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THE EFFECT OF PREMOLAR EXTRACTIONS ON THE CHANGE OF ANGULATION AND ERUPTION SPACE OF THE MANDIBULAR THIRD MOLARS AFTER ORTHODONTIC TREATMENT

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Objectives: Our study was designed to analyze the effect of lower premolar extraction on the evolution space of the lower third molars, as well as their position and angulation during orthodontic treatment.

Methods: This is a cross-sectional, retrospective, descriptive and analytical study comparing two groups of patients: the first group includes 20 patients treated without premolar extraction, and the second group, 27 patients treated with premolar extraction.
Linear and angular measurements were performed on panoramic radiographs and lateral cephalograms of orthodontic pre- and post-treatment.

Results: The eruption space and the horizontal position of the lower third molars, showed a favorable and statistically significant evolution between the two patient groups. Angulation changes did not show a significant difference.

Conclusions: Premolar extractions have a positive and significant influence on the eruption space and the horizontal position of the mandibular third molars. Angulation changes showed a favorable, but not significant development in the group treated with premolar extraction.

Keywords: mandibular wisdom tooth, angulation, eruption space, premolar extraction

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L'EFFET DES EXTRATIONS DE PRÉMOLAIRES SUR LE CHANGEMENT DE L'ANGULATION ET DE L'ESPACE D'ÉRUPTION DES TROISIÈME MOLAIRES MANDIBULAIRES APRÈS TRAITEMENT ORTHODONTIQUE

Objectifs: Notre étude a été conçue pour analyser l'effet de l'extraction des prémolaires sur l'espace d'évolution, la position et l'angulation des troisièmes molaires inférieures.

Méthode: Il s'agit d'une étude transversale, rétrospective, descriptive et analytique comparant deux groupes de patients : le premier groupe comprend 20 patients traités sans extraction de prémolaires et le deuxième, 27 patients traités avec extraction de prémolaires.
Des mesures linéaires et angulaires ont été effectuées sur les radiographies panoramiques et les téléradiographies de profil de pré-traitement et post-traitement orthodontique.

Résultats: L'espace d'éruption et la position horizontale des troisièmes molaires inférieures, ont montré une évolution favorable et statistiquement significative entre les deux groupes de patients. Les changements d'angulation n'ont pas montré de différence significative.

Conclusions: Les extractions de prémolaires ont une influence positive et significative sur l'espace d'éruption et la position horizontale des troisièmes molaires mandibulaires. Les changements d'angulation ont montré un développement favorable, mais non significatif chez le groupe traité avec extraction de prémolaires.

Mots clés: dent de sagesse mandibulaire, angulation, espace d'éruption, extraction prémolaire

Introduction

According to studies, third molars are the teeth most frequently affected by inclusions, with a percentage of 98% [1]. The mandibular third molar is by far the tooth most affected by inclusion after the maxillary third molar, with an inclusion prevalence ranging from 9.5% to 39% depending on the population [2].

In 2015, a meta-analysis of 49 studies involving 83484 cases concluded that the inclusion rate for third molars was 24.40% [3].

Various factors, such as morphology, mesio-distal width, unfavorable uprightness and eruption trajectory, have been associated with third molar inclusion [4]. However, the main reason is assumed to be a lack of retro-molar space, which has been reported by Björk et al. in 90% of cases of third molar inclusion [4-8].

In the mandible, this depends on the resorption of the anterior margin of the ascending ramus and the trajectory of the teeth during the functional eruption phase [9]. Similarly, the further forward the posterior teeth (1st and 2nd molars) erupt, the greater the retro-molar space gets [5, 6].

The direction of growth also plays a key role; thus, predominantly vertical condylar growth is associated with reduced resorption at the anterior portion of the mandibular ramus and anterior rotational growth of the mandible, while condyles' posterior growth is associated with increased resorption at the anterior border of the mandibular ramus and posterior rotational growth [5, 8, 10].

