be present, the pictures had to be clear and the molar relationship had to be visible. The definition of standard photos were: 3 extra oral photos (front smile, front serious and profile) and 5 intra oral photos (front, right side, left side, occlusal views of lower and upper dental arches).

Photos were judged acceptable if their quality was compromised (foggy), but the molar relationship, crossbite, overjet, overbite and midline shift could still be seen. Also the mesial part of the first molar had to be seen on the occlusal pictures.

#### Data analysis

The data was recorded and analyzed in SPSS for Windows 19. Means and frequencies for different variables were calculated. Pearson's chi square was used to test the differences between groups. Differences with P-values < 0.05 were considered as statistically significant.

## Results

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At start of the treatment the age of the patients varied from 7 to 16,5 years with a mean age of 10,5 years. Mean overjet before treatment was 3,2 mm, varying from 0 mm to 6mm. Overbite before treatment varied from -2mm to 6mm with a mean of 2,6 mm.

Before treatment 19/34 (56%) subjects had Angle I molar relationship, 13 (38%) subjects had Angle II and 1 (3%) had Angle Cl III on molars. For 1 subject the information on Angle classification was missing. Before treatment start 44 % had one tooth in posterior crossbite, 18 % had two teeth in posterior crossbite and 38 % had three or more teeth in posterior crossbite.

#### *Treatment outcome*

Treatment was considered successful in 88 % (30/34) of the treated. The success rate was 100 % in subjects with one tooth in posterior crossbite as compared to 79 % in subjects with several teeth in crossbite (Table 2). No significant association was found between treatment success and the dental stage (Table 3).

Expansion plate was the most frequently used appliance (71 %) in posterior crossbite correction (Table 4). It was the main choice of appliance for patients in both early mixed and late mixed dentition (23/29). All except one subject with 3 or more teeth in crossbite were treated with the expansion plate. (Table 4)

For patients in permanent dentition the main choice of appliance was cross elastics (4/5). All 4 subjects, who presented with an unsuccessful outcome, were treated with expansion



plate. However, the difference in success rates between the appliances was not statistically significant ( $p=0,169$ ). (Table 5)

Active treatment time varied from 1 month up to 18 months, with a mean value of 8.0 months. In 22 of the subjects the treatment lasted for 8 months or less, and 11 subjects were treated for more than 8 months. In all unsuccessful cases the duration of treatment was 8 months or less ( $n=4$ ), but the difference regarding treatment duration and success was not significant between the groups ( $p=0,131$ ) (Table 6).

Good cooperation was almost significantly associated with treatment success. There was a tendency towards better results as a consequence of good cooperation. Three out of 4 subjects who did not reach a successful treatment outcome showed compromised/poor cooperation (Table 7). Subjects treated with expansion plate had somewhat less often good cooperation (63 %) as compared with subjects treated with other appliances (80 %)

Information about midline change after treatment was available in only 8 patient journals. The greatest improvement of midlines was 5 mm and the most negative midline change was 2 mm for the worse. The mean improvement in the correction of midline discrepancy was 1,13 mm (range from 2 mm impairment to 5 mm improvement)

### *Documentation*

For 29 out of 34 subjects (85 %) study models before treatment were available, while the corresponding percentage post-treatment was 21% (7/34). (Figure 1)

Of the pre-treatment plaster models 59 % (17/29) were of good quality, 28 % (8/29) were considered acceptable and 14 % (4/29) were unacceptable for diagnostic purposes. Three out of 7 post-treatment plaster models were of good quality, 3 were acceptable and 1 was not acceptable.

Clinical photos were available for 74 % (25/34) of the subjects before treatment and for 53 % (18/34) after treatment. (Figure1).

4 % (1/25) of the pre-treatment clinical photos were of good quality, 32 % (8/25) were acceptable and 64 % (16/25) were not good.

11 % (2/18) of the post-treatment clinical photos were of good quality, 28 % (5/18) were acceptable and 61 % (11/18) were not good.

# Discussion

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Since this was a retrospective study we did not have the opportunity to design the group of study objects. No power calculations were performed, because the main aim was to evaluate the treatment results and documenting practices in the student clinic in IKO. Due to strict inclusion criteria the final number of subjects remained low, resulting in low power of the analyses used in the study.

