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Root Parallelism of Canine and Second Premolar in Pre-adjusted and Standard Edgewise Systems: A Comparative Study

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Abstract

Background: One of the main goals of standard orthodontic treatment is having the roots of teeth adjacent to extraction sites parallel to each other. The purpose of this study was to compare standard edgewise (SEW) and pre-adjusted straight wire (MBT) methods in achieving this goal. **Materials and Methods:** For comparing root parallelism, 228 maxillary quadrants and 225 mandibular quadrants of 127 patients in whom 1st premolar had been extracted during orthodontic treatment plan were evaluated. On pre and post-treatment panoramic views long axis of canines and 2nd premolars of each quadrant were traced and the angulations between them were measured to assess root parallelism. For comparing mean value of angulations measured in post-treatment views between MBT and SEW methods, independent T-test and for comparing root parallelism of canines and 2nd premolars Chi-square test were used. **Results:** Evaluating root movement and root parallelism of maxillary and mandibular canines and 2nd premolars did not show any statistically significant difference between treatment groups (P> 0.05). **Conclusion:** There was no difference between the two methods of MBT and SEW in achieving favorable root parallelism of teeth adjacent to extraction site. If each of these methods is used properly good root parallelism can be achieved in most of the cases**.[GMJ.2014;3(3):176-81]**

Keywords: Standard Edgewise; Pre-Adjusted Straight Wire; Root Parallelism; Tooth Extraction; Orthodontic Space Closure.

Introduction

Standard edgewise (SEW) and pre-adjusted straight wire (MBT) methods are two main fixed orthodontic systems currently used in orthodontic practice. There are few or no built-in pre-adjustments in the SEW system, rendering archwire adjustment necessary which may be time consuming, exhausting and imprecise [1]. Also, it was found that heavy space closure forces used in the traditional SEW system might result in an increased tendency for rolling in of teeth adjacent to extraction sites due to unwanted tip,

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rotation and torque changes [2]. In order to simplify the mechanics of treatment, overcome this time consuming wire bending and achieve reproducible and consistent treatment results, pre-adjusted appliances were developed [3]. One of the modifications of pre-adjusted straight wire appliances which is appropriate for the application of light and continuous force is the McLaughlin–Bennett–Trevisi (MBT) system [4,5].

Root angulation is used to determine the position of teeth in relation to one another [6]. During orthodontic treatment, teeth adjacent to the extraction site should be correctly positioned in the three planes of space. In other words, these teeth should have tight approximation and root paralleling should not be jeopardized [7, 8]. It has been demonstrated that in cases which the roots are not adequately parallel the space between adjacent teeth may reopen; stressing the importance of an appropriate axial inclination of teeth in achieving long term stability of orthodontic treatment [7-10]. Such relapses might cause aesthetic problems and functional inadequacies resulting from absence of interproximal contacts [7]. Root parallelism and the resulting stability is necessary to maintain the corrected occlusal relationships which amends distribution of the occlusal forces. By reducing the reopening of closed contact points between adjacent teeth, root parallelism has the added advantage of eliminating any additional trauma to the periodontium leading to enhanced periodontal prognosis. It has been observed from a restorative point of view that tight contacts between teeth prevent food impaction and subsequent trauma to gingival tissue [11]. Panoramic views are used extensively to assess root angulation and parallelism [7]. A survey in 2002 indicated that 79.1% of American orthodontists use panoramic radiographs for post treatment assessment [12]. In spite of its common use, measurements of root angulation obtained from panoramic analyses must be treated with caution. Panoramic views have been shown to incur a 22% error in the estimation of root angulation, a significant drawback which is more pronounced in the lower jaw [7].

In a study by Mayoral root parallelism of canines and 2nd premolars in 53 extraction cases of 1st premolars treated with light wires was assessed [9]. Results of this study show that the majority of cases (79 percent of cases in maxilla and 72.1 percent of cases in mandible) had favorable parallelism (defined as less than 10° divergence).

To our knowledge there is no published article comparing SEW and Straight wire methods in achieving favorable parallelism of teeth adjacent to extraction sites. We chose to compare the root parallelism of teeth adjacent to a closed extraction space between the straight wire method and SEW. It is common belief that the built-in tip in the straight wire brackets could potentially inhibit the unwanted position of the roots following space closure.

Materials and Methods

Sample: The following study was a historical cohort, analytic and observational study. One hundred and twenty seven patients were selected by convenient sampling method and among patients treated by two expert orthodontists. Extraction of 1st premolar at least in one quadrant as part of orthodontic treatment plan and having had pre and post-treatment panoramic views were inclusion criteria for patients participating in this study. Patients with treatment duration of more than 2 years were omitted from the study, as extended treatment times may have an effect on root parallelism. Demographic and treatment procedures' characteristics of selected patients were taken from their records. These characteristics included age, sex and duration of incorporating Class II and Class III elastics, utilization of maxillary and mandibular gable bends and maxillary and mandibular rectangular wires.

