ORIGINAL ARTICLE

Occlusal and cephalometric Class II Division 1 malocclusion severity in patients treated with and without extraction of 2 maxillary premolars

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Introduction: The purpose of this study was to compare the initial occlusal and cephalometric severity of Class II Division 1 malocclusion patients treated with and without extraction of 2 maxillary premolars. **Methods:** Dental study models and cephalograms of 62 patients were selected. Those in group 1 (n = 42) were treated without extractions, and those in group 2 (n = 20) were treated with 2 maxillary premolar extractions. Grainger's treatment priority index (TPI) was used to assess the final and the initial occlusal status of each subject. Variables such as overjet and overbite were also evaluated. Independent *t* tests were used to compare the occlusal variables at the posttreatment stage, the occlusal and cephalometric variables at the pretreatment stage, and the improvement in TPI values between the groups. **Results:** Patients treated with 2 maxillary premolar extractions had greater initial occlusal TPI values, overjets, cephalometric apical base anteroposterior discrepancies, maxillary incisor protrusions, and anteroposterior molar discrepancies than those treated without extractions. **Conclusions:** For patients with more severe anteroposterior discrepancies, an extraction plan provides more effective treatment with less need for patient compliance. (Am J Orthod Dentofacial Orthop 2006;129:759-67)

Class II malocclusions can be corrected with various treatment approaches.[1-5] In a growing patient, a nonextraction approach with extraoral headgear or a removable functional appliance, associated with fixed appliances, is common.[4,6-8] Another option is the extraction of 2 maxillary premolars to provide space for retraction of the anterior segment.[1-4,9-11] Nonextraction correction of a complete Class II malocclusion requires more patient compliance in using the extraoral headgear and a removable functional appliance than treatment with 2 maxillary premolar extractions.[12,13] Therefore, it is advisable to consider the amount of compliance and the magnitude of the anteroposterior discrepancy in the treatment planning, to provide maximum treatment efficiency.[14] This would eliminate

several treatment reevaluations and inconveniences in the relationship among doctor, patient, and parents, in which an initial Class II nonextraction treatment must be reversed to a 2 maxillary premolar extraction treatment.[15]

Several articles have dealt with the dentoskeletal changes of both treatment approaches,[1,16-24] but few have investigated their efficiency in obtaining these changes in relation to the initial severity of the anteroposterior discrepancy.[25,26] Several investigative methods could be used for this purpose: studying the percentages of complete Class II patients successfully treated by both approaches and comparing them, or comparing the initial Class II occlusal and cephalometric severities of patients who were successfully treated by these approaches. Therefore, the purpose of this study was to test the following null hypothesis: there is no difference in the initial occlusal and anteroposterior cephalometric severity of successfully treated Class II Division 1 patients either without extractions or with extraction of 2 maxillary premolars.

MATERIAL AND METHODS

The sample was retrospectively selected from the files of the orthodontic department at Bauru Dental School in Brazil; the files include over 2000 treated patients. To better standardize the sample regarding

treatment mechanics, the subjects were chosen from patients treated by orthodontic specialty classes that began in 1995 or 1997. The total number of patients treated by these students was 230. Among these, Class II Division 1 patients who were treated without extractions or with 2 maxillary premolar extractions and had good orthodontic results were selected for groups 1 and 2. A good orthodontic result was based on a subjective evaluation of intercuspation, tooth alignment, and incisor relationship,[27,28] with a maximum treatment priority index (TPI)[29] score of 3. Consequently, sample selection was based exclusively on the final dental relationship obtained, regardless of any other dentoalveolar or skeletal characteristic. An additional criterion to be included in the groups was that, at the pretreament stage, all permanent teeth up to the second molars were present. Group 1 comprised 42 Class II Division 1 patients (19 male, 23 female) treated without extractions, with an initial mean age of 12.84 years (SD, 2.43; range, 8.4-19.85 years). The nonextraction approach consisted of extraoral headgears and functional appliances, associated with fixed standard edgewise appliances. Thirty-four subjects used extraoral headgears, 3 used activators, 3 used headgear-activator combinations, and 2 used only Class II intermaxillary elastics to correct the Class II relationship. Group 2 comprised 20 Class II Division 1 patients treated with 2 maxillary-first-premolar extractions (6 male, 14 female) with an initial mean age of 13.94 years (SD, 1.7; range, 10.91-17.83 years). The 2 maxillary premolar extraction approach consisted of extraoral headgear to reinforce anchorage, associated with fixed standard edgewise appliances.

