Orthodontic treatment time in 2- and 4-premolar-extraction protocols

Guilherme Janson,a Fábio Rogério Torres Maria,b Sérgio Estelita Cavalcante Barros,b Marcos Roberto de Freitas,c and José Fernando Castanha Henriquesc
Bauru, São Paulo, Brazil

Introduction: The purpose of this study was to compare the treatment times of complete Class II malocclusions treated with 2- and 4-premolar-extraction protocols. Methods: Ninety-seven patients were selected and divided into 2 groups, according to the 2 extraction criteria. Group 1, treated with 2 maxillary premolar extractions, consisted of 49 patients (30 male, 19 female) with a mean age of 14.35 years. Group 2, treated with 4 premolar extractions, consisted of 48 patients (27 male, 21 female) with a mean age of 13.03 years. Treatment times of the groups were compared with the t test. Results: Treatment times were significantly shorter with the 2-premolar-extraction protocol compared with the 4-premolar-extraction protocol. Conclusions: Treatment time will be shorter and the occlusal results more predictable with a 2-premolar-extraction protocol compared with 4 premolar extractions. (Am J Orthod Dentofacial Orthop 2006;129:666-71)

Class II malocclusions can require different types of treatment when severity of the anteroposterior discrepancy, age, and patient compliance are considered.1 Options for correction of Class II malocclusion include headgear, fixed and removable functional appliances, fixed appliances with Class II elastics, extractions, and orthognathic surgery.2-5 Extractions can involve 2 maxillary premolars,6 or 2 maxillary and 2 mandibular premolars.7 It has been demonstrated that a 2-maxillary-premolar-extraction protocol provides a better occlusal success rate than the 4-premolar-extraction protocol.8

The number of teeth extracted and the severity of the malocclusion can influence treatment time.9 Because malocclusion severity is an inherent characteristic that cannot be controlled, efforts have been made to quantify the influence of extractions on the duration of orthodontic treatment.10,11 Investigations comparing treatment times between malocclusions treated with and without extractions demonstrated that the number of teeth removed is positively correlated to treatment time.10-15 In spite of this evidence, Class II treatment times of 2-maxillary-premolar-extraction and 4 premolar-extraction protocols have not been compared. Therefore, our objective was to test the following null hypothesis: complete Class II treatment time is similar in the 2-maxillary and 4-premolar-extraction protocols.

MATERIAL AND METHODS

The sample was retrospectively selected from the files of over 2000 treated patients at the Orthodontic Department at Bauru Dental School, University of São Paulo, Brazil. Records and the initial dental study models of all patients who initially had complete bilateral Angle Class II malocclusions (molar relationship) and were treated with 2 maxillary premolar extractions or 2 maxillary and 2 mandibular premolar extractions, and standard fixed edgewise appliances were selected and divided into 2 groups. Sample selection was based exclusively on the initial anteroposterior dental relationship, regardless of any other dentoalveolar or skeletal characteristic. Additionally, patients had all permanent teeth up to the first molars, with no tooth agenesis or supernumerary teeth.

Group 1 consisted of 49 patients treated with 2 first maxillary premolar extractions (30 male, 19 female) at an initial mean age of 14.35 years (range, 9.42-27.08 years). Forty-three had Class II Division 1 malocclusions, and 6 had Class II Division 2 malocclusions. Their treatment plans included the extraction of 2 maxillary premolars. Patients with nonextraction treatment plans were excluded.

From the Department of Orthodontics, Bauru Dental School, University of São Paulo, Bauru, São Paulo, Brazil.
aAssociate professor.
bGraduate student.
cProfessor.

Based on research by Dr Fábio Rogério Torres Maria in partial fulfillment of the requirements for the degree of Master of Science in Orthodontics at Bauru Dental School, University of São Paulo.

Reprint requests to: Dr Guilherme Janson, Department of Orthodontics, Bauru Dental School, University of São Paulo, Alameda Octávio Pinheiro Brissola 9-75, Bauru, SP, 17012-901, Brazil; e-mail, jansong@travelnet.com.br.

Submitted, July 2004; revised and accepted, September 2004.

0889-5406/$32.00

Copyright © 2006 by the American Association of Orthodontists.

666
Group 2 consisted of 48 patients with Class II Division 1 malocclusions, treated with 4 premolar extractions (27 male, 21 female) at an initial mean age of 13.03 years (range, 10.67-18.33 years). Thirty-five were treated with 4 first premolar extractions, 11 were treated with first maxillary premolars and second mandibular premolar extractions, 1 was treated with 4 second premolar extractions, and 1 was treated with first and second maxillary premolar extractions on the left and right quadrants, respectively, and first mandibular premolar extractions.

