Maxillary first molar extraction in Class II malocclusion

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CHAPTER 4

EXTRACTION OF MAXILLARY FIRST MOLARS IMPROVES SECOND AND THIRD MOLAR INCLINATIONS

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SUMMARY

Introduction: The aim of this study was to assess the changes in inclination of the maxillary second (M2s) and third (M3s) molars after orthodontic treatment of Class II Division 1 malocclusion with extraction of maxillary first molars.

Methods: Two groups of subjects were studied. The experimental group consisted of 37 subjects, 18 boys and 19 girls (mean age, 13.2 ± 1.62 years). The inclusion criteria were white origin, Class II Division 1 malocclusion, overjet ≥4 mm, no missing teeth or agenesis, and maxillary M3s present. All patients were treated with extraction of the maxillary first molars and the Begg technique. Standardized lateral cephalometric radiographs were taken at the start of active treatment (T1) and at least 3.7 years posttreatment (T2). The control group was drawn from the archives of the Nittedal Growth Material (Oslo University, Oslo, Norway) and included 54 untreated Class I and Class II subjects,18 boys and 36 girls (mean age, 13.4 ± 1.99 years) followed up for a minimum of 3.6 years. M2 and M3 inclinations relative to the palatal plane (PP) and functional occlusal plane (FOP) were measured and compared between groups and time periods.

Results: M2 to PP inclination improved significantly in both the control group (M2-PP at T1, 17.7° ± 5.81°, and at T2, 11.9° ± 4.61°) and the experimental group (M2-PP at T1, 26.7° ± 5.75°, and at T2, 6.9° ± 6.76°). There were also significant increases of the mesial inclination of M3s in the control group (M3-PP at T1, 30.1° ± 8.54°, and at T2, 19.6° ± 9.01°) and extraction group (M3-PP at T1, 32.2° ± 7.90°, and at T2, 12.8° ± 7.36°). By using the FOP as the reference system, no significant change in the inclination of M2s was observed in the control group, whereas, in the extraction group, although more distally inclined at T1, M2s ended up mesially inclined at T2 (M2-FOP at T1, 14.2° ± 4.62°, and at T2, -6.2° ± 6.10°; $P<0.0001$). M3 inclinations were similar between the groups at T1 (M3-FOP control, 17.3° ± 9.35°; M3-FOP experimental, 19.6° ± 7.37°), and these improved significantly in both groups. However, M3 uprighting was almost 4 times greater in the extraction group (M3-FOP from T2-T1, 5.6° vs 19.3°). The greatest distal inclination of M3s at T2 in the extraction group was 9.4°, a value attained by only 43% of the control group.

Conclusions: Extraction of the maxillary first molars in Class II Division 1 patients results in significant uprighting of M2s and M3s and facilitates the normal eruption of M3s.

4.1 INTRODUCTION

Extraction of maxillary first permanent molars (M1s) is an available treatment option for patients with Class II malocclusion with an increased overjet and a fairly well-aligned mandibular arch. Indications may include teeth affected by caries or periodontitis, with extensive restorations and questionable long-term prognosis. It is still controversial whether high-angle individuals would benefit from extractions in the posterior part of the buccal segments.[1-3] It is also argued that the particular extraction pattern will have a less flattening effect on the facial profile.[4] In addition to this, extracting posterior teeth can be advantageous with regard to the inclination of the third molars.[5]

A recent study in Class II Division 1 patients treated with extraction of maxillary first molars and fixed appliances demonstrated good treatment outcomes with a minor retrusive effect on the facial profiles[6]. These investigators could not attribute to this treatment method a clinically significant bite-closing effect. Booij et al[7] termed this treatment modality a 'less-compliance therapy' data underlying the relatively diminished dependence on patient cooperation.

So far, few authors have investigated third molar changes after tooth extractions, solely or combined with orthodontic treatment. Most of them dealt with second molar extractions,[8-12] first premolar extractions (in the maxillary arch,[13] or the maxillary and mandibular arches[14-17]), or unilateral extractions of the mandibular first molar.[18] In the single study that evaluated the extraction of all 4 first permanent molars, a favourable effect on the inclination of third molars was documented.[5] The aim of this study was to assess the change of inclination of maxillary second (M2s) and third (M3s) molars after orthodontic treatment of Class II Division I malocclusion with extraction of the M1s.