In addition to natural growth, retromolar space is also influenced by orthodontic treatment [7]. Straightening the first and second lower molars has a negative influence on the space available for eruption of the lower third molars [11,12], while treatment with extraction therapy improves the latter's chances of eruption.

The study aims to investigate the impact of premolar extractions during orthodontic treatment on both the space available and the angulation of the lower third molars. Also evaluated was the impact of growth direction on space improvement. Therefore, the null hypothesis states that premolar extractions do not significantly affect the angulation or eruption space of mandibular third molars.

Materials and methods

This is a retrospective clinical study, including a sample of 47 patients (94 mandibular wisdom teeth) receiving orthodontic treatment, both in the orthopedic-dento-facial department of the Rabat dental consultation and treatment center, and in the odontology department of the Military Instruction Hospital Mohamed V. The sample size was determined on the basis of previous studies and practical considerations to ensure an adequate number for reliable statistical analysis [13]. The sample was divided into 2 subgroups: a first group of 20 patients (i.e. 40 wisdom teeth) who received orthodontic treatment without premolar extraction, and a second group of 27 patients (i.e. 54 wisdom teeth) treated with premolar extraction.

For each patient, pre- and post-treatment panoramic and lateral cephalometric radiographs were collected.

Our study included a sample of patients aged between 9 and 23 years, with complete dentition and treated with multi-attachment orthodontic treatment, with no additional anchorage preparation and no use of special molar mesialization or distalization systems. The 3rd molar must be in development.

Excluded from our study were all patients requiring asymmetrical extractions, presenting mandibular wisdom teeth that had already erupted on the arch, or any syndromic patient, presenting a supernumerary tooth or with a shape or size anomaly.

Pre-treatment radiographs (T1) were taken approximately one week before orthodontic treatment began, and end-of-treatment radiographs (T2) were taken one week before orthodontic appliance removal. All T1 and T2 radiographs were evaluated, and various measurements were taken.

On lateral cephalometric radiographs (Figure 1), the mandibu-

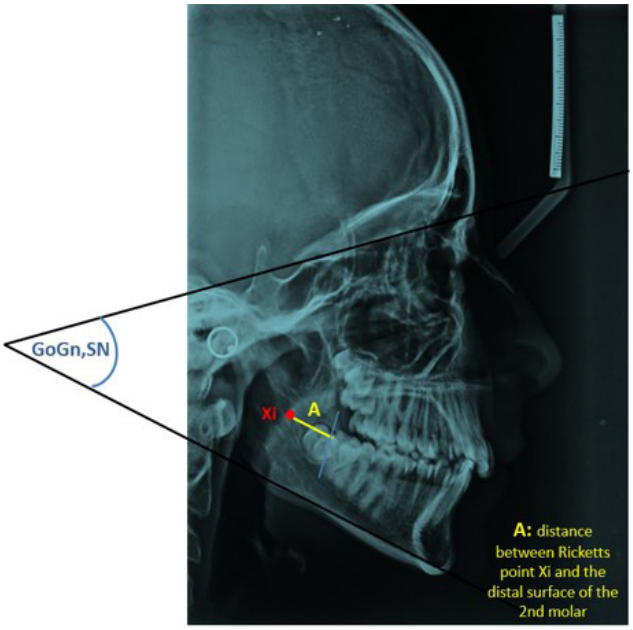

Figure 1. Measurements performed on lateral cephalometric radiographs.

lar plane angle (GoGn,SN) and the eruption space of the lower third molar, defined as the distance between Ricketts point Xi and the distal surface of the lower second molar (Xi-M2), were measured. According to the GoGn,SN angle defined by Steiner, the sample is divided into 2 groups: 1st group of patients with normodivergent vertical growth (27 ° <SN-GoGn <37 °) and 2nd group of patients with hyperdivergent vertical growth (SN-GoGn > 37 °). The eruption space of the lower third molar was also noted on panoramic radiographs, firstly by measuring the retro-molar space (RMS), defined by the distance separating the point of intersection of the plane of occlusion and the anterior border of the Ramus and the most distal point of the 2nd molar, and then using the horizontal classification proposed by Pell & Gregory (PGH stages 1, 2 and 3) (Figure 2).