The mechanics used with the standard fixed edgewise appliances included 0.022 x 0.028-in conventional brackets (not preadjusted), associated with extraoral headgear and lip bumpers to reinforce anchorage for the maxillary and mandibular teeth, respectively, when necessary. Class II elastics were also used when applicable, especially in the 4 premolar-extraction protocol, to aid in correcting the Class II anteroposterior relationship. There was no anchorage preparation. The usual wire sequence began with a 0.015-in twist-flex or 0.016-in nitinol wire, followed by 0.016, 0.018, 0.020-in and, finally, 0.021 x 0.025-in or 0.018 x 0.025-in stainless steel wires (Unitek, Monrovia, Calif). In extraction treatment, the canines are initially retracted a small amount to allow space for leveling and aligning of the anterior teeth. The anterior teeth were retracted en masse with the rectangular wire, after leveling and aligning. If a 0.021 x 0.025-in wire was being used, the dimensions of the rectangular wire were electrolytically reduced in the posterior segments to reduce the friction forces with the brackets and tubes. The canines and anterior teeth were retracted with elastic chains. Deep overbites were usually corrected by reversing and accentuating the curve of Spee of the stainless steel archwires until obtaining overcorrection. This overcorrection was maintained by accentuating and reversing the curve of Spee in the rectangular wire as well. Fixed or removable functional appliances were not used.

From the patient records, the following information was obtained: initial age, sex, date of treatment onset, date of treatment completion, and total treatment time. To evaluate the initial malocclusion severity compatibility of the groups, the initial treatment priority index (TPI)\(^{16}\) and the amount of mandibular crowding were blindly calculated on the pretreatment dental study models of each patient. The TPI index provides weighted subscores for overjet, vertical overbite or open bite, tooth displacement, and posterior crossbite, as well as summary scores reflecting the overall severity of malocclusion. With the exception of rotation and displacement, all TPI components were 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 the first-molar relationship was added to the TPI score. Total scores on the TPI ranged from 0 to 10 or more, with higher scores representing more severe malocclusions.\(^{17,18}\)

TPI components were defined as follows.\(^{17,18}\)

- 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.
- 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.
- 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.
- First-molar relationship: a constant comprising the severity of the malocclusion, based on the relationship between the maxillary and mandibular first molars.
- Posterior crossbite: buccolingual deviation in occlusion of postcanine teeth. The measurement is positive for buccal crossbite (first molar positioned too far to the buccal side) or negative for lingual crossbite. Crossbite is also scored as the number of teeth deviating from ideal cusp-to-fossa fit by cusp-to-cusp relation or worse.\(^{17,18}\)

Mandibular crowding of the initial dental study models was calculated as the difference between arch length (circumference, from left to right first molars) and the sum of tooth widths from first molar to first molar, in millimeters. In a well-aligned arch, arch length was equal to the sum of the tooth widths. Negative values indicated crowding.

**Error study**

Twenty pairs of dental study models were randomly remeasured by the same examiner (F.R.T.M.), for the TPI and the mandibular-crowding evaluations. The casual error was calculated according to Dahlberg’s formula\(^ {19} \)\( S^2 = \Sigma d^2 / 2n \), 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,\(^ {20} \) for \( P < .05 \).
Means and standard deviations for each variable were calculated to enable characterization of both groups. *T* tests were used to compare initial age, TPI, mandibular crowding, and the treatment times of the groups. Because mandibular anterior crowding can influence extraction decisions in the mandibular arch and treatment times, the groups were divided into subgroups without crowding. Therefore, these subgroups were similarly compared to eliminate the influence of crowding in the treatment-time results. Results were considered significant at *P* < .05.

### RESULTS

There were no systematic errors in the TPI and initial mandibular crowding evaluation (Table I). The casual errors were within acceptable levels. The groups were compatible regarding initial TPI, but the subjects in group 2 had more crowding and younger initial ages than those in group 1. Treatment times were also longer in group 2 (Table II). When the groups were divided into noncrowded subgroups, their initial age and TPI were compatible, but treatment time in subgroup 2 was longer than in subgroup 1 (Table III).

### DISCUSSION

The subjects were selected on the basis of having complete bilateral Class II malocclusions, independently of cephalometric skeletal characteristics. Because both groups were similarly chosen, it could be expected that these characteristics would be evenly distributed among them. Usually, it is not the skeletal characteristics of a Class II malocclusion that primarily determine whether it should be treated with 2 or 4 premolar extractions but, rather, the dentoalveolar characteristics.