4.2 MATERIALS AND METHODS

The study group consisted of 37 subjects (18 boys, 19 girls; mean age, 13.2 years; SD, 1.62 years) consecutively with the Begg technique by 1 orthodontist (J.W.B.). The inclusion criteria for the initial enrollment were white patients, Class II Division 1 malocclusion, sagittal overjet of ≥4 mm, treatment plan including extraction of the M1s, no missing teeth or agenesis, M3s present, and 1-stage full fixed appliance treatment. Standardized lateral cephalometric radiographs on the same radiographic unit (Trophy OL 100, Trophy Radiologie, Vincennes, France) were available at the start of active treatment (T1) and at least 3.7 years posttreatment (T2).

The control group consisted of untreated Class I and Class II subjects (18 boys, 36 girls; mean age, 13.4 years; SD, 1.99 years) followed for a minimum of 3.6 years. The subjects were drawn from the archives of the Nittedal Growth Material, a longitudinal study conducted by the Department of Orthodontics, University of Oslo, and described in detail in previous articles.[19, 20] The data was collected within a 20-year period from children called for dental examination at 6 years, and afterwards every three years till the age of 21. Radiographic records of poor quality were excluded from the study material. Table I shows the means and standard deviations for ages and observation periods for all groups.

		Age (y)		*Observation period T2-T1 (y)*	
Group	*n*	*Mean*	*SD*	*Mean*	*SD*
Experimental (boys)	18	13.2	1.27	5.0	1.00
Experimental (girls)	19	13.1	1.93	4.9	1.18
Control (boys)	18	13.4	2.11	5.9	2.32
Control (girls)	36	13.4	1.96	5.4	1.80

Table I. Descriptive statistics of the experimental and control groups.

All lateral headfilms were scanned and digitized by one investigator (C.L.) using cephalometric analysis software (Viewbox 3.0; dHAL Software, Kifissia, Greece).

The landmarks traced on each lateral headfilm are summarized in Figure 1.

A number of skeletal and dental points were digitized for the definition of measurements necessary to evaluate the subjects' molar inclinations and craniofacial patterns.

Molar inclination was assessed by the following angles (Figure 2): M2-PP, the angle between the occlusal surface of M2 (M2OS) and the palatal plane; M2-FOP, the angle between the M2OS and the functional occlusal plane; M3-PP: the angle between the occlusal surface of M3 (M3OS) and the PP; and M3-FOP: the angle between the M3OS and the FOP.

Statistical analysis

The data was analyzed with the StatsDirect statistical software (version 2.7.2; StatsDirect, Cheshire, UK). Nonparametric tests were performed to evaluate the changes between T1 and T2. The reproducibility of the measurements was assessed by statistical analyses of the differences between double measurements of 20 randomly selected and traced radiographs by the same investigator 2 weeks after the initial series of measurements.

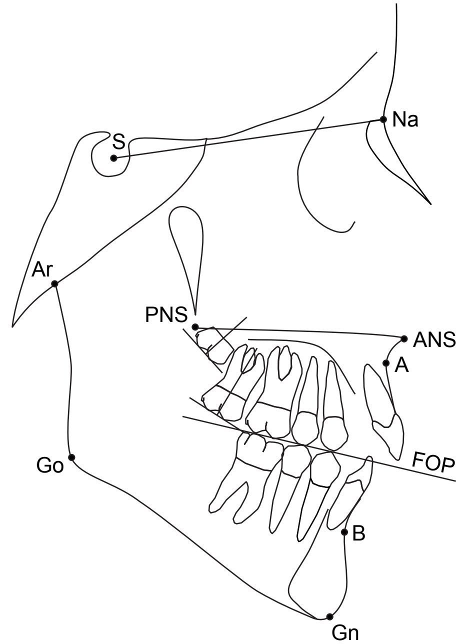

Figure 1. Cephalometric points and reference planes used in the study.