The angulation of the 3rd molar was also measured on panoramic radiographs (Figure 3), so three further measurements were made:

- 3rd molar/2nd molar angle (M3-M2): Intersection of the longitudinal axes of the 3rd and the mandibular 2nd molars.
- 3rd molar/occlusal plane angle (M3-OP): Intersection of the longitudinal axes of the 3rd molar and the occlusal plane.
- 3rd molar/mandibular border angle (M3-MP): Intersection of the longitudinal axis of the 3rd molar and the tangent of the mandibular lower border.

All measures were compared within the two groups: Quantitative variables with the T-Student's test for the independent-sample, qualitative variables with the chi-square test. Data was entered and analyzed using SPSS software version 13.0.

Figure 2. Horizontal classification by Pell and Gregory [14].

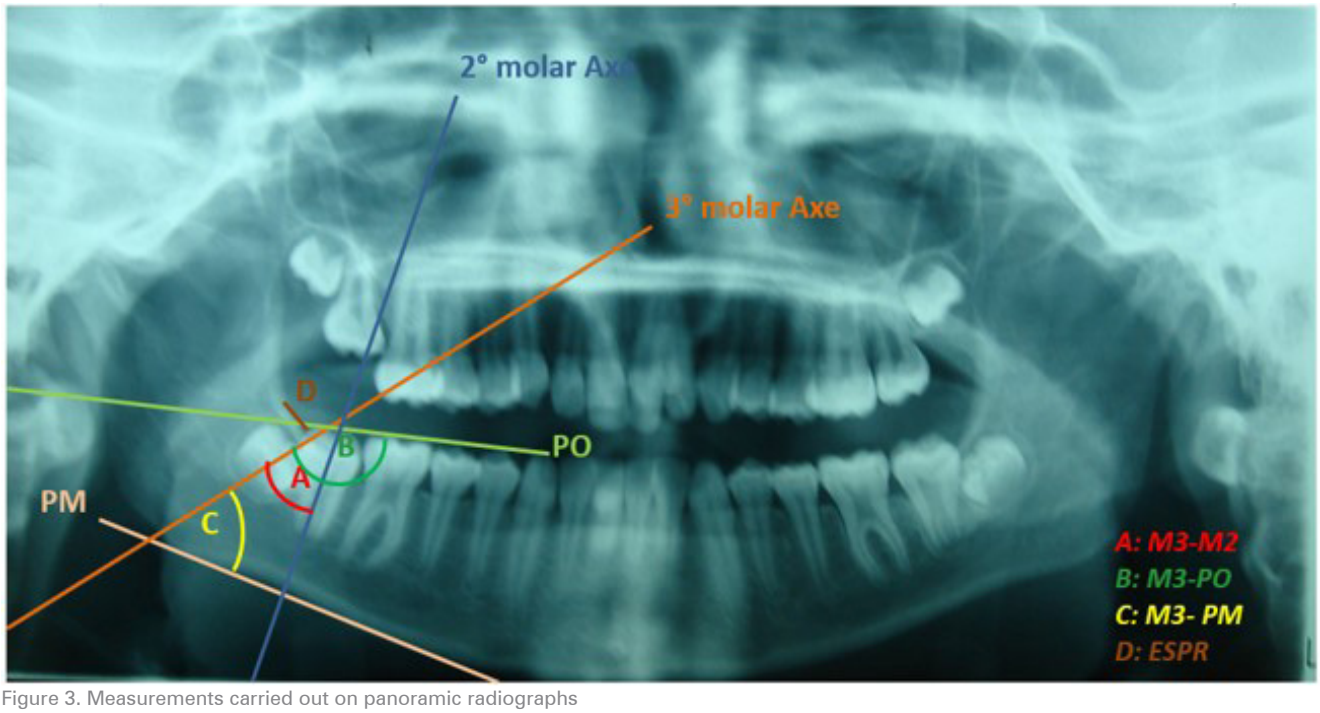

Figure 3. Measurements carried out on panoramic radiographs

Descriptive and analytical results

Among the 47 patients in our sample, 42.6% were male, while 57.4% were female. Their ages ranged from 9 to 23 years, with an average of 13.5 years. The average duration of treatment was 2 years and 9 months (33 months).

