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Changes in third molar position after Class II subdivision malocclusion treatment with asymmetric extractions

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Abstract

Introduction: This study aimed to assess the changes in third molars angulation and their available space after Class II subdivision malocclusion treatment with asymmetric premolar extractions.

Methods: The sample consisted of 37 patients (17 male, 20 female and mean age 13.18 ± 1.99 years) in group 1 (Type 1 Class II subdivision) and 25 (10 male, 15 female, mean age 13.56 ± 2.46 years) in group 2 (Type 2 Class II subdivision). In group 1, extractions were performed in the two maxillary quadrants and in the Class I mandibular quadrant. In group 2, extraction was performed in the Class II maxillary quadrant. Panoramic radiographs were used to evaluate third molar angulations and their available space pre- and post-treatment. Radiographic measurements were performed with Dolphin® Imaging 11.9. Paired t tests were used for intragroup comparison between stages and sides.

Results: In Type 1, there were similar improvements in third molar angulations and increases in the space available on the extraction quadrants in the maxillary arch. In the mandibular arch, there was significantly greater improvement in angulation and greater space availability in the extraction quadrant after treatment. In Type 2, there was significantly greater improvement in angulation and available space for the maxillary third molar on the extraction quadrant. In the mandibular arch, there was a similar improvement in the available space for the third molars.

Conclusions: After treatment, both groups presented better angulation and significantly greater space for third molar eruptions on the extraction quadrants, when compared to the homologous non-extraction quadrants.

KEYWORDS

malocclusion, third molar, tooth extraction

1 | INTRODUCTION

Third molar impactions have been associated with various pathologies, including pericoronitis, cysts, tumours, dental caries, periapical infections and adjacent tooth root resorption.[1] Third molars lead the rank of higher prevalence of impaction, and the absence of space in the arch is a common aetiology.[2] The space available for third molar eruption is usually influenced by bone remodelling and orthodontic treatment.[3,4]

Studies diverge on how orthodontic treatment can affect third molar eruption space and their angulation. Some investigations show that third molar mesialization by interproximal attrition and extraction mechanics increases the space for eruption, decreasing the incidence of impaction.[5] However, other studies demonstrate contradictory results about angulation and third molar occlusal contact after first and second premolar extractions.[6]

Some studies,[7,8] using cephalometric variables and panoramic radiographs, verified that treatment without extractions has been more frequently associated with third molar impactions and that extraction treatment improves their angulation.

Class II subdivision malocclusion is primarily characterized by distal positioning of the mandibular first molar and secondarily by mesial maxillary first molar positioning on the Class II side.[9,10] It may be classified as Type 1 when there is a coincidence of the maxillary dental midline with the midsagittal plane and mandibular dental midline deviation to the Class II side, and as Type 2 when the mandibular midline is coincident with the midsagittal plane and the maxillary midline is deviated to the Class I side.[10] Its treatment can be performed with or without extractions. Type 1 Class II subdivision malocclusions, treated with asymmetric extractions of three premolars, will end with a Class I molar and canine relationship on the Class I side and Class II molar and Class I canine relationships on the Class II side.[10,11] In Type 2, the extraction of one maxillary premolar on the Class II side is also a possible asymmetric protocol when the maxillary midline is deviated to the Class I side.[12]

Third molar space in Class II subdivision malocclusion has been investigated and compared with normal occlusion. It was found that in Type 1, there is smaller space for the mandibular third molars on the Class II side, and in Type 2, there is greater space for the maxillary third molars on the Class II side.[13] These results have clinical implications for third molar extraction strategies.[14,15] However, these results were obtained in untreated Class II subdivision malocclusions. Knowledge of the available space and angulation of third molars would have a more relevant clinical application if obtained after orthodontic treatment.

Therefore, the objective of this study was to evaluate the available space and third molar angulations after Class II subdivision malocclusion treatment with asymmetric premolar extractions.

2 | MATERIAL AND METHODS

This study was approved by the Ethics in Research Committee of Bauru Dental School, University of São Paulo, Brazil (protocol number 71 683 417.9.0000.5417), and all subjects signed informed consent.