The originally found number of patients diagnosed with unilateral posterior crossbite was 74, which shows that posterior crossbite was a common malocclusion treated in the student clinic. Because we wanted to exclusively evaluate the treatment success of unilateral posterior crossbite we had to exclude those who also had anterior crossbite, or other major malocclusion combined. The reason for this was that treatment would otherwise not entirely be focused on the posterior crossbite, which might have confused our results. Two patients were excluded because of a failure in the recall system in UTK. If treatment was not completed within two semesters the patient was transferred from the student in charge of the treatment to another student. The exchange has been carried out by the student who gives a manual list of patients who are not finished with their treatment to the supervisor, and then the responsibility is handed over to UTK. If the list was not thoroughly checked, information could be missing or even wrong and therefore mistakes considering recall are possible. The routine for this exchange of operators seemed not optimal since this sometimes resulted in missing follow-up appointments.

Journals were used as the main source of information because there were too few subjects with satisfying records in form of plaster models and/or clinical photos especially post-treatment. When using patient journals as the source of information, it is always collected by someone else at first hand. Therefore, we had no way of checking if the information was correct. This weakens the reliability of the information. Even so, the journals were checked and signed by an orthodontist after each time the patient had been to the clinic. Based on this double checking of each journal by a specialist, the reliability of the information was assumed satisfactory for this study.

The unilateral posterior crossbite was successfully corrected in 88 % of the cases. The expansion plate was the most frequently used appliance with a success rate at 83 %.

According to a relatively recent RCT-study from Sweden the correction of unilateral posterior crossbite in mixed dentition was successful in 2/3 of the cases when using an expansion plate. (12) This study clearly recommended quad-helix as the appliance of choice in the mixed dentition.

Three out of four non-successful cases were failures, where according to the patient records, the patients had followed instructions and had good or acceptable cooperation, but the correction of crossbite did not take place. One of the three subjects with acceptable or good cooperation had an overexpansion during the treatment with expansion plate and therefore no retention was recommended from the operator. They were hoping for a spontaneously correction of the overexpansion. This resulted in a relapse of the crossbite and further treatment was necessary. The other two patients had good/acceptable cooperation during treatment with the expansion plate and had only one tooth in crossbite when the treatment was ended. At this point the operators decided to use cross elastics to correct the last tooth. This resulted in no retention and a lower degree of cooperation. The treatment with cross elastics was not finished within the period of this study. In these two cases the patient had been following instructions during treatment with expansion plate but was challenged when the treatment changed. Had the operators seen this change in the patients cooperation they may have found another treatment solution instead of continuing with the cross elastics.

None of the factors which were analyzed in relation to treatment success had a significant impact on treatment outcome. Cooperation had a tendency to positively impact on the treatment outcome. Only 1 of 23 with good cooperation had an unsuccessful treatment. The majority of the patients were treated with expansion plate or cross elastics and both appliances require that the patients followed instructions. Only if the patient has good cooperation there is a good chance of a successful outcome. Since our group of subjects was small a significant difference could not quite be achieved. Other studies on the expansion plate versus other treatment options have shown that expansion plate demands high level of cooperation from the patient (12). Another study compared the expansion plate and quad helix. (13). The result was that the treatment outcome was the same for both treatment options. Both studies recommend using Quad-Helix because it was more cost effective compared to the expansion plate. (13)

Our study showed that if the patient had only one tooth in crossbite the treatment was successful in 100% of the cases. The patients in this group had a mean age of 11.5 years and some studies have shown that cooperation is easiest to achieve in young patients. (14). Patients under 12 years old have been shown to have the best cooperation. (15) Also one tooth is generally easier to correct than an entire segment of teeth.

