Levels of root resorption associated with continuous arch and sectional arch mechanics

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The purpose of this study was to evaluate differences in the extent of root resorption between continuous arch and sectional mechanics. Fifty-six persons with similar malocclusions requiring the extraction of four premolars were divided into two equal groups and treated with the two different techniques. Once the canines were retracted with sliding mechanics (continuous arch wire group) or with force driven retraction loops (sectional mechanics group), the anterior teeth were then retracted with 300 gm Sentalloy coil springs (GAC International, Central Islip, N.Y.). The extent of root resorption of the anterior teeth was evaluated radiographically. Both treatment groups exhibited the same levels of resorption indicating that the side effect of treatment may be due to individual variation and not to the "round tripping" of teeth so often assumed. (Am J Orthod Dentofac Orthop 1996;110:321-4.)

Root resorption is a frequent consequence of orthodontic tooth movement,[1-6] and not necessarily limited to specific techniques.[7-9] Maxillary incisors appear to be the most frequently and severely affected, although incidence of this pathologic response may also be seen in other areas of the dentition.[10]

Little doubt remains that orthodontic treatment can generate some degree of resorption. Teeth subjected to extensive movement in the correction of Class II malocclusions or during the closure of extraction spaces may be more susceptible to this phenomenon, however, no statistically significant correlation can be found between the severity of resorption and the extent of movement.[7,9] In an exhaustive review of this problem, Brezniak[11,12] points out the difficulties in studying this subject because of the different methods used and the variables that each case or study displays. In the current medicolegal climate, a resurgence of interest in this area has emerged. It is generally assumed that a variety of conditions may be related to root resorption, one of them being the mechanism used, especially if the teeth appear to have been "round tripped,"[10] during treatment. Assuming that this may be an important factor in resorption the present study was designed to test this hypothesis by using acceptable methods of therapy that inadvertently may provoke this response.

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MATERIALS AND METHODS

Fifty-six persons ranging in age from 11 years, 2 months to 14 years, 1 month, presenting with Class I malocclusions and anterior crowding that required the extraction of four first premolars were chosen for the study. All patients exhibited normal apical base relationships (ANB ranged from 2° to 4°, whereas the A-B:occlusal plane values ranged from −1 to +1 mm). Normal mandibular plane angles (SN-GoGn, 30° to 34°) and normal facial heights were also noted. None of the patients had a history of trauma to their teeth. These patients were then grouped alternately into two categories of treatment: Group 1 consisted of 8 boys and 20 girls treated with continuous arch wire mechanics and group 2 consisted of 16 boys and 12 girls treated with sectional canine retraction on 0.017 × 0.025 looped TMA (Ormco Corp., Glendora, Calif.). This allowed for the spontaneous unravelling of the anterior dentition.

All patients were treated with a programmed "Roth" prescription type appliance with 0.018 incisor slot size and 0.022 slot size in the remainder of the dentition. Those patients receiving the continuous arch appliance were initially levelled over a period of 20 to 24 weeks with 0.018 Ni-Ti (Ormco Corp., Glendora, Calif.) that was annealed and cinched behind the molar tubes. Canine retraction was accomplished through elastomeric chain on 0.018 × 0.022 stainless steel over a period of 22 to 26 weeks.

Once the canines were retracted fully, the remainder of the anterior retraction was accomplished with 300 gm Sentalloy coil springs (GAC International, Central Islip, N.Y.) through sliding mechanics for 40 to 48 weeks. Final detailing before debonding was achieved with 0.018 × 0.018 stainless steel for 6 to 10 weeks. Treatment length ranged from 22 to 27 months for both groups.