Sample size calculation showed that to detect a difference of 7.81°, with a standard deviation of 12.64, in the angle between the right maxillary third molar long axis and the interorbital line (Ang3Mx), at a significance level of 5% and with a test power of 80%, 22 patients would be necessary for each group.[16] The sample was retrospectively selected from the files of the Orthodontic Department at Bauru Dental School, University of São Paulo, Brazil. Subjects with tooth loss treated without extraction, treated with extraction of 4 premolars, tumours or infection and without maxillary or mandibular third molars were excluded.

The sample consisted of 2 experimental groups: Group 1 comprised 37 patients (17 male, 20 female, mean age of 13.18 ± 1.99 years) with Type 1 Class II subdivision malocclusion, treated with extractions of 3 premolars (two maxillary and one mandibular premolar on the Class I side). Group 2 comprised 25 patients (10 male, 15 female and mean age 13.56 ± 2.46 years) with Type 2 Class II subdivision malocclusion, treated with asymmetric extraction of 1 maxillary premolar on the Class II side.

The orthodontic mechanics used fixed edgewise appliances with 0.022 × 0.028-inch brackets. The wire sequence consisted of 0.015-inch twist flex or a 0.016-inch nickel-titanium alloy archwire, followed by 0.016, 0.018, 0.020 and 0.021 × 0.025 or 0.018 × 0.025-inch stainless steel archwires (3 M Unitek, Monrovia, Calif). As anchorage reinforcement, extraoral headgear was used, and Class II elastics were also used when needed. Deep overbites were corrected with accentuated and reversed curve of Spee. Anterior retraction was performed only in the extraction quadrants, and consequently, the deviated dental midline was automatically corrected to the midsagittal plane. Rectangular wires and elastic chains were used for 'en masse' retraction to correct the overjet and Class II canine relationship.

The mesiodistal angulation and the space available for third molars were evaluated at pre- (T1) and post-treatment stages (T2) in panoramic radiographs with the *Dolphin*® Imaging 11.9 software (Dolphin Imaging & Management Solutions, Chatsworth, Calif). One calibrated investigator (JFA) manually demarked the landmarks, and the software traced the respective lines of interest and automatically performed the measurements. Blinding was not possible because the investigator could identify the pre- and post-treatment panoramic radiographs because of the extractions performed. Definitions of the variables used are present in Table 1 and Figure 1.

Third molar angulations were measured by the angle between the long axis of the maxillary and mandibular third molar crowns and the infraorbital line and intermentonian foramen line respectively (Figure 1).

In the maxillary arch, the available space was evaluated by measuring the distance between the distal contact points of the second molar crown to a perpendicular to the infraorbital line, tangent to the tuberosities (Figure 1). In the mandibular arch, it was measured between the distal contact point of the second molar crown and the anterior border of the ramus, following the occlusal plane.

The following parameters were used to evaluate treatment changes in third molar angulation: positive values denoted an

TABLE 1 Definitions of the cephalometric variables

Variables	Definition
Ang3MxCLI	Angle formed by the long axis of maxillary third molar and the infraorbital line on the Class I side
Ang3MxCLII	Angle formed by the long axis of maxillary third molar and the infraorbital line on the Class II side
Ang3MdCLI	Angle formed by the long axis of mandibular third molar and the inter mentonian foramen line on the Class I side
Ang3MdCLII	Angle formed by the long axis of mandibular third molar and the inter mentonian foramen line on the Class II side
Spa3MxCLI	Space available for the maxillary third molar irruption on the Class I side
Spa3MxCLII	Space available for the maxillary third molar irruption on the Class II side
Spa3MdCLI	Retromolar space available for the mandibular third molar irruption on the Class I side
Spa3MdCLII	Retromolar space available for the mandibular third molar irruption on the Class II side
Ang3Mx	Angular difference in maxillary third molars between T2 and T1
Spa3Mx	Linear difference in maxillary third molars between T2 and T1
Ang3Md	Angular difference in mandibular third molars between T2 and T1
Spa3Md	Linear difference in mandibular third molars between T2 and T1