The only way to evaluate orthodontic treatment outcome is to have a proper patient documentation before- and after treatment. According to this study, the documentation on treatment done at UTK was not acceptable. Many of the subjects had no records after treatment, and for those who had, the records were often of poor quality. The reasons behind this can be several. Different tutors could have different opinions on what is considered necessary post-treatment documentation. Moreover, it seems that regarding the plaster models and clinical photos the quality control system was not functioning properly. In our opinion, the students were not properly informed about the importance of good post-treatment records. Many of the plaster models were not trimmed and had no index. This shows that they have been taken without consideration for the later use of them. Better information to the students about the use of pre- and post-treatment plaster models, and instructions to the supervisors regarding control and approval on these plaster models would most likely have a positive effect on the documentation problems in the student clinic.

Our results indicate that the student clinic should have a more strict routine on what records are needed to be taken before and after treatment. Plaster models are the most useful pre- and post-treatment record, and we suggest that this becomes a routine in the clinic. And if, for some reason, plaster models cannot be taken it should be documented in the patient journal. Clinical photos are also of value to evaluate the treatment, but in order to use them they have to be of good quality. Badly taken photos are not at all useful, and therefore clinical photos should always be checked and accepted by the supervisor's signature in the journal.

## Conclusions

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The majority of patients with unilateral posterior crossbite were successfully treated and the results at the University student clinic in Tromsø seemed comparable to results reported previously in the literature. The practice of treatment documentation, especially regarding plaster models and clinical photos, was inconsistent and calls for improvement.

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# Tables and figures for Results

**Table 2. Treatment success among the subjects in relation to number of teeth in posterior crossbite.**

			Success		Total
			Crossbite not eliminated	Crossbite corrected	
Crossbite	1 tooth in crossbite	n	0	15	15
		%	,0%	100,0%	100,0%
	2 teeth in crossbite	n	1	5	6
		%	17%	83%	100,0%
	3 or more teeth in crossbite	n	3	10	13
		%	23%	77%	100,0%
Total		n	4	30	34
		%	12%	88%	100,0%

p=0,154, N.S Chi-square: 1 tooth in crossbite vs 2 or more teeth in crossbite p=0,059

**Table 3. Treatment success in relation to dental stage of the treated subjects**

		Dental stage			Total
		Early mixed	Late mixed	Permanent	
Success	Crossbite not eliminated	2 (14%)	2 (13%)	0 (0%)	4 (12%)
	Crossbite corrected	12 (86%)	13 (87%)	5(100%)	30 (88%)
Total		14 (100%)	15 (100%)	5 (100%)	34 (100%)

**Table 4. Number of teeth in crossbite in relation to appliance.**

			Appliance				Total
			Expansion plate	Crosselastics	Ex.plate + cross elastics	Grinding	
Crossbite	1 tooth	n	8	5	1	1	15
	in crossbite	%	53 %	33 %	7 %	7 %	100 %
	2 teeth	n	4	2	0	0	6
	in crossbite	%	67 %	33 %	,0 %	,0 %	100 %
	3 or more teeth in crossbite	n	12	1	0	0	13
		%	92 %	8 %	0 %	0 %	100 %
Total		n	24	8	1	1	34

**Table 5. Treatment success in relation to appliance**

			Success		Total
			Crossbite not eliminated	Crossbite corrected	
<i>Appliance</i>	Expansion plate	n	4	20	24
		%	17 %	83 %	100 %
	Other	n	0	10	10
		%	0 %	100 %	100 %
<b>Total</b>		n	4	30	34
		%	12 %	88 %	100 %

**Table 6. Treatment time in relation to success**

			Success		Total
			Crossbite not eliminated	Crossbite corrected	
<i>Treatment time</i>	8 months or less	n	4	18	22
		%	18 %	82 %	100 %
	More than 8 months	n	0	11	11
		%	0 %	100 %	100 %
<b>Total</b>		n	4	29	33
		%	12 %	88 %	100 %

**Table 7. Treatment success among the subjects in relation to patient cooperation**

			Success		Total
			Crossbite not eliminated	Crossbite corrected	
<i>Cooperation</i>	Good	n	1	22	23
		%	4 %	96 %	100 %
	Compromized/ poor	n	3	8	11
		%	27 %	73 %	100 %
<b>Total</b>		n	4	30	34
		%	12 %	88 %	100 %

p=0,052



**Fig 1. Number of documents available pre- and post treatment. (N=34)**

