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Buccal bone plate thickness after rapid maxillary expansion in mixed and permanent dentitions

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Introduction: Rapid maxillary expansion (RME) might cause buccal displacement of anchor teeth. Dislocation of teeth outside their alveolar process can damage the periodontium; for this reason, maxillary expansion using deciduous teeth as anchorage in the mixed dentition might be suggested. The aim of this study was to compare changes of buccal bone plate thickness on the maxillary permanent first molars after RME in the mixed and permanent dentitions with different types of anchorage. **Methods:** Two groups of patients were evaluated with cone-beam computed tomography before and after RME. Group E (21 patients) underwent RME using deciduous teeth as anchorage; group 6 (16 patients) underwent RME using permanent teeth as anchorage. The Wilcoxon test was used to compare changes between the time points in the same groups, and the Mann-Whitney U test was used to compare differences between the groups. **Results:** In group E, generally, no statistically significant reduction was found in buccal bone plate thickness between the time points. In group 6, most measurements showed significant reductions in buccal bone plate thickness ($P < 0.05$) between the time points, with a maximum decrease of 1.25 mm. **Conclusions:** RME in the mixed dentition with the appliance anchored to deciduous teeth did not reduce the buccal bone plate thickness of the maxillary permanent first molars, except for the mesial roots on both sides. RME in the permanent dentition caused a reduction of the buccal bone plate thickness of the maxillary permanent first molars when they were used as anchorage in the permanent dentition. (Am J Orthod Dentofacial Orthop 2019;155:198-206)

Rapid maxillary expansion (RME) uses intermittent high-intensity forces to create, with heavy forces, hyalinization of the periodontal ligament of the anchor teeth, where the appliance is fixed. During the hyalinization phase, all forces exerted by the appliance should be discharged on the midpalatal suture[1] to obtain more orthopedic effect and less orthodontic effect compared with slow maxillary expansion protocols.[2] Nevertheless, RME can cause buccal displacement and buccal tipping of anchor teeth.[3] Dislocation of teeth outside their alveolar process might damage the periodontal support, and reduced buccal bone thickness and height, gingival recession, fenestrations, or root resorption might occur,[4-6] as shown in many recent studies with computed tomography (CT).[3,7-9]

To prevent these side effects on permanent teeth, miniscrew-supported appliances[10] or appliances anchored to deciduous teeth[11-18] were proposed as valid alternative protocols for RME. Even if there are different protocols to increase the arch perimeter, miniscrew-supported appliances or appliances anchored to deciduous teeth are a good alternative to avoid using permanent teeth.[19,20]

Garib et al[8] investigated bone changes after RME. According to their results, RME induced bone dehiscence on the buccal aspect of the supporting permanent teeth, especially in subjects who initially had thinner buccal bone plates. Rungcharassaeng et al[9] showed similar results, including buccal bone loss in both the horizontal and vertical dimensions for all posterior teeth after expansion. Moreover, they reported significant correlations with the amount of screw activation, initial buccal bone plate thickness, and patient's age. Buccal bone side

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effects produced by RME in the permanent dentition raised interest for research about the effect of RME in the early phases of the mixed dentition.[21] According to previous evidence, separation of the maxillary halves should correspond to 50% of the screw activation in the early mixed dentition and to about 30% of the screw activation in the permanent dentition with consequently a lower orthopedic effect.[22] Baccetti et al[23] also observed that RME before the peak of skeletal maturation produces more skeletal effects than does RME after the peak.

Cozzani et al[16] showed that RME on deciduous teeth allows the resolution of a crossbite of the permanent first molars because these teeth spontaneously follow the deciduous teeth. Furthermore, the permanent first molars should follow the expansion with a more bodily movement and avoid the buccal tipping that usually occurs when the appliance is anchored on them.[17]

Few studies have been conducted with CT or cone-beam CT (CBCT) to evaluate changes of buccal bone thickness or height of maxillary first molars 3 dimensionally after RME when these are used as anchor teeth.[8,9,24] The authors of only 1 previous study have investigated the possible changes when deciduous molars are used as the anchor teeth.[18] To the best of our knowledge, no other authors have investigated changes in the buccal bone plate thickness of the maxillary permanent first molars by comparing appliances on deciduous teeth for anchorage with appliances on permanent teeth for anchorage in the same study.

The aim of this study was to evaluate changes in buccal bone plate thickness of the maxillary permanent first molars after RME, using CBCT images to compare the changes between RME in the mixed dentition with the appliance anchored on deciduous teeth, and RME in the permanent dentition with the appliance anchored on permanent teeth.