Descriptive data is summarized in Table 1 (Tab.1), which shows the distribution of the sample according to sex, age and duration of treatment in the two patient groups treated without and with premolar extraction.

Table 1. Sample distribution according to gender, age and duration of treatment.

	Without extraction	With extraction	P
Sex (%)0 : Male	40	44.4	0,7
Female	60	65.6	
Pre-treatment age (per year) (Avg / SD)	13.02 ± 3.31	13.96 ± 2.42	0,08
Treatment duration (in months) (Med)	24 [15 ; 36]	36 [24 ; 48]	0,11

**Significant if p<0.05*

In order to assess the changes in position of the lower 3rd molar that occurred during orthodontic treatment, the reduction in the angles M3-OP and M3-M2, and the increase in the angle M3-MP, are considered a sign of favorable evolution in the position of the lower third molar, indicating a straightening movement of the tooth, with subsequent chances of eruption in the mouth.

The results concerning changes in angulation of the lower third molar during orthodontic treatment are shown in Table 2.

Table 2. Angulation changes of the 3rd molar from the beginning to the end of orthodontic treatment in groups with and without premolar extraction.

Post-treatment – pre-treatment	Without extraction	With extraction	p
M3-M2	- 0,5 [-13 ; 12,75]	-4 [-16,5 ; 8]	0.25
M3-OP	-3,5 [-16 ; 16,75]	-4 [-15,75 ; 7]	0.79
M3-MP	7,5 [-10,5 ; 15,5]	4 [-5 ; 16]	0.70

**Significant if p<0.05*

Table 3. Difference in retromolar space and Xi-M2 distance before and after orthodontic treatment in groups with and without premolar extraction.

Post-treatment – pre-treatment	With extraction	Without extraction	p
RMS	5,1 [2,82 ; 7,4]	2 [0,4 ; 3,7]	<0.001*
XIM2	3,35 [1,97 ; 5,95]	2,44 [-0,18 ; 6,16]	0.43

**Significant if p<0.05*

Analysis of the data assessing changes in 3rd molar angulation between the start and the end of orthodontic treatment showed a reduction in the M3-OP and M3-M2 angles, with an increase in the M3-MP angle, indicating a favorable development of 3rd molar angulation in both patient groups.

The adjustment of the 3rd mandibular molar axis in relation to the 2nd mandibular molar (M3-M2) was greater in the premolar extraction group than in the non-extraction group. However, the difference was not statistically significant.

Similarly, the change in the 2 angulations M3-OP and M3-MP was favorable for both groups, with a greater uprighting, but not significant for the extraction group.

Evaluation of lower third molar eruption space (ESPR and PGH) on panoramic radiographs revealed a highly significant (p<0.001) increase in eruption space over the course of treatment, which was statistically higher in patients treated with premolar extractions. (Tables 3 and 4)

Concerning the Xi-M2 distance measured on lateral cephalometric radiographs, we noted a greater increase in eruption space in the group with extractions. However, the difference was not statistically significant. (Table 3)

Table 5 shows the statistical results concerning the relationship between growth direction and retromolar space evolution. Examination of the data presented in this table shows a smaller increase in retromolar space in the normodivergent group (2.62mm) than in the hyperdivergent group (4mm). Similarly, the XI-M2 distance showed a greater increase in the hyperdivergent group (4.44mm) than in the normodivergent group (2mm). The results of these findings were highly significant.

