



Class II subdivision treatment success rate with symmetric and asymmetric extraction protocols

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The purpose of this study was to compare the success rates of Class II subdivision malocclusion patients treated with either symmetric or asymmetric extractions. The sample consisted of 51 patients with Class II subdivision malocclusion. The patients were divided into 2 groups. Group 1 included 28 patients who were treated with 4 premolar extractions. The 23 patients in group 2 were treated with 3 premolar extractions (2 maxillary premolars and 1 mandibular premolar on the Class I side). The initial and final study models were evaluated by means of Grainger's treatment priority index (TPI). Individual evaluations of improvements in maxillary-to-mandibular dental midline deviation, overjet, and overbite were also made. The final mean TPI and the mean improvement in TPI and in the other variables of each group were compared with independent *t* tests. The results showed a statistically significant difference only for the improvement in maxillary-to-mandibular dental midline deviation of the groups. The 3-premolar-extraction group had a greater improvement of the initial interdental midline deviation. There is a tendency for a slightly better treatment success rate when Class II subdivision patients are treated with asymmetric extraction of 3 premolars, compared with extraction of 4 premolars. (*Am J Orthod Dentofacial Orthop* 2003;124:257-64)

Patients with Class II subdivision malocclusions have Class I characteristics on one side and Class II characteristics on the other, primarily because of the distal positioning of the mandibular first molar in relation to the maxillary first molar on the Class II side.¹⁻³ This malocclusion can also be produced by the more mesial position of the maxillary first molar in relation to the mandibular first molar³ on the Class II side. The resulting asymmetric occlusal relationship complicates orthodontic treatment.

In most patients with Class II subdivision malocclusion, the maxillary dental midline is coincident to the midsagittal plane, or has a minimal deviation,

whereas the mandibular dental midline is usually displaced toward the Class II side.¹⁻³ The possible treatment approaches include symmetric extraction of 4 premolars and asymmetric extraction of 3 premolars.³⁻⁷ The 4-premolar-extraction approach will produce a final occlusion with bilateral Class I molar and canine relationships. However, attaining a Class I molar relationship on the original Class II side and a consequent coincidence of the maxillary and mandibular dental midlines depends largely on patient compliance in the use of Class II and anterior diagonal intermaxillary elastics.^{3,8-12} On the other hand, asymmetric extraction of 3 premolars (2 maxillary premolars and 1 mandibular premolar on the Class I side) will produce Class I canine and molar relationships on the Class I side and Class II molar and Class I canine relationships on the Class II side, along with coincidence of the maxillary and mandibular dental midlines to each other and in relation to the midsagittal plane.^{1,3-7,13} Correcting the interdental midline deviation with this treatment is easier, because it is achieved simultaneously with closing the extraction space in the mandibular arch. There is also minimal need for Class II and anterior diagonal intermaxillary elastics, because the molars on the Class II side will remain in their initial positions and the correction of the interdental midline deviation will be consequent to closing the mandibular extraction space.^{3,12} Thus, it is speculated that the treatment

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success rate of Class II subdivision patients treated with this asymmetric extraction protocol is greater than that of treatment with symmetric extraction of 4 premolars, because it does not heavily depend on patient compliance in the use of intermaxillary elastics.^{3-5,7}

The purpose of this study was to test the null hypothesis that there is no difference in the treatment success rate of Class II subdivision malocclusions treated with either 4 or 3 premolar extractions. Initial and final treatment priority index (TPI) values and the changes in TPI during treatment were compared between 2 groups treated with these different approaches. Similarly, interdental midline deviation and amount of overbite and overjet were individually compared between the 2 groups.

MATERIAL AND METHODS

The sample was selected retrospectively from the files of the Orthodontic Department at Bauru Dental School, University of São Paulo, which included more than 2000 documented, treated cases. Initial and final study models of 51 patients who initially had Class II subdivision malocclusions and were treated with fixed edgewise appliances were collected and divided into 2 groups. Group 1 included 28 patients (11 males, 17 females) treated with 4 symmetric extractions, at an initial mean age of 13.55 years (range, 10.25 to 19.75). Group 2 included 23 patients (10 males, 13 females) treated with 3 asymmetric extractions, at an initial mean age of 14.87 years (range, 11.66 to 17.83). The selection criteria were a full Class II molar relationship on one side and a Class I molar relationship on the other and all permanent teeth up to the first molars. Sample selection was based exclusively on the initial antero-posterior dental relationship, regardless of any other dentoalveolar or skeletal characteristic. Forty nine patients had Class II Division 1 subdivision malocclusions (27 in group 1 and 22 in group 2), and 2 had Class II Division 2 subdivision malocclusions (1 in each group).