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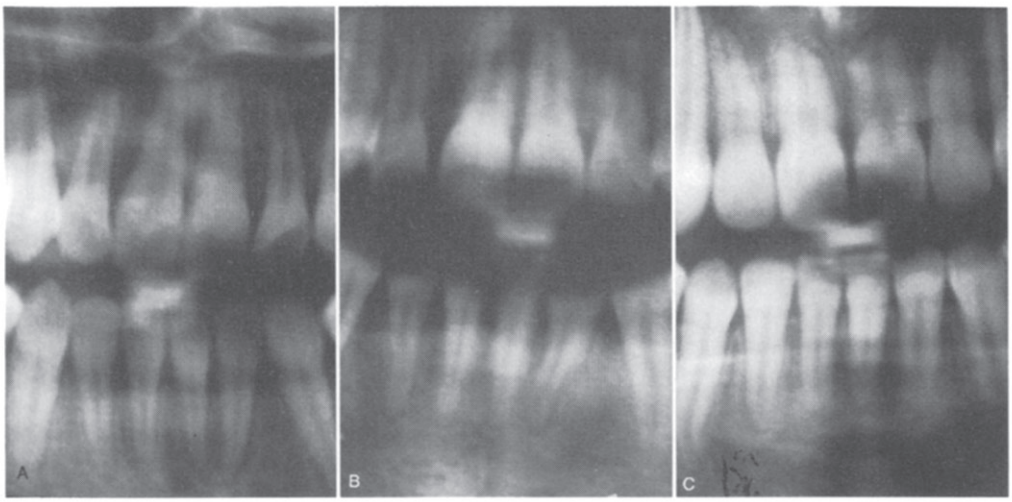

Fig. 1. A, Panoramic radiograph displaying slight blunting of root apex (Category 1). **B,** Panoramic radiograph displaying moderate blunting of root apex (Category 2). **C,** Panoramic radiograph displaying excessive blunting of root apex (Category 3).

Table I. Prevalence of root resorption using sectional or full archwire retraction methods

	Full arch wire treatment		*Sectional retraction*	
	Prevalence of r.r.	*%*	*Prevalence of r.r.*	*%*
Maxilla				
Central incisors	12/56	21	9/56	16
Lateral incisors	14/56	25	15/56	27
Mandible				
Central incisors	10/56	18	11/56	20
Lateral incisors	9/56	16	14/56	25
Total				
Maxillary	26/112	23	24/112	21
Mandibular	19/112	17	25/112	22

Prevalence of root resorption (r.r.) is derived by the number of roots resorbed/the number of roots examined.

Table II. Individual tooth severity scores of root resorption based on treatment mechanics

	Full arch wire treatment		*Sectional retraction*	
	Mean	*SE*	*Mean*	*SE*
Maxilla				
Central incisors	0.27*	0.06	0.29	0.08
Lateral incisors	0.39*	0.07	0.35	0.11
Mandible				
Central incisors	0.21	0.05	0.25	0.06
Lateral incisors	0.20	0.05	0.29	0.08
Total				
Maxillary	0.33	0.07	0.33	0.08
Mandibular	0.21	0.05	0.27	0.07

*t test $P < 0.05$.
Key
0 = no apical resorption; 1 = slight blunting.

Before treatment and immediately after debonding, panoramic and occlusal radiographs were taken to evaluate root resorption. Cephalometric radiographs were taken at the start and the completion of treatment to determine the amount and the direction of movement of the maxillary and mandibular incisors. The examination concentrated on the roots of the maxillary and mandibular incisors because these teeth are more commonly affected. The teeth were scored using the following four categories suggested by Sharpe et al.[13]

0 = No apical resorption
1 = Slight blunting of the apex root (Fig. 1, *A*)
2 = Moderate blunting of the root apex up to one-fourth of the root length (Fig. 1, *B*)
3 = Excessive blunting of the root apex beyond a fourth of the root length (Fig. 1, *C*)

The same Ritter Midwest Panoral (Des Plaines, Ill.) and Gendex GX900 (Gendex, Milwaukee, Wis.) machines were used to obtain the panoramic and occlusal films. The same operator was responsible for taking films.

Root resorption scores were determined for each subject by adding the resorption scores for all of the teeth examined. A mean group score was then calculated by using the sum of the scores for the 28 subjects within each group.[13] In addition, mean scores were calculated for each tooth type by using the sum of resorption scores for the specific tooth and the number of teeth of that

Table III. Average angular and linear changes associated with root resorption during continuous arch and sectional arch mechanics

Teeth	Angular change: During retraction full/sectional treatment (degrees)		Linear change: During retraction full/sectional treatment (mm)		Severity of root resorption full/sectional treatment	
Maxillary incisors	8.4	6	6	6	0.33 ± 0.07	0.33 ± 0.08
Mandibular incisors	5.6	5.2	4	5	0.21 ± 0.05	0.27 ± 0.07

RESULTS

The extent of root resorption from both sectional and full arch wire retraction methods was determined visually by radiographic assessment. Root resorption was high for the total sectional group (21% to 22%) and for the total full arch wire group (17% to 23%) as shown in Table I. Maxillary incisors showed a higher prevalence of resorption in both the full arch wire group and sectional treatment group.