MATERIAL AND METHODS

In this retrospective study, we enrolled patients requiring orthodontic treatment with no history of previous orthodontic treatment. Our sample consisted of patients selected from the Department of Orthodontics at the University of Insubria, Varese, Italy, and the Department of Dentistry at the University of Alberta, Edmonton, Alberta, Canada; all subjects had RME on the deciduous or permanent molars. As a routine procedure, a signed informed consent was obtained from the parents of patients before starting treatment for use of the diagnostic records for scientific purposes. The protocol was reviewed and approved by the Ethics Committee (number 826) of the University of Insubria (Varese, Italy), and the procedures complied with the World Medical Organization's Declaration of Helsinki.

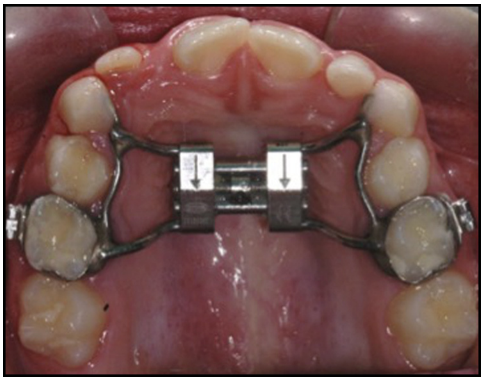

Fig 1. Tooth-borne hyrax expansion appliance anchored on deciduous teeth, used for group E.

The sample was selected according to the following inclusion criteria: good general health, early mixed dentition with permanent first molars erupted, skeletal transverse discrepancy with posterior unilateral or bilateral crossbite before treatment, good periodontal health, no decay with 2 or more surfaces involved, and available initial and final diagnostic records including CBCT scans of good quality without movement artifacts. The exclusion criterion was poor quality CBCT scans or missing records. All patients who had RME in the mixed dentition (group E), with the appliance anchored on deciduous teeth were treated at the Department of Orthodontics, University of Insubria, Varese, Italy. All patients who had RME in the permanent dentition (group 6), with the appliance anchored on maxillary permanent first molars were treated at the Department of Orthodontics, University of Alberta, Edmonton, Alberta, Canada. Each patient in the 2 groups had 2 CBCT scanning sessions, before starting treatment with RME (T0) and within 30 days after the expansion appliance was removed (T1). The group E sample consisted of 21 subjects (10 boys, 11 girls) with a mean age of 8.8 ± 1.13 years at T0. The group 6 sample consisted of 16 subjects (8 boys, 8 girls) with a mean age of 13.9 ± 1.29 years at T0.

The RME appliance used for group E was a tooth-borne hyrax expansion appliance (Fig 1) with bands on the deciduous second molars, extension arms bonded on the deciduous canines, and no distal extension arm to the permanent first molars. Expansion appliances were cemented with glass ionomer cement (Multi-Cure Glass ionomer; 3M Unitek, Monrovia, Calif) according to manufacturer's instructions. The expansion screw was initially activated twice (0.45-mm initial activation). Later, the parents of the patients were instructed to activate the screw twice a day starting the day after insertion (0.45-mm per day activation). Maxillary expansion was performed until dental overcorrection, defined as the point where the palatal cusp of the maxillary permanent first molars occludes on the inner slope of the buccal cusp of the mandibular permanent first molars. The screw was activated 30 $\pm$ 3 turns (mean opening, 7.5 mm) for group E. After active expansion treatment, the appliance was kept in place passively for 6 months. During this period, no patient had other orthodontic treatment. CBCT scans (i-CAT, 120 kV, 3.8 mA, 30 seconds; Imaging Sciences International, Hatfield, Pa) were performed before and after treatment, immediately after appliance removal (mean interval, 9 $\pm$ 1 months).

The appliance used for group 6 was a tooth-borne hyrax expansion appliance (Fig 2) with bands on the permanent first molars and first premolars. The expansion screw was activated twice a day (0.45 mm per day activation) until dental overcorrection was obtained. After active expansion treatment, the appliance was kept in place passively for 6 months. During this period, no patient had other orthodontic treatment. CBCT scans (3G Newtom, 110 kV, 6.19 mA, 9 seconds; Aperio Services, Verona, Italy) were performed before and after treatment, immediately after appliance removal (mean interval, 8 $\pm$ 2 months). The screw was activated 20 $\pm$ 5 turns (mean opening, 5 mm) for group 6.

DICOM files were analyzed with Mimics software (version 19.0; Materialise, Leuven, Belgium).