Occlusal evaluation

The TPI was calculated on each patient's posttreatment and pretreatment dental study models, according to Figure 1. The TPI index provides weighted subscores to describe overjet, vertical overbite or open bite, tooth displacement, and posterior crossbite, as well as summary scores reflecting the overall severity of the malocclusion. With the exception of rotation and displacement, all TPI components are measured along a continuous scale from positive to negative values. Thus, mandibular overjet and open bite are entered as negative overjet and negative overbite, respectively. A constant corresponding to molar occlusion is added to the TPI score. Total scores on the TPI range from 0 to 10 or more, with higher scores representing more severe malocclusions.[30,31]

The TPI components are defined as follows[30,31]:

1. Overjet: anterior distance from the most mesial part of the labial surface of the maxillary central incisor to the labial surface of the opposing mandibular incisor, measured perpendicularly to the coronal plane.
2. Overbite or open bite: with the dental models in centric (convenience) occlusion, the amount of vertical overlap of the maxillary central incisor over the mandibular central incisor taken as a ratio of the total crown height (cervix to incisal edge) of the mandibular incisor.
3. Tooth displacement: the sum of the number of teeth noticeably rotated or displaced from ideal alignment, plus 2 times the number of teeth rotated more than 45° or displaced more than 2 mm.
4. First-molar relationship: a constant comprising the severity of the malocclusion and based on the relationship between the maxillary and mandibular first molars.
5. Posterior crossbite: a measure of buccolingual deviation in the occlusion of the postcanine teeth, positive for buccal crossbite (first molar positioned too far to the buccal aspect) and negative for lingual crossbite. Crossbite is also scored as the number of teeth deviating from ideal cusp-to-fossa fit by a cusp-to-cusp relationship or worse.[30,31]

Two copies of Figure 1 were required for calculating each patient's TPI. On the first, the achieved value showed the final occlusal status after orthodontic treatment, with the initial severity of the malocclusion on the second. The improvement in malocclusion was calculated as the difference between the TPI values. In the 2 maxillary premolar extraction patients, it was assumed that a Class II molar relationship after treatment would be classified as a neutral relationship in the TPI because this is the correct posterior tooth arrangement to provide a normal relationship of the anterior teeth in this treatment approach.

Characteristics of the interdental relationships of each patient were separately evaluated for both groups because, when they are combined in the TPI, an improvement in one might be neutralized by lack of improvement in the other, and therefore the overall comparison of the index will not show these differences.[32,33] Final and initial values were achieved for overjet and overbite in millimeters. These variables are described below.

1. Overjet: horizontal distance between the labial aspect of the mandibular incisor and the labial aspect of the most prominent maxillary incisor at the final and initial stages.
2. Overbite: the vertical distance between the incisal edge of the mandibular incisor to the projection of the incisal edge of the maxillary incisor on the labial surface of the mandibular incisor at the final and initial stages.