A form (Fig) was used to calculate the TPI¹⁴ on the pretreatment and posttreatment study models of each patient. The items measured were restricted to those describing an occlusal anomaly, excluding factors related to cause (eg, habits) or measurements related to malocclusion per se (eg, intercanine width). Set patterns or combinations of the selected items defined syndromes. A total of 7 syndromes were developed to define incisor relationship horizontally (underjet, overjet) and vertically (overbite, open bite), occlusion of the buccal segments (posterior crossbite), and tooth displacement (rotation and crowding). On the basis of multiple regression analysis, the syndromes were

weighted according to the permanent first molar relationship—mesio-, neutro-, or distocclusion. A constant, also corresponding to molar occlusion, was added to the TPI score. The final result constitutes the TPI value, which represents the severity of malocclusion and can range from 0 to more than 10.¹⁵

Two copies of the form (Fig) were required to calculate the TPIs of each patient. On the first, the achieved value corresponded to the initial severity of the malocclusion, and the second showed the final occlusal status after orthodontic treatment. The improvement in malocclusion was calculated as the difference between the initial and final TPIs.

Maxillary-to-mandibular dental midline deviation, overbite, and overjet were measured before and after treatment with Mitutoyo calipers (Mitutoyo America, Aurora, Ill), as follows:

- Dental midline deviation: transversal distance between the maxillary and mandibular dental midlines;
- Overbite: vertical distance from the incisal edge of the mandibular incisor to the perpendicular projection of the incisal edge of the maxillary incisor on the labial surface of the mandibular incisor;
- Overjet: horizontal distance between the labial surface of the mandibular incisor and the incisal edge of the maxillary incisor.

To determine the error, 30 pairs of study models were randomly remeasured by the same examiner (E.A.D.). The casual error was calculated according to Dahlberg's formula,¹⁶ $S^2 = \sum d^2/2n$, where S^2 is the error variance and d is the difference between the 2 determinations of the same variable. The systematic error was calculated with dependent t tests, for $P < .05$.

The mean and standard deviation (SD) for each variable were calculated for both groups. The t test for independent samples was used for normal distributions and verified by the Kolmogorov-Smirnov test (for initial and final values, as well as for the changes). The results of the tests were nonsignificant for all variables. Therefore, t tests were used to compare the initial and final variables and the changes in the variables during treatment, between the groups. $P < .05$ was considered significant.

RESULTS

None of the variables presented statistically significant systematic errors, and the range of casual errors varied from 0.19 to 0.88. The Table shows that there were significant differences between the groups only for initial mean age and final midline deviation and its change during treatment. The initial mean age of group 1 was less than that of group 2. Group 1 had greater

final midline deviation and smaller change in midline deviation with treatment than did group 2. The other variables did not have significant differences between the groups.

DISCUSSION

Compatibility of the groups

The subjects were selected primarily on the basis of having a full Class II molar relationship on one side and Class I molar relationship on the other, independently of the associated cephalometric skeletal characteristics. Because both groups were similarly chosen, it could be expected that these characteristics would be evenly distributed among them. Again, the primary objective was to investigate whether there was a difference in the final treatment success rate only in the occlusal aspects between these 2 treatment protocols, independently of any other characteristic. Extractions of either the first or second premolar was not a concern for several reasons. First, all patients in the file who satisfied the criteria were included in the study for both groups. Thus, the probability of extraction of the second premolars would be similar in both groups. Second, previous studies have shown that resistance to mesial movement of the posterior segments is similar after extracting the first or second premolar.¹⁷ Another selection criterion was all permanent teeth up to the first molars before treatment. The absence of any tooth might, in some instances, either simplify or complicate correction of the malocclusion, and this could interfere with the results.¹⁸

The initial mean age of group 2 was significantly greater than that of group 1 (Table). Correcting a Class II anteroposterior relationship becomes increasingly difficult with age.^{18,19} Class II subdivision patients having 4-premolar extractions will require large anteroposterior correction of the Class II posterior segment; therefore, treatment at a younger age would be more likely to obtain a good occlusal result. Conversely, patients treated with 3-premolar extractions will not require anteroposterior correction of the Class II posterior segment; thus, treatment at a later age will have less impact on the expected anteroposterior occlusal results, similar to the protocol of extracting 2 maxillary premolars in full bilateral Class II cases.^{18,20} Therefore, the age difference between the groups would favor treatment with the 4-premolar-extraction protocol.