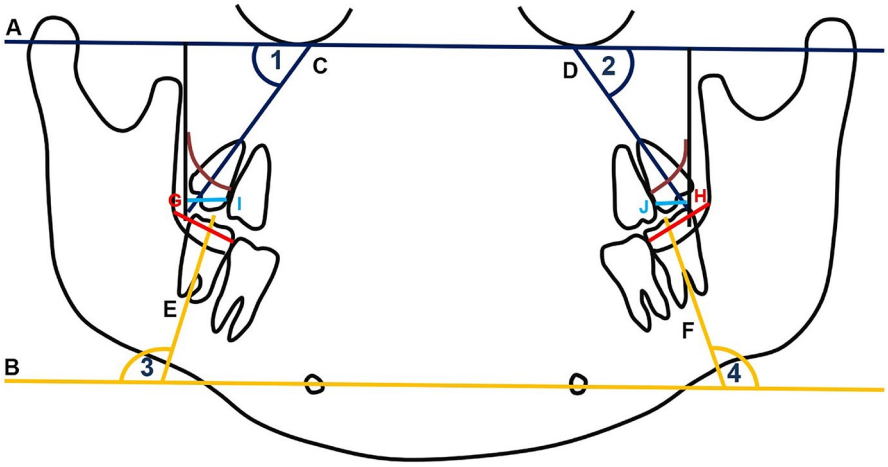

FIGURE 1 Reference lines and cephalometric variables in panoramic radiograph. (A) Infraorbital line, (B) Intermentonian foramen line, (C) Long axis of maxillary third molar on the Class I side, (D) Long axis of maxillary third molar on the Class II side, (E) Long axis of mandibular third molar on the Class I side, (F) Long axis of mandibular third molar on the Class II side, (G) Retromolar space available for the mandibular third molar on the Class I side, (H) Retromolar space available for the mandibular third molar on the Class II side, (I) Space available for the maxillary third molar irruption on the Class I side, (J) Space available for the maxillary third molar irruption on the Class II side. (1) Angle formed by the long axis of maxillary third molar and the infraorbital line on the Class I side, (2) Angle formed by the long axis of maxillary third molar and the infraorbital line on the Class II side, (3) Angle formed by the long axis of mandibular third molar and the intermentonian foramen line on the Class I side, (4) Angle formed by the long axis of mandibular third molar and the intermentonian foramen line on the Class II side

increase in mesioangulation, and negative values denoted a decrease in mesioangulation. An increase in mesioangulation for the maxillary third molars and a decrease in mesioangulation for the mandibular third molars, with treatment, were considered as improvements in their positions, with greater eruption possibility.

Measurements were obtained at pre-treatment (T1) and post-treatment (T2) stages. Treatment changes were calculated as T2-T1.

2.1 | Error study

Fifteen days after the first measurement, twenty randomly selected radiographs were redigitized, retraced and remeasured by the same calibrated examiner (JFA). Random errors were calculated with Dahlberg's formula,[17] (Se2 = ∑ d2 / 2n) where S^2 is the error variance and d is the difference between 2 determinations of the same

variable. Systematic errors were evaluated with paired *t* tests, at $P < .05$.

2.2 | Statistical analyses

Normal distribution was assessed with Kolmogorov-Smirnov tests. Intergroup sex distribution, mean age and treatment time were compared with chi-square and *t* tests respectively. Intragroup comparisons were performed with paired t tests.

All statistical analyses were performed using Statistica software (Statistica for Windows, version 7.0; StatSoft Inc, Tulsa, Okla, USA), at $P < .05$.

3 | RESULTS

The random errors ranged from 1.96 (Ang3MxCLII) to 2.69 (Ang3MxCLI) degrees and from 0.12mm (Spa3MdCLI) to 0.19mm (Spa3MxCLII and Spa3MdCLII), within acceptable limits.[18] No significant systematic errors were found.

The groups were comparable regarding sex distribution, initial Class II malocclusion severity, pre- and post-treatment ages and treatment times (Table 2).