Regarding the initial compatibility of the 2 groups, Table II shows no statistically significant differences in initial TPI between groups. However, the statistically significant difference between the initial crowding of both groups might influence the decision between the treatment protocols and perhaps treatment time. The greater the mandibular crowding, the greater the tendency for a 4-premolar-extraction protocol. For that reason, the groups were divided into subgroups without crowding; they were compared with the *t* test to investigate any interference of this initial difference in the results. The 6 Class II Division 2 subjects in group 1 and none in group 2 should not cause incompatibility of the groups, because the larger score of the TPI from a larger overjet in the Division 1 subjects would be compensated by the larger overbite of the Division 2 subjects. Accordingly, the anchorage reinforcement would also be similar because of the greater labial crown torque that should be applied to the maxillary incisors to correct their inclination and to retract them in the Class II Division 2 subjects.

Group 1 had a significantly shorter treatment time than group 2 (Table II). This result corroborates the findings of several studies in which shorter treatment times were related to protocols with fewer extractions. Group 1 patients had a significantly higher age range than group 2; this tends to make Class II treatment more difficult and consequently longer, as found in previous studies. However, the results suggested otherwise, and this age difference even corroborated them. Comparing the subgroups without initial crowding demonstrated a similar tendency (Table III). Treatment time in the noncrowded subgroup 2 tended to be slightly greater than that in group 2 (Tables II and III). This tendency opposes previous speculations.

---

**Table I. Results of error study**

<table>
<thead>
<tr>
<th>Variable</th>
<th>First measurement Mean</th>
<th>SD</th>
<th>Second measurement Mean</th>
<th>SD</th>
<th><em>P</em> Dahlberg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPI</td>
<td>8.37</td>
<td>1.17</td>
<td>8.35</td>
<td>1.08</td>
<td>0.804</td>
</tr>
<tr>
<td>Initial MC</td>
<td>2.55</td>
<td>3.04</td>
<td>2.45</td>
<td>2.71</td>
<td>0.587</td>
</tr>
</tbody>
</table>

MC, Mandibular crowding (mm).

**Table II. Results of *t* test between groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1 (n = 49) Mean</th>
<th>SD</th>
<th>Group 2 (n = 48) Mean</th>
<th>SD</th>
<th><em>t</em></th>
<th><em>P</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial TPI</td>
<td>7.94</td>
<td>1.29</td>
<td>8.21</td>
<td>1.09</td>
<td>−0.11</td>
<td>0.868</td>
</tr>
<tr>
<td>Initial MC</td>
<td>0.75</td>
<td>1.28</td>
<td>3.44</td>
<td>2.73</td>
<td>6.22</td>
<td>0.000*</td>
</tr>
<tr>
<td>Initial age (y)</td>
<td>14.35</td>
<td>2.79</td>
<td>13.03</td>
<td>1.68</td>
<td>2.79</td>
<td>0.006*</td>
</tr>
<tr>
<td>TT</td>
<td>23.52</td>
<td>5.86</td>
<td>28.12</td>
<td>7.59</td>
<td>−3.35</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

*Statistically significant *P* < .05.

MC, Mandibular crowding (mm); TT, treatment time (months).

**Table III. Results of *t* test between subgroups without crowding**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subgroup 1 (n = 35) Mean</th>
<th>SD</th>
<th>Subgroup 2 (n = 14) Mean</th>
<th>SD</th>
<th><em>t</em></th>
<th><em>P</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>14.10</td>
<td>2.26</td>
<td>13.23</td>
<td>1.83</td>
<td>1.28</td>
<td>0.204</td>
</tr>
<tr>
<td>Initial TPI</td>
<td>7.94</td>
<td>1.35</td>
<td>7.78</td>
<td>0.82</td>
<td>0.40</td>
<td>0.687</td>
</tr>
<tr>
<td>TT</td>
<td>24.35</td>
<td>5.64</td>
<td>30.13</td>
<td>8.89</td>
<td>−2.72</td>
<td>0.008*</td>
</tr>
</tbody>
</table>

*Statistically significant *P* < .05.

TT, Treatment time (months).
that crowding increases treatment time.\textsuperscript{25-27} Generally, it might be reasonable to expect that crowding would increase treatment time because it increases the severity of the malocclusion, which is more difficult to treat.\textsuperscript{11,32-34} However, this might not apply in every situation, especially when complete Class II malocclusion treatment protocols are being compared, such as in this study. It could be speculated that there was a tendency for treatment time to be shorter in group 2 than in the noncrowded subgroup 2 because, after the mandibular extractions in the crowded subjects, most of the spaces are used to correct crowding during the leveling and alignment phase, leaving minor spaces to be closed during the anterior en-masse retraction phase. On the other hand, in noncrowded subjects, in whom mandibular extractions were performed to correct incisor proclination, only small amounts of the spaces are closed during leveling and alignment, and most of the spaces are closed during the retraction phase. This would increase retraction time and overall treatment time. Further specific studies are necessary to confirm this speculation.