First molar relationship Select the appropriate column	(6) Distocclusion				NEUTRAL	(7) Mesiocclusion				WEIGHTS	Syndrome Type
	Full Cl II both sides	½ Cl II 1 side and full Cl II other side	½ Cl II both sides or full Cl II 1 side	½ Cl II 1 side		½ Cl III 1 side	½ Cl III both sides or full Cl III 1 side	½ Cl III 1 side and full Cl III other side	Full Cl III both sides		
Incisor horizontal relationship (mm)											
(1) upper overjet 9+	2.0	3.4	5.4	9.3	10+	9.3	5.4	3.4	2.0		Retrognathism
9	1.4	2.5	4.0	6.9	10+	6.9	4.0	2.5	1.4		
8	1.0	1.8	2.8	4.8	8.0	4.8	2.8	1.8	1.0		
7	.6	1.1	1.8	3.0	5.1	3.0	1.8	1.1	.6		
6	.4	.6	1.0	1.7	2.9	1.7	1.0	.6	.4		
5	.2	.3	.4	.8	1.3	.8	.4	.3	.2		
2-4 mm											
NORMAL Score = 0											
(2) lower overjet 1	.2	.3	.4	.8	1.3	.8	.4	.3	.2		Prognathism
0	.4	.6	1.0	1.7	2.9	1.7	1.0	.6	.4		
1	.6	1.1	1.8	3.0	5.	3.0	1.8	1.1	.6		
2	1.0	1.8	2.8	4.8	8.0	4.8	2.8	1.8	1.0		
3	1.4	2.5	4.0	6.9	10+	6.9	4.0	2.5	1.4		
3+	2.0	3.4	5.4	9.3	10+	9.3	5.4	3.4	2.0		
Incisor vertical relationship bite 3/3+	2.9	3.8	4.8	6.2	8.0	6.2	4.8	3.8	2.9		Overbite
(3) overbite 2/3-3/3	1.5	2.0	2.4	3.2	4.1	3.2	2.4	2.0	1.5		
in relation to 1/3-2/3	.5	.7	.9	1.1	1.5	1.1	.9	.7	.5		
crown thirds 0-1/3											
NORMAL Score = 0											
<2	1.5	2.0	2.4	3.2	4.1	3.2	2.4	2.0	1.5		Open bite
(4) open bite 2-4	2.9	3.8	4.87	6.2	8.0	6.2	4.8	3.8	2.9		
in mm 4+	4.9	6.3	.9	10+	10+	10+	7.9	6.3	4.9		
(10) Calculation of dental displacement											Distocclusion and/or posterior buccal crossbite
- sum of 45º-rotated teeth or 2-mm displaced 2											
3	.1	.1	.2	.3	.4	.3	.2	.1	.1		It may be:
4	.2	.3	.4	.7	1.1	.7	.4	.3	.2		**YES:** - maxilla
- sum of >45º-rotated teeth or >2-mm displaced 5	.3	.5	.9	1.2	1.9	1.2	.9	.5	.3		- expansion
6	.5	.8	1.2	1.9	3.0	1.9	1.2	.8	.5		- Brodie's syndrome
7	.7	1.1	1.8	2.8	4.3	2.8	1.8	1.1	.7		**NO:** - maxilla
- total (0, 1 with no calculation) 8	1.0	1.5	2.4	3.9	5.9	3.9	2.4	1.5	1.0		- collapse
9	1.3	1.9	3.1	4.9	7.7	4.9	3.1	1.9	1.3		- posterior crossbite
9+	1.7	2.5	4.1	6.2	9.7	6.2	4.1	2.5	1.7		
Calculation	2.0	3.0	4.9	7.7	10+	7.7	4.9	3.0	2.0		
Constants	5.17	3.95	2.72	1.50	0.27	1.50	2.72	3.95	5.17		

(8) Sum of number of teeth in posterior crossbite

		Mx Post Teeth buccally tipped #	0	1	2	3	4	5	6	7	8	More
		Weight	0	.1	.6	1.3	2.2	3.5	5.0	6.9	9.0	10
		Mx Post Teeth lingually tipped #	0	1	2	3	4	5	6	More		
		Weight	0	.3	1.0	2.3	4.2	6.5	9.4	10		

Sum of the weights represents the treatment priority index =
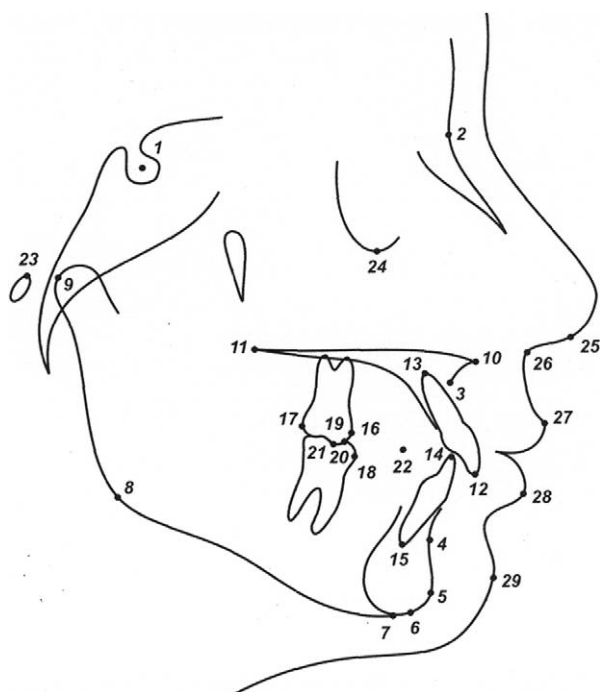
Fig 1. TPI data collection form.