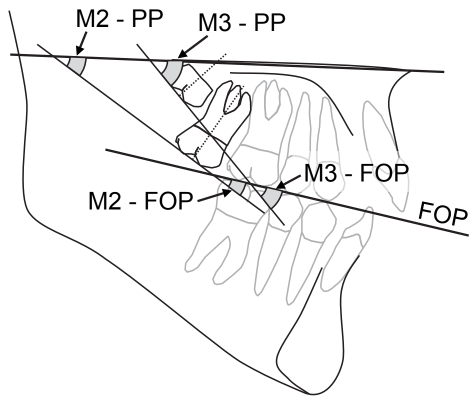

Figure 2. Angular measurements used for evaluation of inclination of M2s and M3s.

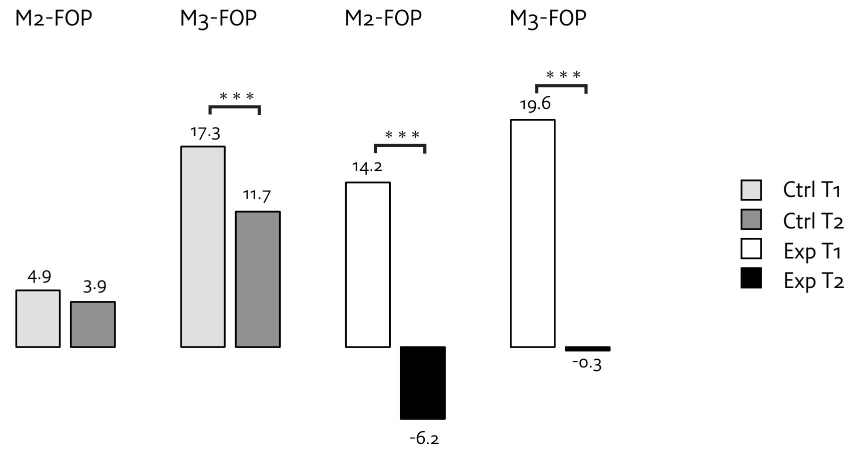

Figure 3. Inclination measurements in relation to the FOP (*Exp*, Experimental; *Ctrl*, Control). *Asterisk bars* denote statistically significant changes at $P<0.001$.

4.3 RESULTS

Random error was calculated according to Houston.[21] Errors ranged from 3.21° (M2-PP) to 4.78° (M3-PP). Paired t-tests did not show any systematic error between the 2 measurements ($P>0.05$).

The measurements were tested for normality of distribution and equality of variance (F test). For some variables, the F test was significant; therefore, it was decided to apply more robust nonparametric methods (Mann-Whitney and Wilcoxon signed ranks) for intergroup comparisons.

Comparison of T1 skeletal values of control and experimental boys revealed significant differences for the angles SNB, ANB, PP-MP. The female groups displayed significant differences in the angular measurements ANB, PP-SN, PP-MP, Ar-Go-Gn. It generally seemed that the experimental subjects were more retrognathic and hyperdivergent than were the controls (Table II).

The average molar angular values and standard deviations of the experimental and control groups are presented in Table III. There were statistically significant differences in the angles M2-PP, M2-FOP between experimental and control groups for both males and females at T1. The measurements for the M3s between groups at T1 did not differ significantly. However, all groups showed significant differences in all measurements at T2.

	Boys			*Girls*		
Measurement	*Ctrl (n=18)*	*Exp (n=18)*	*95% CI*	*Ctrl (n=19)*	*Exp (n=36)*	*95% CI*
SNA (°)	83.7 (2.53)	81.1 (4.47)	-6.29 to -2.14	82.2 (3.47)	83.6 (4.47)	83.6 (4.47)
SNB (°)	80.3 (2.54)	76.0 (3.84)	-4.97 to 0.21 ***	78.2 (2.53)	77.2 (4.17)	77.2 (4.17)
ANB (°)	3.3 (3.02)	5.2 (1.94)	0.03 to 3.66 *	4.0 (2.04)	6.3 (2.11)	6.3 (2.11)
PP-SN (°)	8.2 (3.70)	6.7 (4.13)	4.67 to 1.01	8.1 (3.01)	5.9 (3.52)	5.9 (3.52)
PP-MP (°)	19.8 (6.39)	26.2 (2.81)	3.53 to 10.27 **	20.7 (4.11)	26.9 (4.80)	26.9 (4.80)
Ar-Go-Gn (°)	125.6 (5.90)	124.5 (6.26)	-4.99 to 2.69	124.1 (5.36)	125.4 (4.03)	125.4 (4.03)

Ctrl, Control group; *Exp*, experimental group

$*P<0.05$; $**P<0.01$; $***P<0.001$

Table II. Means (SDs) of skeletal measurement at T1 and 95% CI of intergroup differences (Mann-Whitney U test).