The 2 patients with Class II Division 2 subdivision malocclusion were included in the sample because there was 1 for each group and also because correction of the dentoalveolar anteroposterior discrepancy is similar in both types of Class II malocclusion.²¹ Their inclusion should not have interfered with the results. The groups were also very similar in sex distribution.

Finally, to attest to the compatibility of the groups regarding degree of malocclusion, the initial severity of the variables had no statistically significant differences between them, as shown in the Table.

Study design

The best way to evaluate initial malocclusion severity and final occlusal outcome is a direct clinical evaluation of each patient.²² However, this would be almost impossible in a retrospective study. Obviously, the initial status of the malocclusion could not be obtained from this evaluation at the start of the study. Even if the initial status could have been obtained through a direct clinical evaluation, other problems regarding final status would be apparent. The first would be tracking the patients for years after treatment; many might have changed their addresses or moved to other cities. Even if many of the patients could be found, their treatment results could be affected by relapses or dental losses.²³⁻²⁶

The TPI, as developed by Grainger,¹⁴ was selected among other indexes^{15,22,27-32} because it allows for dental cast evaluation, presents compatibility with the initial mean age of the patients, and contains measurable items that describe the occlusal anomaly, except for the factors related to cause (eg, finger sucking).¹⁵ The most commonly used indexes are valid for determining treatment priorities. The TPI is particularly applicable for comparing orthodontic treatment results.^{15,22} It is also a good epidemiologic indicator.²² With this index, it was possible to evaluate malocclusion severity before orthodontic treatment, occlusal condition after treatment, and improvement between the initial and final stages for posterior comparison between the groups. Furthermore, the TPI was applied because its reliability has already been demonstrated.^{15,22,28,29}

Individual evaluations of tooth position were performed and compared between the groups. When improvements are combined in the TPI, an improvement in 1 position might be neutralized by lack of improvement in another, and the overall comparison of the index will not reflect these differences.^{15,22} Thus, these individual evaluations are useful for detecting small differences between the 2 approaches. Additionally, the index does not include the interdental midline deviation evaluation.

Treatment changes

There were no statistically significant differences between the groups in the final values of TPI, overbite, overjet, or treatment changes in these variables (Table). These results indicate a similarity of the 2 treatment

Fig. Treatment priority index data collection form.

First molar relationship Select the appropriate column	(6) Distocclusion					
	Complete CI II at both sides	1/2 CI II at one side and complete CI II at the other	1/2 CI II at both sides or complete CI II at one side	1/2 CI II at one side	Neutral	
Incisor horizontal relationship (mm)*						
Upper overjet						
9+	2.0	3.4	5.4	9.3	10+	
9	1.4	2.5	4.0	6.9	10+	
8	1.0	1.8	2.8	4.8	8.0	
7	.6	1.1	1.8	3.0	5.1	
6	.4	.6	1.0	1.7	2.9	
5	.2	.3	.4	.8	1.3	
2-4mm						
Lower overjet						
1	.2	.3	.4	.8	1.3	
0	.4	.6	1.0	1.7	2.9	
1	.6	1.1	1.8	3.0	5.	
2	1.0	1.8	2.8	4.8	8.0	
3	1.4	2.5	4.0	6.9	10+	
3+	2.0	3.4	5.4	9.3	10+	
Incisor vertical relationship (bite)*						
Overbite (in relation to crown thirds)						
3/3+	2.9	3.8	4.8	6.2	8.0	
2/3-3/3	1.5	2.0	2.4	3.2	4.1	
0-2/3	.5	.7	.9	1.1	1.5	
Open bite (mm)						
<2	1.5	2.0	2.4	3.2	4.1	
2-4	2.9	3.8	4.87	6.2	8.0	
4+	4.9	6.3	.9	10+	10+	
Tooth displacement score						
Sum of 45°-rotated teeth or 2-mm displaced						
Sum of >45°-rotated teeth or >2-mm displaced × 2						
Total (0, 1 no score)	2	.1	.1	.2	.3	.4
	3	.2	.3	.4	.7	1.1
	4	.3	.5	.9	1.2	1.9
	5	.5	.8	1.2	1.9	3.0
	6	.7	1.1	1.8	2.8	4.3
	7	1.0	1.5	2.4	3.9	5.9
	8	1.3	1.9	3.1	4.9	7.7
	9	1.7	2.5	4.1	6.2	9.7
	9+	2.0	3.0	4.9	7.7	10+
Constants	5.17	3.95	2.72	1.50	0.27	
Sum of number of teeth in posterior crossbite						
Mx posterior teeth buccally tipped						
No.	0	1	2	3	4	
Weight	0	.1	.6	1.3	2.2	
Mx posterior teeth lingually tipped						
No.	0	1	2	3	4	
Weight	0	.3	1.0	2.3	4.2	

*Normal score = 0.