Fig 2. Cephalometric landmarks used on lateral tracings: *1,* sella turcica (S); *2,* nasion (N); *3,* subspinale (A); *4,* supramentale (B); *5,* pogonion (P); *6,* gnathion (Gn); *7,* menton (Me); *8,* gonion (Go); *9,* condylion (Co); *10,* anterior nasal spine (ANS); *11,* posterior nasal spine (PNS); *12,* maxillary central incisor edge (MxIE); *13,* maxillary central incisor apex (MxIA); *14,* mandibular central incisor edge (MdIE); *15,* mandibular central incisor apex (MdIA); *16,* maxillary first molar mesial surface (MxMMS); *17,* maxillary first molar distal surface (MxMDS); *18,* mandibular first molar mesial surface (MdMMS); *19,* maxillary first molar mesial cusp (MxMMC); *20,* mandibular first molar mesial cusp (MdMMC); *21,* occlusal contact of first molars (OCM1); *22,* occlusal contact of premolars (OCPM); *23,* porion (Po); *24,* orbitale (Or); *25,* columella (Cl); *26,* subnasale (Sn); *27,* labrale superius (LS); *28,* labrale inferius (LI); *29,* soft-tissue pogonion (P′).

Cephalometric evaluation

Anatomic tracing and the location of dentoskeletal landmarks were manually carried out by 1 investigator (J.T.A.G.) and then digitized (Numonics AccuGrid XNT, model A30TL.F, Numonics Corporation, Montgomeryville, Pa) (Fig 2, Tables I and II). These data were then stored in a computer and analyzed with Dentofacial Planner (version 7.02, Dentofacial Planner Software, Toronto, Ontario, Canada). This software also corrected the magnification factors of the radiographic image of the patients that were 6%, 7.4%, and 9.8%, depending on which x-ray machine they had been taken.

Table I. Skeletal cephalometric variables

Maxillary	
SNA	SN to NA angle
Co-A	Condylion to A-point distance
A-Nperp	A-point to nasion-perpendicular
Mandibular	
SNB	SN to NB angle
Co-Gn	Condylion to gnathion distance
B-Nperp	B-point to nasion-perpendicular
P-Nperp	P-point to nasion-perpendicular
Maxillomandibular	
ANB angle	NA to NB angle
Dif. Co-A/Co-Gn	Maxillomandibular difference
Wits	Distance between perpendicular projections of Points A and B on functional occlusal plane
NAP	NA to AP angle (convexity angle)
Vertical components	
SN.GoGn	SN to GoGn angle
FMA	Frankfort mandibular plane angle
NS.Gn	Angle between lines NS and SGn
PFH (posterior face height)	Distance from sella turcica to gonion
TAFH (total anterior face height)	Distance from nasion to menton
PFH/TAFH	Proportion between PFH and TAFH
LAFH	Distance from anterior nasal spine to menton

Twenty randomly selected patients from both groups had their dental casts remeasured and radiographs retraced, redigitized, and remeasured by the same examiner. The casual error was calculated according to Dahlberg's formula ($S^2 = \Sigma^2 d/2n$),[34] where S^2 is the error variance, and d is the difference between the 2 determinations of the same variable and the systematic error with dependent *t* test,[35] at $P < .05$.

Statistical analyses

The independent *t* test was used to evaluate compatibility between the occlusal characteristics of the groups after treatment and to compare their initial occlusal and cephalometric severities. The test of differences between percentages was used to compare the sex distribution in the groups. Results were considered to be statistically significant at $P < .05$.

RESULTS

No systematic errors were detected. The range of casual errors varied from 0.21 to 2.56, with 31 variables below 1° or 1 mm, 4 below 2° or 2 mm, and only 2 variables above this level. The groups were compatible regarding initial age, final occlusal characteristics, and sex distribution (Table III). The occlusal and cephalometric results showed greater malocclusion severity for

Table II. Dental and soft-tissue cephalometric variables

Maxillary
  U1.NA — Maxillary incisor long axis to NA angle
  U1-NA — Distance between most anterior point of crown of maxillary incisor and NA line
  U1.PP — Maxillary incisor long axis to palatal plane angle
  U6-PP — Perpendicular distance between mesial cusp of maxillary first molar and palatal plane