The severity scores of root resorption are displayed in Table II. The maxillary incisors in both groups exhibited greater resorption albeit minimal when compared with the mandibular incisors. Difference in retraction mechanics showed no significantly greater resorption activity. However, a statistically significant difference in resorption severity between maxillary central and lateral incisors was observed in the full arch wire treatment group. Angular and linear changes of the maxillary and mandibular incisors showed no statistically significant difference because of retraction mechanics or to their resorption severity (Table III).

DISCUSSION

It is generally accepted that some level of root resorption will occur in patients undergoing orthodontic treatment. The amount of resorption reported in this study is in agreement with other reported findings in the population.[7,9,10,13] The maxillary incisors also appear to be highly susceptible to this insult.[14] Although many treatment factors have been related to this phenomenon,[9,11-12,15-18] the presence of "jiggling" movements or "round tripping" have anecdotally been stated as a cause for resorption without any hard evidence.[19] Reitan[6] and Wainwright[16] have both stated that root resorption is closely correlated with tipping movements. However if this was the case, all forms of tipping mechanics should show this side-effect of treatment, a finding that has not been seen in any greater prevalence than with other methods of tooth movement.[20]

Is root resorption a function of appliance design or mechanics used to finalize tooth position? Theoretically, sectional mechanics do not place any direct force on teeth unattached to the appliance and therefore should not direct any unnecessary forces on the anterior roots as canines are retracted. Initial full arch wire engagement of the dentition can inadvertently cause unphysiologic force levels on the roots and periodontium as the teeth unravel and flare. The *round tripping* term can then be applied as the teeth are retracted later in treatment. Root resorption as a result of full arch wire engagement of the anterior teeth was not observed in this study to any greater degree than in sectional retraction. Consequently, this may lead to the belief that root resorption is more of a function of individual susceptibility than a result of appliance design. It was interesting to note, however, that maxillary lateral incisor roots did show the highest levels of resorption that could reflect a relationship of their root structure combined with the tip built into the preangulated bracket system.

Although many clinicians believe that the extent of root resorption is directly related to the distance moved,[9,13,21,22] no such differences were seen in the two groups examined, although the maxillary incisors displayed a greater severity of resorption when compared with the mandibular incisors. This was in agreement with other reports.[11,12] Since no anterior intrusion mechanics were used in our subjects the interpretation of direct apical movement (vertical) in these patients combined with retraction mechanics (anteroposterior) cannot be made. It would be informative if a study was designed to relate the additive effects of these mechanics on the root anatomy during treatment. Since combinations of treatment objectives requiring intrusion and retraction are common, such a study may be more relative to actual treatment modalities along with their associated risks. In general, however, teeth placed in continuous arch mechanisms are at no greater risk of root resorption than those teeth that are

tive to actual treatment modalities along with their associated risks. In general, however, teeth placed in continuous arch mechanisms are at no greater risk of root resorption than those teeth that are engaged to the arch wire after the canines have been retracted with sectional mechanics.

CONCLUSION

The assumption that teeth subjected to continuous arch wire mechanics are more prone to resorption when compared with sectional mechanics may be erroneous. Similar pretreatment dental and skeletal values along with comparable distances of retraction and length of treatment time display the equivalent levels of root resorption when the two techniques are compared. Neither technique appeared to predispose the dentition to higher levels of risk. Interestingly, the maxillary lateral incisors showed the highest level of resorption that may be due to their root structure or other iatrogenic or idiopathic factors. Future studies should explore changes that take place in the second and third order angulation of individual anterior teeth, as well as a combination of treatment mechanics that may further impact on this ubiquitous observation of root resorption.

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