Treatment: The patients in the SEW group were bonded with 0.022 slot brackets (Standard Edgewsie, American Orthodontics, Sheboygan, WI). Leveling and aligning was achieved using a 0.016 NiTi wire followed by a succession of stainless steel wires from 0.014 to 0.018. The space closure was performed using sliding mechanics via an elastic chain separately for the canines and closing loops for the anterior teeth mainly on a 0.018

stainless steel wire; however, 0.016 x 0.022 stainless steel wire was used in the circumstances were excessive lingual tipping of the incisors was not desirable. The other group, were bonded with 0.022 brackets incorporating the MBT torque prescriptions (Master brackets, American Orthodontics, Sheboygan, WI). Leveling and aligning was initiated using a 0.016 NiTi wire, and according to the practitioner was either followed by a 0.014 or a 0.016 stainless steel wire. Practitioner A continued his aligning up to 0.017 × 0.025 stainless steel wire in every patient while practitioner B stopped at 0.016 × 0.022 wires. Space closure was used in the same manner as the SEW method, with canines retracted individually and the anterior teeth retracted via closing loops. In both treatment, gables were used as necessary when it was observed clinically that tipping was occurring during space closure. Inter-arch elastics were used in a case-specific fashion wherever needed. The wire sequence utilized by each of clinicians is listed in table-1 (American Orthodontics, Sheboygan, WI).

Radiographic analysis: In the panoramic views the long axes of canines and 2nd premolars were traced on a view box by one observer. For determination of the long axes of the teeth, incisal edge of canines and buccal cusp tip of 2nd premolars were connected to the apices of these teeth. The cases in which teeth were rotated the pathway of pulp was traced and used to represent the long axes of the teeth. Also, as rotated premolars might have two roots or root canals, identifying the long axes in these cases needed special consideration. In these teeth a line connecting tips of buccal and palatal cusps was drawn, then a line joining the midpoint of this line and apex (or midpoint of two apices) of the tooth was considered as long axis of these teeth [9]. Since in 4 patients the roots had severe dilacerations (i.e. dilacerations close to right angles with a faded apex), the coronal two thirds of the roots were traced as the long axis of those specific teeth. After tracing, the angulation between the long axes of canines and 2nd premolars in the same quadrant was measured by a single protractor (Student protractor with accuracy of 0.5 millimeter). All the measurements in this study were done 2 times with mean interval of 2 weeks.

After tracing the panoramic views, it was observed that in some cases the roots were quite parallel to each other and the angle between them was considered as 0°. In other cases the roots were diverged cervical or apical. In the former, the angulation was classified as negative and the latter was considered as positive angled. At the end, according to the classification described by Mayoral [9], the measured angulations of each jaw were allocated as good, acceptable, poor and over-treated parallelism

Statistical analysis: In order to assess concordance of 1st and 2nd time measurement of treatment outcomes Pearson correlation coefficient method was utilized. For comparing mean value of angulations measured in post-treatment views between the 2 methods of MBT and the SEW method, independent T-test was used. Also, in order to compare root parallelism of canines and 2nd premolars in post-treatment panoramic views between 2 methods of MBT and SEW, Chi-square test was utilized. Success rate of each treatment method in root parallelism was obtained by

Table 1. Wire Sequence Used by the Two Clinicians During Treatment Procedure.

Clinician A (MBT)	Clinician B (MBT)	Clinician B (SEW)
0.016 NiTi	0.016 NiTi	0.016 NiTi
0.016 Stainless Steel	0.014 Stainless Steel	0.014 Stainless Steel
0.018 Stainless Steel	0.016 Stainless Steel	0.016 Stainless Steel
0.016 * 0.022 Stainless Steel	0.018 Stainless Steel	0.018 Stainless Steel
0.017 * 0.025 Stainless Steel 0.019 * 0.025 NiTi	0.016 * 0.022 Stainless Steel	0.016 * 0.022 Stainless Steel or 0.019 * 0.025 Beta Ti

comparing the number of quadrants which had acceptable and good parallelism to number of quadrants which had poor parallelism or over-treatment angles. Independent T-test was used to compare the mean amount of root movement between 2 methods of MBT and SEW. The significance level for all of the aforementioned tests is P<0.05.

Results

The numbers of quadrants assessed for root parallelism are mentioned in table-2. Assessing reliability between 1st and 2nd time measurements showed an excellent correlation between them (correlation coefficient from 0.96 to 0.98; P<0.001). As there was high correlation between both measurements, we decided to evaluate the 1st time measurements.

The mean age for the MBT and SEW treatment groups was 17.73±5.40 and 16.46±5.49 respectively which did not demonstrate a significant difference (P=0.19). Furthermore the male/female ratio (M/F) was also insignificant (P=0.46) between the two groups.

Table-3 includes treatment characteristics of patients participating in this part of study. Class III elastic were used longer in SEW group than in MBT group. (P=0.047) However, maxillary and mandibular rectangular wires were used more in patients treated by MBT group (P<0.001).