Mandibular
  L1.NB — Mandibular incisor long axis to NB angle
  L1-NB — Distance between most anterior point of crown of mandibular incisor and NB line
  IMPA — Incisor mandibular plane angle
  L6-MP — Perpendicular distance between mesial cusp of mandibular first molar and mandibular plane
  L6-PTV — Perpendicular distance between mesial cusp of mandibular first molar and line perpendicular to Frankfurt plane, tangent to pterygomaxillary fissure distal surface

Maxillomandibular
  Overjet — Distance between incisal edges of maxillary and mandibular central incisors, parallel to occlusal plane
  Overbite — Distance between incisal edges of maxillary and mandibular central incisors, perpendicular to occlusal plane
  U1.L1 — Angle between long axis of maxillary and mandibular incisors
  M.REL (molar relationship) — Distance between mesial cusps of maxillary and mandibular first molars, parallel to functional occlusal plane

Soft tissue
  Nasolabial angle — Angle between landmarks Cl.Sn.LS
  Upper lip protrusion — Distance from most anterior point of upper lip to S line
  Lower lip protrusion — Distance from most anterior point of lower lip to S line

Table III. Results of *t* test between initial age and between final occlusal characteristics of groups and difference between sex distribution in groups (compatibility tests)

Variable	Group 1 (n = 42)		Group 2 (n = 20)		P
	Mean	SD	Mean	SD	
Initial age (y)	12.84	2.43	13.94	1.7	.07
Final TPI	1.74	0.97	1.35	1.13	.1670
Final overjet (mm)	1.55	0.77	1.75	1.07	.3990
Final overbite (mm)	2.05	1.01	2.15	0.81	.6930
	Male	Female	Male	Female	
Sex distribution (%)	45.24	54.76	70.0	30.0	.0727

Division 1 and 10 had Division 2 malocclusions. After excluding patients treated with various treatment approaches, those with agenesis, those who abandoned treatment, and some with incomplete records, the final groups included 42 nonextraction subjects and 20 with 2 maxillary-first-premolar extractions. Although group 1 had sufficient subjects, group 2 can be criticized for having only 20. This resulted from randomizing the experiment and selecting patients who fulfilled the established criteria from the 2 classes.

Because this study was reversely designed—its objective was to compare the initial characteristics of Class II Division 1 subjects having good orthodontic results with both treatment protocols—it follows that the groups would be occlusally compatible at their final stages. It was not believed that the groups should be statistically compatible at the end of treatment because some differences are always expected in the final cephalometric variables with these 2 treatment approaches.[1] But, in spite of different final cephalometric variables, the occlusal results in well-finished cases with these 2 approaches had to be similar. Table III shows that the groups were compatible because there were no statistically significant differences in the final TPI, overjet, and overbite. Despite apparent dissimilarities in sex distribution, the test of differences between percentages did not show a statistically significant difference between the groups.

Study design

The best way to evaluate occlusal outcome and initial malocclusion severity would be direct clinical evaluation of each patient.[32] However, this type of evaluation would be almost impossible because of the study's retrospective design. It is obvious that the initial status of the malocclusion could not be obtained through this type of evaluation at the time of the investigation. Even if the initial status of the occlusion

the 2 maxillary premolar extraction group (group 2) than the nonextraction group (group 1) (Table IV).

DISCUSSION
Sample selection and compatibility of the groups

To have an unbiased representative sample of Class II Division 1 malocclusions treated with or without 2 maxillary premolar extractions from the orthodontic department files, we decided to draw the sample from all patients who were treated during 2 specialty program classes that began in 1995 and 1997. With this rationale, the primary selection criterion was good orthodontic treatment results. From the total of 230 patients, 144 had Class II malocclusions, 78 had Class I malocclusions, and 8 had Class III malocclusions. Among the Class II malocclusion patients, 134 had

Table IV. Results of *t* test between initial occlusal and cephalometric characteristics