Measurement	Boys			Girls		
T1	*Ctrl (n=18)*	*Exp (n=18)*	*95% CI*	*Ctrl (n=36)*	*Exp (n=19)*	*95% CI*
M2-PP	17.1 (7.13)	26.5 (5.15)	4.33 to 13.67 ***	18.1 (5.12)	27.0 (6.40)	5.62 to 12.68 ***
M2-FOP	4.4 (5.99)	14.4 (4.77)	6.37 to 13.57 ***	5.2 (5.96)	13.9 (4.58)	5.66 to 12.34 ***
M3-PP	29.6 (7.87)	32.5 (8.57)	-2.27 to 8.92	30.3 (8.94)	31.8 (7.42)	3.09 to 6.37
M3-FOP	16.9 (7.13)	20.5 (8.31)	-2.76 to 9.64	17.5 (9.94)	18.8 (6.48)	-2.46 to 5.18
Measurement	Boys			Girls		
T2	*Ctrl (n=18)*	*Exp (n=18)*	*95% CI*	*Ctrl (n=36)*	*Exp (n=19)*	*95% CI*
M2-PP	11.4 (5.16)	6.2 (5.99)	-8.75 to -1.87 **	12.1 (4.37)	7.6 (7.51)	-7.20 to -0.87 *
M2-FOP	2.7 (4.35)	-5.2 (5.06)	-10.90 to -4.22 ***	4.5 (4.71)	-7.1 (6.96)	-14.12 to -8.30 ***
M3-PP	19.6 (9.70)	11.2 (6.73)	-13.16 to -2.38 **	19.7 (8.79)	14.3 (7.79)	-10.66 to-0.83 *
M3-FOP	10.9 (11.28)	-0.2 (6.54)	-16.13 to -4.88 ***	12.1 (10.01)	-0.4 (7.19)	-17.87 to -7.99 ***

Ctrl, Control group; *Exp*, experimental group

*P<0.05; **P<0.01; ***P<0.001

Table III. Means (SDs) of dental measurement at T1 and T2, and 95% CI of intergroup differences (Mann-Whitney U test).

Measurement	*T1*	*T2*	*95% CI*
	Ctrl (n=54)		
M2-PP	17.7 (5.81)	11.9 (4.61)	4.21 to 7.39 ***
M2-FOP	4.9 (5.94)	3.9 (4.63)	-0.83 to 2.76
M3-PP	30.1 (8.54)	19.6 (9.01)	7.93 to 13.00 ***
M3-FOP	17.3 (9.35)	11.7 (10.36)	3.15 to 8.13 ***
	Exp (n=37)		
M2-PP	26.7 (5.75)	6.9 (6.76)	17.37 to 22.72 ***
M2-FOP	14.2 (4.62)	-6.2 (6.10)	17.68 to 22.98 ***
M3-PP	32.2 (7.90)	12.8 (7.36)	16.62 to 22.30 ***
M3-FOP	19.6 (7.37)	0.3 (6.79)	16.68 to 23.23 ***

Ctrl, Control group; *Exp*, Experimental group

***P<0.001

Table IV. Means (SDs) of dental measurements and 95% CI of intergroup differences (Mann-Whitney U-test) in the pooled groups.

No significant differences were found between the sexes for any of the dental measurements. To prevent clutter, we compared the molar inclinations at T1 and T2 by combing the sexes, presenting the results in Table IV. Despite the more upright positions of M2s and M3s in the control group, there were greater improvements in the molar angulations in the experimental group.