Group 1 presented significant increases in the mesioangulation and space for the maxillary third molars on both sides, mesioangulation decrease for the mandibular third molars on the Class I side and space increase for mandibular third molars on both sides (Table 3A).

In Group 1, the changes in mandibular third molar angulation were significantly different between both sides. On the Class I side, the mesioangulation decreased, and on the Class II side, it increased. Besides, there was significantly greater increase in the space for mandibular third molars on the Class I side (Table 4A).

Group 2 presented significant increases in the mesioangulation and space for the maxillary third molars on the Class II side, mesioangulation decrease for the mandibular third molars on the Class I side and increases in the space available for third molars on both mandibular sides (Table 3B).

On the Class II side of Group 2, the maxillary third molar mesioangulation and available space increased significantly more than on the Class I side. Regarding third molar angulation, there was significant mesioangulation decrease on the Class I side and significant increase on the Class II side (Table 4B).

4 | DISCUSSION

Third molar angulation has been widely evaluated in panoramic radiographs over the years.[2] Some authors reported that it can cause distortions and do not reproduce the clinical condition accurately.[19,20] However, others defend that panoramic radiographs are the method of choice to evaluate third molars. Because they are inexpensive, they end up been more commonly used, what facilitates communication. Its specificity ranges from 96% to 98%, presenting reliable linear and angular measurements with consistent accuracy.[21,22] Besides, despite some distortion and magnification, these factors should not have influence on the results as the comparison was performed between the sides of the same panoramic. Therefore, distortion and magnification would most likely affect both sides similarly.

Type 1 Class II subdivision malocclusion had significant increases in the mesioangulation and spaces for the maxillary third molars, suggesting that maxillary premolar extractions may have contributed to these changes (Table 3A). These changes were similar on both sides, showing that the symmetric maxillary extractions produced symmetric favourable changes for the third molars bilaterally, as expected[8,13,23] (Table 4A).

TABLE 2 Intergroup comparison of sex, Class II malocclusion severity distribution, pre- and post-treatment ages, and treatment times

Variables	Group 1—Type 1 n = 37		Group 2—Type 2 n = 25		*P*
Sex					
Male	17		10		.642[a]
Female	20		15		
Malocclusion severity					
¼ Cusp Class II	0%		0%		.723[a]
½ Cusp Class II	15%		0%		
¾ Cusp Class II	5%		23%		
Full-Cusp Class II	80%		77%		
	Mean	**SD**	**Mean**	**SD**	
Pre-treatment age	13.18	1.99	13.56	2.46	.517[b]
Post-treatment age	16.81	2.29	16.76	2.78	.937[b]
Treatment time	3.40	1.11	3.08	0.90	.231[b]

[a]chi-square test.
[b]*t* test.

TABLE 3 Third molar treatment changes of Type 1 and Type 2 Class II subdivision malocclusion (paired *t* tests)

	T1		T2		
Variable	Mean	SD	Mean	SD	*P*
3A					
Group 1 (Type 1)					
Ang3MxCLI	55.77	14.80	69.76	12.22	.000*
Spa3MxCLI	5.76	2.47	8.51	2.45	.000*
Ang3MxCLII	56.50	13.14	69.54	12.49	.000*
Spa3MxCLII	6.22	2.56	9.05	2.58	.000*
Ang3MdCLI	141.23	11.35	135.33	17.98	.015*
Spa3MdCLI	5.12	3.69	10.52	2.47	.000*
Ang3MdCLII	142.39	11.42	145.25	16.18	.249
Spa3MdCLII	4.62	3.67	7.24	3.64	.000*
3B					
Group 2 (Type 2)					
Ang3MxCLI	54.35	11.57	58.67	10.43	.085
Spa3MxCLI	6.25	2.59	6.80	2.30	.212
Ang3MxCLII	59.84	11.70	70.04	13.35	.000*
Spa3MxCLII	7.44	2.97	9.85	2.44	.000*
Ang3MdCLI	137.52	12.95	130.25	17.36	.020*
Spa3MdCLI	6.40	3.93	8.60	2.92	.003*
Ang3MdCLII	143.14	11.74	145.75	18.57	.458
Spa3MdCLII	5.52	3.88	7.18	3.02	.018*

*Statistically significant at $P < .05$.