	Group 1 (n = 42)		Group 2 (n = 20)			
Measurement	*Mean*	*SD*	*Mean*	*SD*	*t*	P
Occlusal characteristics						
Initial TPI	5.94	2.17	7.12	1.09	−2.30	.025
Initial overjet	4.19	1.71	6.10	2.61	−3.44	.001
Initial overbite	2.76	2.24	3.55	2.11	−1.31	.192
TPI changes	4.20	2.52	5.77	1.40	2.59	.011
Skeletal cephalometric variables						
Maxillary component						
SNA	81.59	4.32	80.76	5.14	0.66	.509
Co-A	104.77	5.97	106.71	5.26	−1.25	.217
A-Nperp	0.70	3.44	0.39	3.29	0.34	.734
Mandibular component						
SNB	76.95	4.14	76.96	4.47	−0.01	.989
Co-Gn	83.34	4.13	84.51	3.99	−1.06	.293
B-Nperp	−5.99	5.35	−5.26	5.44	−0.49	.623
Pg-Nperp	−4.75	6.04	−3.09	6.14	−1.01	.317
Maxillomandibular relationships						
ANB	4.66	2.19	3.81	2.02	1.46	.148
Dif. Co-A/Co-Gn	21.43	4.32	22.22	4.97	−0.64	.522
Wits	2.31	2.49	4.04	2.10	−2.67	.009
NAP	7.26	4.99	4.65	4.88	1.94	.056
Vertical components						
SN GoGn	34.36	5.43	30.61	6.28	2.42	.018
FMA	25.34	4.70	20.74	5.37	3.44	.001
NS.Gn	59.29	3.22	57.74	3.04	1.81	.075
PFH	68.59	5.33	73.25	5.72	−3.15	.002
TAFH	109.81	6.65	110.65	6.66	−0.46	.645
PFH:TAFH	62.55	4.47	66.36	5.86	−2.84	.006
LAFH	59.40	4.66	60.07	4.72	−0.53	.598
Dental cephalometric variables						
Maxillary dentoalveolar component						
U1.NA	23.46	5.66	26.59	8.40	−1.73	.088
U1-NA	4.31	2.44	6.16	3.22	−2.52	.014
U1.PP	111.79	4.32	113.56	8.48	−1.09	.280
U6-PP	20.97	2.21	22.82	2.25	−3.06	.003
Mandibular dentoalveolar component						
L1.NB	26.92	5.98	24.33	5.58	1.63	.108
L1-NB	5.22	1.93	4.41	1.29	1.71	.092
IMPA	93.68	7.67	94.84	7.37	−0.56	.573
L6-MP	27.61	2.39	28.14	1.99	−0.85	.398
L6-PTV	14.51	3.53	17.84	8.07	−2.26	.027
Dentoalveolar relationships						
Overjet	4.82	1.42	6.46	2.53	−3.27	.001
Overbite	3.32	2.04	3.83	2.69	−0.83	.407
U1.L1	124.96	8.69	125.29	10.68	−0.13	.898
Molar relationship	−0.51	1.52	1.15	1.37	−4.15	.000
Soft tissue						
Nasolabial angle	109.42	9.52	107.73	12.13	0.60	.552
Upper lip protrusion	4.05	1.48	4.50	2.08	−0.98	.331
Lower lip protrusion	3.12	1.80	2.82	2.12	0.59	.560

had been obtained before, through direct clinical evaluation, other problems in obtaining the final status would be apparent. The first problem would be to track the patients some years after treatment. Many might have changed addresses or moved to other cities. Even if a significant number of patients could attend, evaluation of treatment results would be affected by possible relapses or subsequent dental losses after many years.[36,37]

The TPI, as developed by Grainger,[29] was selected among other indexes[32,33,38,39] because it allows for

Table V. Levels of severity and treatment needs of malocclusion as established by TPI

Interpretation	TPI	Range
1. Virtually classic "normal" occlusion	0	
2. Minor manifestations of malocclusion; treatment need is slight	1-3	≤3.99
3. Defined malocclusion, treatment elective	4-6	4-6.99
4. Severe handicap, treatment highly desirable	7-9	7-9.99
5. Very severe handicap, treatment mandatory	>10	>10

dental-cast evaluation, is compatible with the patients' initial mean age, and contains measurable items that describe the occlusal anomaly, except for factors related to their causes (eg, finger sucking).[33] The most commonly used indexes, despite providing reasonably specific data in relation to others, are valid for determining treatment priorities. Yet the TPI is particularly applicable for comparison of orthodontic treatment results,[32,33] and it is a good epidemiological indicator.[32] With this index, it was possible to evaluate occlusal condition after treatment, malocclusion severity before treatment, and improvement achieved between the initial and final stages for posterior comparison between the groups. Moreover, this evaluation method was applied because its reliability has already been demonstrated.[32]