Image analysis was performed to measure the thickness of the buccal bone corresponding to the maxillary first molars on the mesiobuccal and distobuccal roots for the right and left sides. First, image orientation was changed to create a plane passing through the long axis of the maxillary permanent first molar defined with 3 landmarks: the more coronal point of the buccal furcation; the apex of the palatal root, and the center of pulp chamber floor. This step allowed for comparison of similar slices at different time points and for measurements to be taken that were not biased by the rotation of the maxillary permanent molars, since they were performed in the perpendicular coronal view. On the reformatted images, the mesiobuccal and distobuccal roots were triangulated for each tooth.

For each root, 3 dental landmarks were placed: (1) cementoenamel junction (CEJ); (2) root point 3, the intersection of a circle with a 3-mm radius, with the center corresponding to the CEJ landmark, and the buccal root profile; and (3) root point 6, the intersection of a circle with a 6-mm radius, with the center corresponding to the CEJ landmark, and the buccal root profile (Fig 3). A line passing through the CEJ and root point 3 (line 3) and a line passing through the CEJ and root point 6 (line 6) were then drawn. Buccal bone plate thickness was measured on the lines perpendicular to lines 3 and 6 at the height of root points 3 and 6, respectively (Fig 4). The same measurements were made for the maxillary right and left permanent first molars and both time points. The definition of the corresponding buccal bone plate thickness was indicated by the number of the maxillary molar (16 or 26), the initial of the root (M, mesial, or D, distal), and the corresponding height at root point 3 or 6.

Fig 2. Tooth-borne hyrax expansion appliance anchored on permanent teeth, used for group 6.

Dental expansion was measured according to a previously published method at the level of the pulp chamber of the maxillary permanent first molars.[25] The mean amounts of expansion of the maxillary permanent first molars were 4.44 $\pm$ 1.38 mm in group E and 4.35 $\pm$ 1.20 mm in group 6.

Statistical analysis

Sample size was first calculated. To retrieve $\beta = 0.80$ with α set at 0.05, a sample of at least 10 subjects per group was necessary. Sample size was calculated based on 5 subjects per group on the buccal bone plate thickness of the mesial root of the maxillary right first molar at root point 6 (16 MRP6) where the difference between the means was −1.14 mm with a higher standard deviation of 0.92 mm. Dropout patients should be considered for the retrospective design of the study; therefore, more patients were enrolled to allow for at least 10 patients per group. SPSS software (version 22.0; IBM, Armonk, NY) was used for the statistical analysis. The Shapiro-Wilk test showed a nonnormal distribution of the data; therefore, nonparametric tests were used for the statistical analysis. Means and standard deviations were calculated for both groups. The Mann-Whitney U test was used to compare the starting forms of the 2 groups. Each group was analyzed as a whole without stratification for sex. Buccal bone plate thickness changes in

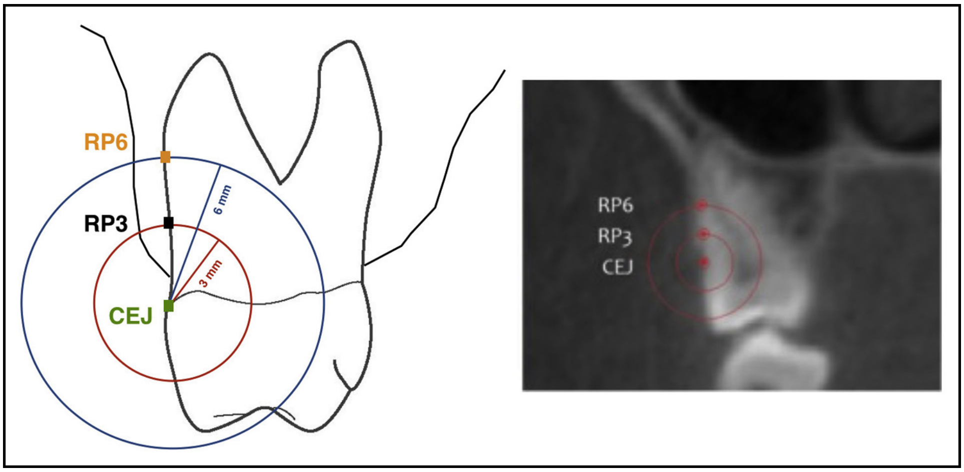

Fig 3. Definition of the landmarks for measurements of buccal bone plate thickness. For each root, 3 dental landmarks were placed: *CEJ*, cementoenamel junction; *RP3*, root point 3, intersection of a 3-mm radius circle (*red circle*) with the center corresponding to the CEJ landmark and the buccal root profile; and *RP6*, root point 6, intersection of a 6-mm radius circle (*blue circle*) with the center corresponding to the CEJ landmark and the buccal root profile.