Sum of the weights represents the treatment priority index =
CI, Class; Mx, maxillary.

Fig. continued

(7) Mesioocclusion

<i>1/2 Cl III at one side</i>	<i>1/2 Cl III at both sides or complete Cl III at one side</i>	<i>1/2 Cl III at one side and complete Cl III at the other</i>	<i>Complete Cl III at both sides</i>	<i>Weights</i>	<i>Syndrome type</i>	
					Retrognathism	
9.3	5.4	3.4	2.0			
6.9	4.0	2.5	1.4			
4.8	2.8	1.8	1.0			
3.0	1.8	1.1	.6			
1.7	1.0	.6	.4			
.8	.4	.3	.2			
					Prognathism	
.8	.4	.3	.2			
1.7	1.0	.6	.4			
3.0	1.8	1.1	.6			
4.8	2.8	1.8	1.0			
6.9	4.0	2.5	1.4			
9.3	5.4	3.4	2.0			
					Overbite	
6.2	4.8	3.8	2.9			
3.2	2.4	2.0	1.5			
1.1	.9	.7	.5			
					Open bite	
3.2	2.4	2.0	1.5			
6.2	4.8	3.8	2.9			
10+	7.9	6.3	4.9			
					Is distocclusion and/or posterior crossbite present?	
.3	.2	.1	.1		<u>Yes</u>	<u>No</u>
.7	.4	.3	.2		Maxillary expansion syndrome	Maxillary collapse syndrome
1.2	.9	.5	.3			
1.9	1.2	.8	.5			
2.8	1.8	1.1	.7			
3.9	2.4	1.5	1.0			
4.9	3.1	1.9	1.3			
6.2	4.1	2.5	1.7			
7.7	4.9	3.0	2.0			
1.50	2.72	3.95	5.17			
					More	
5	6	7	8			
3.5	5.0	6.9	9.0			
					More	
5	6		10			
6.5	9.4		10			

protocols in correcting these irregularities. However, the final values and the treatment changes in these

variables point toward a greater success rate for the 3-premolar-extraction treatment (group 2). The absence

Table. Results of *t* tests between groups

	Group 1		Group 2		P
	Mean	SD	Mean	SD	
Initial mean age (y)*	13.553	1.866	14.873	1.669	.011
Initial TPI	8.265	3.107	8.759	4.060	.634
Initial midline deviation	1.785	1.205	2.130	1.110	.293
Initial overbite	2.589	1.551	2.717	2.485	.830
Initial overjet	4.750	2.562	5.347	2.711	.426
Final TPI	1.791	1.630	1.178	0.785	.086
Final midline deviation*	0.607	0.785	0.130	0.309	.005
Final overbite	2.464	0.999	2.304	0.822	.533
Final overjet	2.607	1.108	2.413	0.685	.447
Change in TPI	6.474	3.099	7.581	3.801	.267
Change in midline deviation*	1.178	1.334	2.000	1.107	.02
Change in overbite	0.125	1.573	0.413	2.570	.641
Change in overjet	2.142	2.340	2.934	2.710	.275

*Difference between groups reached statistical significance for this variable.

of statistically significant differences in the TPI might reflect the influence of the variables that are included in the index; this could have affected the comparison, as demonstrated by Ghafari et al¹⁵ and Lewis et al.²² The greater change in overjet is probably due to the smaller amount of retraction of the mandibular incisors required in patients with asymmetric extractions^{33,34} than in those having 4 premolar extractions. There is also a greater difficulty in controlling the overbite when 4 first premolars are extracted³⁴; this might explain why the 3-premolar-extraction approach showed a tendency for a better correction of this vertical irregularity.