Table 4. Modification of HMP after treatment in the extraction and non-extraction groups

		PGH before traitement		P	PGH after traitement		P
		Without extraction Sample size (%)	With extraction Sample size (%)		Without extraction Sample size (%)	With extraction Sample size (%)	
PGH	Level 1	11 (27,5%)	11 (20,4%)	0.37	20 (50%)	44 (81,5%)	0.001*
	Level 2	2 (5%)	7 (13%)		12 (30%)	9 (16,7%)	
	Level 3	27 (67,5%)	36 (66,7%)		8 (20%)	1 (1,9%)	

**Significant if $p<0.05$*

Table 5. Relationship between GOGN-SN and retromolar space.

	Normodivergent	Hyperdivergent	p
RMS Post-treatment - pre-treatment	2,62 [0,48 ; 5,15]	4 [2,52 ; 7,4]	0.01*
XI-M2 Post-treatment - pre-treatment	2 [-0,4 ; 4,61]	4,44 [1,92 ; 6,89]	0.02*

**Significant if $p<0.05$*

Discussion

The aim of our study is to investigate the effect of growth direction, as well as premolar extraction, on the angulation and available space for the development of the lower third molar. To examine these potential effects, we combined lateral cephalometric and panoramic radiographs taken before and after orthodontic treatment in two groups of patients treated with and without premolar extraction.

The angulation of the third molars was assessed on panoramic radiographs. Despite criticisms regarding their use due to possible distortions and magnifications [14], several authors have reported that angular measurements can be accurately analyzed on these radiographs, and their use has been deemed conclusive (Bjoörk et al., 1956; Silling, 1973) [13, 15-17].

In our sample, 42.6% of patients were male, while 57.4% were female. This percentage difference is attributed to a higher frequency of consultations among women compared to men. The average treatment duration was 2 years and 9 months (33 months).

The average age of our sample in this study is 13.5 years. During this period, the development of the third molar bud occurs, and significant pre-eruptive movements take place. This age group is ideal for evaluating the effect of extraction during orthodontic treatment on the angulation and eruption space of the third molar. The final clinical eruption or impaction of the third molar could not be fully assessed because the average age of subjects at the end of treatment was 17 years, and the eruption period of the third molar typically ranges from 18 to 24 years.

Firstly, the potential change in the lower third molar angulation was investigated. In the present study, both patient groups showed a favorable development of mandibular third molar angulation, with a greater, but not significant, uprightness in the group treated with premolar extraction. Thus, these results are in perfect agreement with other studies, which in turn found that angulation changes over time, but with no significant difference between patients treated with and without premolar extraction [16, 17].

Tarazona and al. [18, 19] studied the influence of first and second premolar extraction on lower third molar angulation, and concluded that third molar angulation improved over time, regardless of treatment, with or without premolar extraction.

Furthermore, in a retrospective study of 44 out-of-growth subjects, including 22 patients treated with first premolar extractions, Türkoz [4] found no significant change in the angulation of the lower third molar during orthodontic treatment. This echoes what Di Giovanni and al. [13] found in their cross-sectional study; orthodontic treatment involving premolar extractions has no impact on lower third molar angulation.

The results of these studies suggest that factors other than extractions could influence the inclination and subsequent eruption of third molars. Bjork [5] and Svendsen [20] suggested that residual mandibular growth, early physical maturity and late mineralization of the third molar could be etiological factors in mandibular third molar inclusion.

In contrast to our findings, previous studies have reported that premolar extraction increases the available space in the molar region, thereby improving the angulation of the third molar (Jain and Valiathan, 2009; Richardson, 1980) [17]. Other studies also link a significant increase in the frequency of third molar impaction to non-extraction therapies [9].

According to these studies, orthodontic therapy involving extractions initiates mesial movement of the molars, leading to a simultaneous increase in eruption space for the third molar with a change in its angulation, consequently reducing the frequency of its inclusion [2, 21-24].

Haavikko and al. [25] concluded that premolar extraction improves the chances but does not necessarily promote the eruption of the third molar. Conjointly, Butaye and al. [26] found that second premolars extractions resulted in a widening of the lower retromolar space and an increased likelihood of the third molar eruption after the treatment achievement.