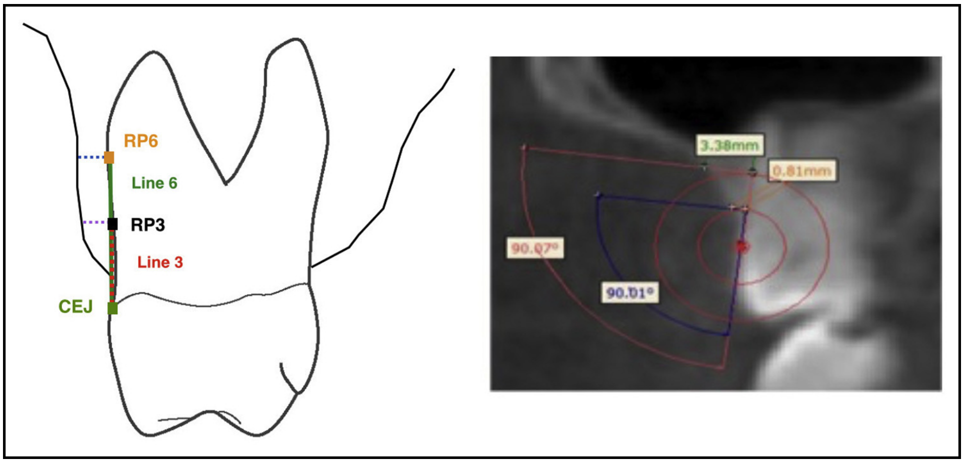

Fig 4. Definition of buccal bone plate thickness measurements. A line passing through CEJ and RP3 (*line 3, red dots*) and a line passing through CEJ and RP6 (*line 6, green*) were then drawn. Buccal bone plate thickness was measured on the lines perpendicular to lines 3 and 6 at the height of RP3 (*violet dotted line*) and RP6 (*blue dotted line*), respectively.

group E were compared with those in group 6. The Wilcoxon test was used to compare changes between the time points in the same group, and the Mann-Whitney U test was used to compare differences between groups.

To calculate the error of the method, measurements from 10 randomly selected subjects were repeated by the same examiner (M.V.D.) 3 times with a month between the measurements. The reported average error was 0.14 mm, with a minimum error of 0.02 mm and a maximum error of 0.34 mm.

RESULTS

Descriptive statistics were computed for all variables. The Mann-Whitney U test showed that none of the tested variables showed significant differences between the groups at T0, so the groups were comparable (Table I).

The Wilcoxon test was used to compare the mean differences between T0 and T1 for each variable in each group. Group E (Table II) showed buccal bone plate

Table I. Comparisons of the mean differences between groups E and 6 at T0

Buccal bone plate thickness	Group E		Group 6		
	Mean	SD	Mean	SD	P
16 MRP3	1.87	0.72	1.36	0.81	0.17
16 MRP6	2.83	1.08	1.63	1.23	0.09
16 DRP3	2.31	0.71	1.90	0.76	0.09
16 DRP6	2.89	0.94	2.13	1.13	0.12
26 MRP3	1.96	0.82	1.34	0.69	0.10
26 MRP6	2.84	0.69	1.61	0.81	0.08
26 DRP3	2.49	0.58	2.05	0.46	0.09
26 DRP6	3.06	0.77	2.41	0.70	0.08

Data are shown as means and standard deviations.
The Mann-Whitney U test was used to compare differences between groups.
The corresponding buccal bone plate thickness was defined by indicating the number of the maxillary molar (16 or 26), then the initial of the root (M, mesial; D, distal), and then the corresponding height at root points (RP) 3 and 6.

Table II. Group E mean differences compare between T0 and T1

Buccal bone plate thickness	T0		T1		
	Mean	SD	Mean	SD	P
16 MRP3	1.87	0.72	1.89	0.70	0.87
16 MRP6	2.83	1.08	2.40	0.66	0.02*
16 DRP3	2.31	0.71	2.54	0.86	0.14
16 DRP6	2.89	0.94	2.95	0.60	0.96
26 MRP3	1.96	0.82	1.77	0.60	0.18
26 MRP6	2.84	0.69	2.33	0.88	0.00*
26 DRP3	2.49	0.58	2.48	0.87	0.96
26 DRP6	3.06	0.77	2.83	0.87	0.16