Regarding the measurements based on the PP, M2 and M3 inclinations improved significantly in both control and extraction groups (Table IV). However, the increase of mesial inclination of M2s and M3s was 3.4 and 1.8 times greater, respectively, in the extraction group (M2-PP from T2-T1: 5.8° vs 19.8°; M3-PP from T2-T1: 10.5° vs 19.4°).

The results for the measurements related to the FOP are shown in Figure 3. In the control group, there was no significant change in the initial distal inclination of M2s, whereas, in the extraction group, although more distally inclined at T1, M2s ended up mesially inclined at T2 (M2-FOP: T1: 14.2 ± 4.62°, T2: -6.2 ± 6.10°; P<0.0001). M3 inclinations were similar between groups at T1, (M3-FOP control, 17.3 ± 9.35°; M3-FOP experimental, 19.6 ± 7.37°) and improved significantly in both groups; however M3 uprighting was almost 4 times larger in the extraction group (M3-FOP from T2-T1, 5.6° vs 19.3°).

4.4 DISCUSSION

This is, to our knowledge, the first study to investigate the effect of M1 extractions on the inclinations of M2s and M3s in orthodontically treated patients, in comparison to non-orthodontic patients.

We decided not to use panoramic images because of the inbuilt distortion effect of the rotational panoramic radiography[22] and the less reliable angular measurements when compared with those on lateral cephalograms.[23] The use of cephalometric films also enables evaluation of the axial inclination of teeth in relation to skeletal planes that are regularly used for cephalometric analysis. The superimposition of bilateral structures was addressed by drawing the average outline of the right and left images.

The potential change of the FOP angulation during treatment was considered, and that was the reason for additionally using the PP for evaluation of molar inclination. Results from both reference systems are presented and led to similar conclusions. However, we have stressed the FOP-related results because the functional significance of molar inclination pertains to the occlusal plane rather than to the PP.

The shortcomings of our investigation basically derive from the characteristics of the selected controls. The ideal control group would include subjects of similar age, sex, origin, nationality and craniofacial pattern. Because of the retrospective nature of the study, we had to compromise with radiographic data collected for past research purposes, and consequently apply less strict criteria for group selection. However, we were able to closely match the control to the experimental group by age. We did our best to match groups by sex, and this is reflected by the number of participants in each group. For the control girls, the availability of age-matched subjects permitted the inclusion of double the number of participants in relation to treated girls.

Statistical tests confirmed differences in the skeletal measurements between the experimental and control groups at T1. Our experimental group was similar to study groups of German and Icelandic origin presented in other studies.[24-26] Although our experimental group comprised more high-angle subjects than did the control group, there was greater improvement in molar inclination. This outcome was contrary to what might have been expected from the findings of Breik and Grubor,[27] whose hypodivergent subjects demonstrated an almost 2 times lower incidence of mandibular third molar impaction compared with hyperdivergent subjects.

Unpredictable changes in the position and angulation of third molars tend to occur over the years. In a panoramic radiographic study of the positional changes of unerupted third molars in nonorthodontic patients (young adults), Sandhu and Kaur[28] recorded a 24% percentage of molars erupted to the occlusal plane. Interestingly enough, 20% of our control and 54% of the experimental M3s erupted good inclinations relative to the FOP ($-6^\circ < \text{M3-FOP} < 6^\circ$).

Dachi and Howell[29] on a survey of 3,874 full-mouth radiographs, reported a 29.9% incidence of M3 impaction in the general population. In orthodontic patient samples managed with extraction of M1s[5] or M2s[9, 11] and fixed appliances, the percentage of 'successful' M3 eruptions were between 96% and 100%. All M3s from our experimental group erupted to a good position. Still, direct comparison with the aforementioned eruption rates cannot be made because of differences in the definition of 'success' and use of panoramic rather than cephalometric images.

When it is necessary to extract teeth in the orthodontic treatment of patients with Class II maloclussion, it is common practice to choose either the 2- or 4-premolar extraction regimen and under special circumstances the maxillary molar extraction. In such cases, our investigation confirms the positive influence of first molar extraction on the angulation of M2s and M3s.

4.5 CONCLUSION

The findings of this study suggest that orthodontic treatment with extraction of M1s results in significant improvement of the position of the M2s and M3s. In this case, normal eruption of the M3s can be expected to be highly likely.

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