TABLE 4 Treatment changes (T2-T1) comparison between Class I and Class II sides, in Group 1—Type 1 and in Group 2—Type 2 Class II subdivision malocclusion (paired *t* tests)

	T2-T1		T2-T1			
	Class I		Class II			
Variable	Mean	SD	Mean	SD	Diff.	*P*
4A						
Group 1 (Type 1)						
Ang3Mx	13.99	10.27	13.03	9.71	0.956	.584
Spa3Mx	2.75	2.84	2.83	2.92	0.07	.805
Ang3Md	-5.90	14.05	2.86	14.90	8.76	.008*
Spa3Md	5.40	2.67	2.61	3.03	2.78	.000*
4B						
Group 2 (Type 2)						
Ang3Mx	4.32	12.05	10.19	11.53	5.87	.036*
Spa3Mx	0.54	2.13	2.41	2.14	1.86	.000*
Ang3Md	-7.27	14.70	2.61	17.33	9.88	.033*
Spa3Md	2.19	3.43	1.65	3.27	2.04	.199

*Statistically significant at $P < .05$.

In the mandibular arch, the asymmetric extraction on the Class I side produced a significant decrease in third molar mesioangulation on the same side, favouring its eruption viability (Table 3A). Nonetheless, both sides had significant space increases for the third molars, suggesting that the asymmetric extraction on the Class I side did not strongly favour third molar eruption on this side. Conversely, in the inter-side

comparison, the Class I side presented significantly greater distoangulation and increase in third molar space than the Class II side, where no extraction was performed (Table 4A). Therefore, it reinforces that the asymmetric extraction on the Class I side provides greater space availability and a more favourable angulation for third molar eruption on this side. The space increase that occurred on the Class II side could be consequent to a natural growth that the patients were undergoing.[5,8,24,25]

The Type 2 group presented significant increases in the mesioangulation and spaces for the maxillary third molar on the Class II side, suggesting that the unilateral premolar extraction may have contributed to these changes (Table 3B). Furthermore, these changes were significantly greater on the Class II side, showing that the asymmetric extraction on the Class II side produced asymmetric changes for the third molars space and angulation, favouring eruption on the extraction quadrant (Table 4B).

In the mandibular arch, there was a decrease in the mesioangulation for the mandibular third molars on the Class I side and increases in the spaces for mandibular third molars on both sides (Table 3B). Inter-side comparison revealed significantly greater distoangulation on the Class I than on the Class II side, with similar increases in available space on both sides (Table 4B). Since there was no extraction in the mandibular arch in this group, the space increase for the third molars can only be attributed to growth, which occurred symmetrically.[5,8,24,25] The greater decrease in mesioangulation (greater distoangulation) on the Class I side still has to be investigated. It may be consequent to the great variability in angulation that third molars usually present.[26-28]

One may argue whether the extractions or the different mechanics used on the Class I and Class II sides in these two types of Class II subdivision malocclusions mostly contributed to the different amounts of space and angulations for the third molars. It seems that the extractions were the primary factors that contributed to the differences because the mechanics are dependent upon the extraction or non-extraction choice.[29,30]

These results support the findings of a previous investigation regarding pre-treatment third molar available space in Class II subdivision malocclusions.[13] At that occasion, the mandibular molar space asymmetry was significantly greater in Type 1 than in the normal occlusion group. The available space for mandibular third molar on the Class II side was smaller than on the Class I side. In Type 2, there was significantly greater maxillary molars space asymmetry compared with normal occlusion. The Class II side had a numerically greater maxillary third molar space availability than the Class I side.