According to Fink and Smith,\textsuperscript{10} each premolar extraction accounts for an additional 0.9 months of treatment. Our study demonstrated that treatment time in the 4-premolar-extraction group was longer than the treatment time in the 2-maxillary-premolar protocol than would be expected, based on the study of Fink and Smith (Tables II and III). This suggests that other variables might influence treatment time in this comparison. It is speculated that this variable is the anteroposterior molar Class II relationship correction that is necessary in group 2. Patients must comply in using extraoral headgear or Class II elastics to correct Class II anteroposterior discrepancies.\textsuperscript{8,35-38} If the necessary compliance level is not obtained, the occlusal results are compromised,\textsuperscript{35,39} and treatment time will be increased.\textsuperscript{32} Previous studies that compared treatment times in extraction and nonextraction subjects did not distinguish between Class I and Class II malocclusions and did not compare 2- and 4-premolar-extraction protocols in complete Class II malocclusion corrections.\textsuperscript{10,11,13-15,28,29} According to this rationale, it would be expected that a Class II malocclusion treated with 2 premolar extractions could have a treatment time similar to that of 4-premolar extraction Class I treatment.\textsuperscript{40,41} The required time to close the maxillary extraction spaces in Class II patients would be similar to the time necessary to simultaneously close the maxillary and mandibular spaces in Class I patients. However, if 4 premolars are extracted in Class II malocclusions, treatment time is increased not because of the greater amount of space to be closed, but because of the Class II anteroposterior relationship that must be corrected;\textsuperscript{32} this depends on patient compliance in using headgear or Class II elastics.\textsuperscript{8,35,38,40}

Group 2 and subgroup 2 had treatment times that were 4.6 and 5.78 months longer than group 1 and subgroup 1, respectively. This might not be considered clinically significant, but, when patients or parents are very demanding, it might represent a doctor/patient/parents relationship problem. To be efficient, one must consider every aspect that can influence treatment time. The treatment protocol is only 1 aspect. If other variables that also cause minor treatment time increases act simultaneously, the overall increase could be clinically significant. Additionally, the patients were not selected based on excellent treatment outcomes. It has been suggested\textsuperscript{37,40} and demonstrated\textsuperscript{8} that in Class II patients the 4-premolar-extraction protocol has more complicated orthodontic mechanics, and therefore its occlusal success rate is lower than the 2-premolar-extraction protocol, especially in complete Class II malocclusions. The most difficult aspect to be corrected in the 4-premolar-extraction protocol is the Class II anteroposterior discrepancy. Therefore, because correction of anteroposterior discrepancies in complete Class II 4-premolar-extraction protocols requires more patient compliance, presumably treatment time in well-finished patients would be even longer, when compared with well-finished patients with 2-maxillary-premolar extractions; this should be investigated in the future.

Treatment times for both groups in this study were longer than reported in the literature.\textsuperscript{13,28,42} Perhaps this can be explained because graduate students treated them, whereas in the other investigations the patients were treated in private practices. It is speculated that treatment times are usually shorter in the hands of more experienced clinicians.\textsuperscript{32,43}

**Clinical implications**

Considering that the 4-premolar-extraction protocol for Class II malocclusion treatment usually has longer treatment times and less satisfactory occlusal success rates,\textsuperscript{8} because greater compliance is needed for the treatment mechanics than the 2-premolar-extraction protocol, it should be used in carefully selected patients. The decision in every treatment plan depends on a cost-benefit ratio.\textsuperscript{44} The orthodontic treatment goals usually include obtaining good facial balance, an optimal static and functional occlusion, and stable treatment results.\textsuperscript{12,45} Four pre-
molar extractions in complete Class II patients are usually used to correct crowding and incisor proclination, leading to these objectives. Nevertheless, because of the great orthodontic discrepancies and the patients’ primary concerns, optimal objectives cannot always be attained. Therefore, when considering the several variables involved, one must also consider the greater difficulty and time in obtaining a good occlusal result in complete Class II malocclusion treatment with the 4-premolar-extraction protocol. For example, it may be that to provide an optimal facial balance, a 4-premolar-extraction protocol in a complete Class II malocclusion would be the best option. However, because of the patient’s advanced age and poor compliance attitude, along with increased treatment time, a 2-premolar-extraction protocol would provide greater benefits and would be the selected treatment option. If the benefits of a 4-premolar-extraction protocol in Class II malocclusion treatment outweigh the time and the greater mechanical difficulty costs, it should be undertaken. Otherwise, a 2-premolar-extraction protocol should be preferred. The treatment objectives might be compromised, but treatment time will be shorter, and the occlusal results more predictable.

CONCLUSIONS

The null hypothesis was rejected because complete Class II treatment time with the 2-premolar-extraction protocol was significantly shorter than treatment time with the 4-premolar-extraction protocol.

REFERENCES