In contrast to these results, there was a statistically significant difference between the groups in the final mean values and in the treatment changes for interdental midline deviation (Table). The results indicate that there was a better success rate of correcting the interdental midline deviation with asymmetric extractions; this confirms clinical speculations.³ This suggests that, despite the similar correction probability of the TPI, overbite, and overjet in both groups, correcting the interdental midline deviation allows a better chance of a successful result with asymmetric extractions. Because maxillary and mandibular dental midline coincidence is a consequence of a good anteroposterior relationship of the posterior segments, treatment with asymmetric extractions will also provide better correction in these aspects. It would be more difficult to correct the anteroposterior discrepancy of the posterior segments on the Class II side when 4 premolars are extracted. That is because the Class II molar relationship must be corrected by means of Class II intermaxillary elastics with extraoral headgear, which requires intense patient compliance. Without adequate patient

compliance, a mild Class II molar relationship will remain; this will also be reflected in a mild Class II canine relationship and consequently some interdental midline deviation.

The literature demonstrates that the main factor contributing to the asymmetric anteroposterior relationship in Class II subdivision malocclusions is the dentoalveolar component.¹⁻³ This dentoalveolar asymmetry is primarily related to the distal positioning of the mandibular first molar on the Class II side or, less frequently, to the more mesial positioning of the maxillary molar on the Class II side.³ This leads to a coincidence or a minimum deviation of the maxillary dental midline to the midsagittal plane, as well as a mandibular dental midline deviation to the Class II side in relation to the midsagittal plane in most Class II subdivision malocclusion patients.³ This might be why authors such as Cheney,^{4,5} Lewis,¹² Alavi et al,¹ and Janson et al^{3,6} suggest extracting 2 maxillary premolars and 1 mandibular premolar in the Class I side as a good treatment option, when the patient's profile allows for retracting the maxillary and mandibular incisors. According to these authors, the final occlusion on the Class I side will have Class I molar and canine relationships, and the Class II side will have Class II molar and Class I canine relationships, with the maxillary and mandibular dental midlines coincident to each other and to the midsagittal plane. Correcting the midline deviation in this treatment is easier, because it will be achieved simultaneously with closing the extraction space in the mandibular arch, with little or no need for intermaxillary elastics for midline correction¹² and patient compliance.

In patients with the same previous characteristics, a

variation on this pattern, suggested by Cheney^{4,5} and Wertz,¹³ involves extracting the second premolar on the Class II side; this establishes a difference in anchorage between the right and left canines to obtain a Class I relationship. Although this second extraction protocol might also provide satisfactory results, it requires greater use of intermaxillary elastics to reach a Class I molar relationship in the original Class II side.¹² Correcting an interdental midline deviation is also more arduous because the mandibular midline will tend to displace even more toward the Class II side during closure of the mandibular premolar extraction space. In this situation, Class II elastics on the Class II side and diagonal anterior elastics must be used to help correct the interdental midline deviation.¹⁰ This creates a greater dependence on patient compliance for a satisfactory result and therefore a greater risk for failure.

Treatment time of these extraction protocols should also be considered. The number of extracted premolars has a direct relationship to treatment time, according to Fink and Smith.³⁵ Treatment time is increased by 0.9 months for each extracted premolar. Thus, patients treated with 3 premolar asymmetric extractions can be treated faster than those having 4 premolar extractions, not only because of the easier orthodontic mechanics, but also because of fewer extracted teeth. This might apply even more to adult treatment because, as Alexander et al³³ stated, extracting 4 premolars in an adult increases treatment time and the amount of retraction of the anterior teeth, increasing patient discomfort and the probability for root resorption and periodontal problems. In adult patients with Class II subdivision malocclusion, asymmetric extractions would also help to decrease these unfavorable consequences.

Another clinical observation supported by the current results is that, when the treatment plan does not involve changes in the anteroposterior relationship of the posterior segments, the prognosis for malocclusion correction is better, because that correction usually demands patient compliance in wearing extraoral appliances or intermaxillary elastics.

Although no statistically significant difference in relation to the overall occlusal result between the 2 groups was shown by the TPI, the greater effectiveness of the asymmetric extraction protocol in correcting the interdental midline deviation is highly relevant. It indirectly reflects a greater success rate of anteroposterior relationship correction of the posterior segments in patients treated with asymmetric extractions. Thus, according to our findings, asymmetric extractions have a tendency for greater success in obtaining more satisfactory results in correcting Class II subdivision malocclusions.

CONCLUSIONS

According to the results of this study, our null hypothesis was rejected. Treatment of Class II subdivision malocclusions with extraction of 3 premolars showed a tendency to a slightly better treatment success rate in correcting the maxillary-to-mandibular dental midline deviation and consequently a tendency for a slightly better correction of the anteroposterior discrepancy of the posterior segments, compared with 4-premolar-extraction treatment. However, there were no statistically significant differences in the final values of TPI, overbite, overjet, or treatment changes in these variables between the Class II subdivision groups treated with either protocol.

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