It may be argued that there was also an increase in the available space for the mandibular third molars in the Type 2 malocclusion, obviously, consequent to skeletal growth (Table 4B—Class I and Class II sides). However, this space may not be enough to allow eruption of the mandibular third molars because, when the extraction was performed in the mandibular quadrant, the available space at the end of treatment was more than twice the space provided only by growth (Table 4A—Class I side). Still, it can be argued that the amount of space increase in the mandibular quadrants in Type 2 was almost similar to the increase in maxillary third molar space when extractions were performed in both maxillary quadrants in Type 1 (Tables 4B and 4A). Nevertheless, when no extraction was performed in the maxillary quadrant, the increase with growth was minimal (Table 4B—maxillary Class I side). It suggests that a smaller amount of space is necessary to favour maxillary third molar eruptions than mandibular third molar eruptions.

The clinical implications for these results are that the quadrants in which premolar extractions were performed are more prone to have available space for third molar eruption. Therefore, Type 1 cases treated with 3 premolar extractions may, at the time of third molar eruption, have available space for the third molars in the quadrants where extractions were performed, but not in the mandibular quadrant of the Class II side, where no extraction was performed. Analogously, Type 2 cases treated with 1 maxillary premolar extraction on the Class II side may require third molar extractions on the three quadrants where no premolar extraction was performed, but may have enough available space for eruption on the extraction quadrant. Therefore, third molar extraction would be required only on the quadrants where no premolar was extracted.

This study showed that, in general, the quadrants with extractions had favourable changes for third molar eruptions. However, the observation period was restricted to only three years. Thus, longer observation periods should be evaluated to confirm the results of this investigation.

One may argue that whether only the mandibular third molar is extracted on the Class II side the maxillary third molar may extrude. However, it would not be true because, on the Class II side, the maxillary third molar will occlude with the distal of the mandibular second molar and will not extrude[31,32] (Figure 2). Cases treated with extractions should be preserved from additional extractions unless extremely necessary.[8,13]

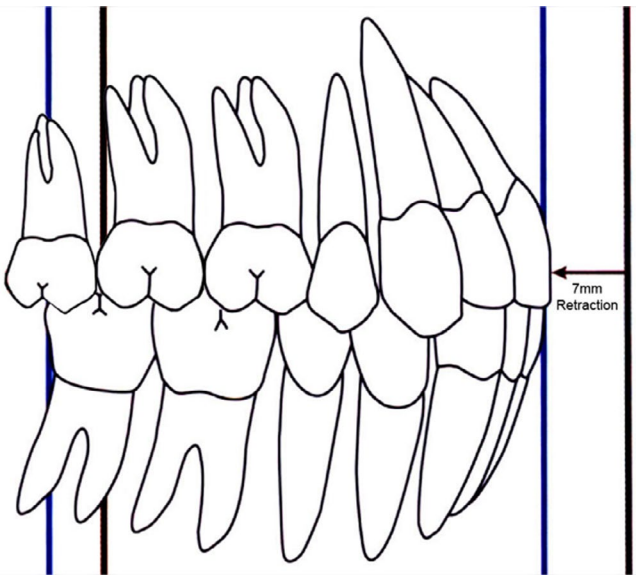

FIGURE 2 Lateral occlusal view showing the maxillary third molar occluding with the distal occlusal surface of the mandibular second molar

5 | CONCLUSIONS

- In Type 1 Class II subdivision malocclusion, treated with three premolar extractions, there was greater improvement in third molar angulations and increases in the space available in the extraction quadrants in the maxillary and mandibular arches, after treatment;
- In Type 2 Class II subdivision malocclusion, treated with 1 maxillary premolar extraction on the Class II side, there was greater improvement in the available space and angulation for the maxillary third molar on the Class II side.

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CONFLICT OF INTEREST

Dr Janson, Dr Almeida, Dr Valerio, Dr Velásquez, Dr Aliaga-Del Castillo and Dr Garib have nothing to disclose.

AUTHOR'S CONTRIBUTION

Guilherme Janson involved in conceptualization, project administration and supervision. Jéssica Ferreira de Almeida involved in data curation, investigation, formal analysis and writing—original draft. Marcelo Vinicius Valerio, Gonzalo Velásquez and Aron Aliaga Del-Castillo involved in data checking, writing—review and editing. Daniela Garib involved in validation.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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