Categorizing post-treatment angulation between canines and 2nd premolars of each quadrant to good, acceptable, poor and over-paralleled and mean value of angulation between them in upper and lower quadrants did not show any statistically significant difference between the two treatment groups (Table-4). Furthermore, mean value of post-treatment angulation between canine and 2ndpremolars in both arches did not show any statistically significant difference between these 2 treated groups (P=0.170 for maxillary quadrants; P=0.443 for mandibular quadrants).

No statistically significant difference was observed between MBT and SEW methods in both jaws in terms of the mean value of root movement of teeth adjacent to extraction sites (P=0.52).

Table 2. Number of Quadrants Assessed for Root Parallelism of Canines and 2nd Premolars in 1st Premolar Extraction Cases.

Quadrants	MBT	SEW	Total
Upper right	55	59	114
Upper left	55	59	114
Lower right	55	57	112
Lower left	56	57	113

Discussion

After categorizing post-treatment parallelism of canines and 2nd premolars of each quadrant to good, acceptable, poor and over-parallelism, no statistically significant differences were observed between both maxillary and mandibular quadrants in patients treated by MBT and SEW methods (P>0.05). It should be mentioned that in both treatment methods more than 68% of patients showed good and acceptable parallelism in both jaws (Table-4).

Table 3. Comparative Analysis of Treatment Procedure Duration in 1st Premolar Extraction Cases Assessed for Root Parallelism of Canines and 2nd Premolars.

Treatment procedures duration (day) Mean ± SD	**Group**		**P. value**
	MBT	SEW	
Class II elastic	117.93 ±165.27	90.08 ± 100.33	0.106
Class III elastic	13.93 ± 49.72	28.13 ± 62.97	0.047
Maxillary gable	1.14 ± 6.78	0.49 ± 3.91	0.511
Mandibular gable	7.19 ± 25.53	12.75 ± 29.33	0.257
Maxillary rectangular wire	88.38 ± 106.77	2.71 ± 21.54	<0.001
Mandibular rectangular wire	113.00 ± 129.11	3.59 ± 19.02	<0.001

Table 4. Comparative Analysis of Post-Treatment Angulation Between Canines and 2nd Premolars in 1st Premolar Extraction Cases.

Parallelism	Maxilla			Mandible		
	MBT N (%)	SEW N (%)	P value	MBT N (%)	SEW N (%)	P value
Good	62 (56.4)	60 (50.8)	0.207	62 (55.9)	65 (57)	0.563
Acceptable	15 (13.6)	21 (17.8)		26 (23.4)	19 (16.7)	
Poor	13 (11.8)	7 (5.9)		6 (5.4)	8 (7)	
Over	20 (18.2)	30 (25.4)		17 (15.3)	22 (19.3)	
Mean ± SD	1.03 ± 7.83	-0.37 ± 7.46	0.170	7.23 ± 8.39	6.35 ± 8.84	0.443

Also the mean value of post-treatment angulation between maxillary and mandibular canines and 2nd premolars did not show any statistically significant difference (P>0.05).
Furthermore, no statistically significant difference was observed between MBT and SEW method in both jaws in term of the mean amount of root movement of teeth adjacent to extraction sites (P>0.05).
Root parallelism plays an important role in establishing a good occlusal relationship and preventing relapses after orthodontic treatment.
Mayoral in 1982 evaluated root parallelism of canines and 2nd premolars in fifty-three 1st premolars extraction cases treated with light continuous wire [9]. The author states that round 0.016 stainless steel wires were used for space closure which is similar to the technique used in the SEW group in the present study where 0.018 round wires were used for this purpose. Also in both studies canine retraction was performed individually followed by the retraction of the anterior teeth as a unit. Furthermore instead of using gables Mayoral used up-righting springs whenever they were needed. In 78 % of assessed maxillary quadrants and 72.15 of mandibular quadrants good and acceptable root parallelism was obtained. Results of this study agree with our study that the orthodontic treatment in the majority of patients finishes with favorable parallelism between teeth adjacent to extraction sites (maxilla: 70% and 68% for MBT and SEW respectively; mandible: 79.8% and 73.7% for MBT and SEW; respectively).
The clinicians should notice that in response to too-rapid space closure, there is an increased tendency for rolling in of teeth adjacent to extraction sites [1].
Treatment mechanics such as size of rectangular wires and the incorporation duration of wires during treatment procedure might influence treatment results. Therefore, in order to compare these 2 methods more precisely, it would be better if these parameters are also taken in to consideration in subsequent studies. Another limitation of the study is that panoramic views were used to assess root parallelism. Several studies have discussed the limitations of using panoramic views in showing tooth angulations [12, 13]. Cone beam computed tomographies are better suited for this purpose [13]; however, the cost and the radiation exposure means that it's not usually included in the records of orthodontic patients.

Conclusion

MBT and SEW methods do not differ in achieving favorable root parallelism of teeth adjacent to extraction sites and if used properly favorable root parallelism can be achieved in most of the cases.

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