The results of our study regarding the effect of premolar extractions on retro-molar space revealed that the increase in retro-molar space was significantly ($p<0.01$) higher in patients treated with premolar extractions (5.1 mm) compared to those treated without extractions (2 mm), consistent with previous studies [19, 27] explaining this space increase by mesial movement of the first and second molars during closure of the extraction space. Turkoz and al. in 2013 [4] found that non-extraction treatment increased retro-molar space by 0.03 mm and increased it by 1.30 mm with premolar extraction, this difference was statistically significant and they concluded that the inclusion rate of third molars was significantly reduced in the group with premolar extraction.

Similarly, Patel and al. in 2015 [18] found an increase in retro-molar space of 1.8 mm in patients treated without extraction and 4.2 mm in patients treated with extraction, this difference was statistically significant ($p=0.029$). Behbehani and al. [27] also reported that the increase in retro-molar space and mesial movement of molars during orthodontic treatment reduced the risk of third molar inclusion.

Other studies based on the Pell & Gregory classification [16] found similar results. Miclotte A. and al. in 2013 [28] revealed that only 35.6% of patients treated without premolar extractions had sufficient eruption space for the lower third molar (PGH-1) at the end of treatment, whereas in patients treated with premolar extractions, sufficient eruption space was observed in 55.6% of cases [28]. In a subsequent study [16], the same authors found that, at the end of treatment, PGH-1 was observed in 23% of patients treated without premolar extractions, in 47% of patients treated with first premolar extractions, and in 77% of patients treated with second premolar extractions. The results of our study, also based on Pell & Gregory's horizontal classification, were similar: at the end of treatment, 81.5% of third molars were PGH1 in patients treated with premolar extractions, compared with only 50% of third molars in patients treated without extractions.

Kim & al. [9] reported that the Xi-M2 distance was 2.6 mm larger in patients treated with premolar extractions compared to those treated without extractions. Additionally, Miclotte & al. [16] found a change of 5 mm in patients treated without extraction, 7.9 mm in patients treated with first premolar extraction, and 6.9 mm in patients treated with second premolar extraction, which corresponds to our results (Table 5).

In a non-growing patient group, Patel & al. [18] observed a significant change ($p=0.015$) in the Xi-M2 distance of 4.47 mm in patients treated with first premolar extractions compared to 1.93 mm in patients treated without extractions.

Schulhof in 1976 [29] stated that third molar inclusion was more likely to occur when Xi-M2 decreased below 25 mm. This was challenged by other authors who found that more than 60% of patients in their sample with less than 23 mm for Xi-M2 experienced eruption of the lower third molars.

Artun and al. in 2005 [30] and Behbehani and al. in 2006 [27] attempted to identify risk factors for third molar impaction by studying orthodontic patient radiographs taken before, after, and at least 10 years after inclusion, concluding that the decision to extract premolars in the mandible reduced the risk of third molar inclusion by 63%. Furthermore, the study by Behbehani and al. [27] revealed that, in line with other authors [6, 9, 10], anterior rotation of the mandible increased the risk of inclusion. In our study, the Xi-M2 distance and retro-molar space were significantly ($p=0.02$) greater in hyperdivergent patients ($GOGNSN>37$). These results align perfectly with the literature. Miclotte and al. [16], in turn, revealed that the Xi-M2 distance was significantly ($p<0.01$) greater in patients with increased vertical dimension.

Conclusion

During orthodontic treatment in growing patients, the angulation of mandibular third molars, as well as their eruption space, undergo significant changes, which are influenced by both natural growth and the type of orthodontic treatment.

Our study was designed to evaluate, across a range of parameters, the influence of orthodontic therapy with and without premolar extraction on the angulation and position of lower third molars.

The data from this study supports the concept that orthodontic treatment involving premolar extractions improves mandibular third molar angulation and eruption space. However, this improvement does not necessarily guarantee that these molars will appear in the correct position, as other factors may intervene and influence them.

Therefore, it may be prudent for orthodontists to inform their patients that premolar extractions may not prevent the need for third molar extractions in the future.

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