Occlusal results

The results showed that the initial TPI value and overjet were greater in the 2 maxillary premolar extraction group than in the nonextraction group (Table IV). Although overbite was also greater in group 2, it was not statistically significant. These results confirm the expectation that the 2 maxillary premolar extraction group would have more severe malocclusions than the nonextraction group.[25] The anteroposterior molar relationship has a large weight in the TPI score.[29] Because overjet was also statistically greater in group 2, and overjet is consequent to the anteroposterior malrelationship of the posterior segments, it seemed that the primary factor that differentiated the groups was the greater anteroposterior interarch discrepancy. Additionally, the initial TPI values of the 2 groups in Table V, which shows treatment needs based on the index, demonstrate that group 1 would be scored as level 3, characterizing a "defined malocclusion, treatment elective," and group 2 would be scored as level 4, characterizing a "severe handicap, treatment highly desirable." This supports the statement that most Class II malocclusions that respond favorably to nonextraction treatment with extraoral headgear and removable functional appliances have mild degrees of anteroposterior discrepancy.[19,25,40]

Prospective studies that have investigated removable appliance effects in nonextraction treatment also present samples comprising mild Class II malocclusions.[19,40] In the first study, the sample consisted of many half-Class II subjects; the author reported only 38% success with the bionator and 50% success with the headgear after phase 1.[40] Prospective studies demonstrating successful correction of complete Class II patients with functional appliances include those treated with the Herbst appliance, a fixed appliance that does not require patient compliance.[41] Additionally, the rate of success of nonextraction therapies for severe (complete) Class II malocclusions is quite low with removable appliances.[40,42] To emphasize these statements even more, Table IV also demonstrates that the change in TPI score was greater in group 2 than in group 1, showing the difference in treatment-approach effectiveness.

Cephalometric results

The cephalometric results confirmed the occlusal results, with group 2 having a greater anteroposterior apical base discrepancy (Wits), maxillary incisor protrusion, overjet, and molar anteroposterior relationship than group 1 (Table IV). However, group 1 had a greater vertical growth tendency regarding SN.GoGn, FMA, PFH, and PFH/TAFH (see Table I for definitions). It is known that, in a horizontal growth pattern, nonextraction treatment is more advisable, whereas, in a vertical growth pattern, extraction treatment is more favorable.[43-46] Therefore, this demonstrates that even when the growth pattern is favorable for nonextraction treatment in Class II malocclusions, its anteroposterior severity discrepancy plays a major role in the decision for a 2 maxillary premolar extraction approach. Additionally, this extraction protocol enables better vertical control to prevent autorotation of the mandible and provides a more favorable chin projection. Although no differences in the few soft-tissue variables were found between the groups, more specific studies should be conducted.

Clinical implications

According to our results, some important clinical conclusions can be drawn. To most effectively correct Class II Division 1 malocclusions, despite all other important factors in treatment planning,[5,25,47] one must consider the amount of anteroposterior correction that is necessary. In deciding how to treat these patients, one must take into account that the more severe the anteroposterior discrepancy, the greater the tendency for choosing the 2 maxillary premolar extraction option. This provides a more effective treatment with less

patient compliance[12-14] and without the inconvenience of treatment reevaluation and explanation to the parents.[15] This was supported by observation of the subjects during the sample selection in this study: 58 patients were initially planned to receive treatment without extractions, but only 42 (72.4%) were completed with this approach. This means that 16 (27.5%) nonextraction treatment plans were reversed to 2 premolar extraction protocols because of poor patient compliance in using the headgear or removable functional appliance to correct the Class II relationship. Therefore, it would be interesting to compare the compliance level, and the occlusal and cephalometric characteristics, of the nonextraction patients who were excluded because of poor results, to these subjects with good results in the future.

CONCLUSIONS

The null hypothesis was rejected because of differences in initial occlusal and anteroposterior cephalometric discrepancies between successfully treated Class II Division 1 patients without extractions and those treated with extraction of 2 maxillary premolars. Those treated with extractions had initially greater occlusal TPI values, overjets, cephalometric apical base anteroposterior discrepancies, maxillary incisor protrusions, and anteroposterior molar discrepancies than those treated without extractions.

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