Data are shown as means and standard deviations.
Wilcoxon test results are shown for the comparison between the time points for the treated group.
The corresponding buccal bone plate thickness was defined by indicating the number of the maxillary molar (16 or 26), then the initial of the root (M, mesial; D, distal), and then the corresponding height at root points (RP) 3 and 6.
*$P < 0.05$.

thickness ranging from 1.87 to 3.06 mm at T0, with no statistically significant differences ($P < 0.05$) for the tested variables between T0 and T1, except for mesial root point 6, which reported an average reduction of 0.43 mm for buccal bone plate thickness of the maxillary right permanent first molar (16 MRP6) and 0.51 mm for the maxillary left first permanent molar (26 MRP6). In group 6 (Table III), buccal bone plate thickness ranged from 1.34 to 2.41 mm at T0, and all variables had statistically significant differences ($P < 0.05$) between T0 and T1, with mean reductions of 0.73 mm (minimum) (16 MRP3) and 1.25 mm (maximum) (16 DRP6).

Mean differences between the groups were compared using the Mann-Whitney U test (Table IV). All variables showed statistically significant differences ($P < 0.05$), except for 2: 16 MRP6 and 26 MRP6, which were the variables that also had statistically significant differences between T0 and T1 in group E. In group 6, Buccal bone plate thickness showed significant reductions for most measurements compared with group E.

Table III. Group 6 mean differences compare between T0 and T1

Buccal bone plate thickness	T0		T1		
	Mean	SD	Mean	SD	P
16 MRP3	1.36	0.81	0.63	0.85	0.00*
16 MRP6	1.63	1.23	0.80	1.06	0.00*
16 DRP3	1.90	0.76	1.09	1.01	0.01*
16 DRP6	2.13	1.13	0.88	1.11	0.00*
26 MRP3	1.34	0.69	0.43	0.59	0.00*
26 MRP6	1.61	0.81	0.55	0.78	0.00*
26 DRP3	2.05	0.46	1.13	0.82	0.00*
26 DRP6	2.41	0.70	1.28	0.99	0.00*

Data are shown as means and standard deviations.
The Wilcoxon test results are shown for the comparison between the time points for the treated group.
The corresponding buccal bone plate thickness was defined by indicating the number of the maxillary molar (16 or 26), then the initial of the root (M, mesial; D, distal), and then the corresponding height at root points (RP) 3 and 6.
*$P < 0.05$.

DISCUSSION

In this study, we compared the buccal bone plate thickness changes of the maxillary permanent first molars after maxillary expansion with the appliances anchored on deciduous and permanent teeth. CBCT scans used to evaluate the buccal bone plates as traditional 2-dimensional radiographic images (eg, cephalometric and panoramic radiography) can only represent the anatomy in 2 dimensions and have limitations related to the magnification and superimposition of anatomic structures.[26-29] CBCT scans were previously used to take accurate measurements of buccal bone plates after RME with a reasonable exposure to ionizing radiation.[18] CBCT scans give much information, therefore requiring rigorous standardization of images if comparisons of similar measurements are needed.[18] For this purpose, all measurements in this study were performed in a resliced view passing through the long axis of the examined tooth to prevent errors related to the position of the tooth itself at the different time points. Also, the measurements were performed for the buccal bone plate thickness on the mesial and distal aspects

Table IV. Comparisons of the mean differences (T1-T0) between groups E and 6

Buccal bone plate thickness	Group E		Group 6		
	Mean	SD	Mean	SD	P
16 MRP3	0.02	0.62	−0.73	0.59	0.00*
16 MRP6	−0.43	0.75	−0.83	0.64	0.10
16 DRP3	0.23	0.64	−0.82	1.04	0.00*
16 DRP6	0.05	0.62	−1.25	0.84	0.00*
26 MRP3	−0.19	0.46	−0.92	0.82	0.01*
26 MRP6	−0.51	0.65	−1.06	0.81	0.06
26 DRP3	0.00	0.60	−0.92	0.72	0.00*
26 DRP6	−0.23	0.77	−1.12	0.68	0.00*

Data are shown as means and standard deviations.
The Mann-Whitney U test was used to compare differences between groups.
The corresponding buccal bone plate thickness was defined by indicating the number of the maxillary molar (16 or 26), then the initial of the root (M, mesial; D, distal), and then the corresponding height at root points (RP) 3 and 6.
*$P < 0.05$.

of the roots at different distances to minimize possible errors by increasing the number of measurements.

RME in the mixed dentition was recently suggested to produce an orthopedic effect represented by midpalatal suture split associated with dental changes, similar to the results observed when the appliance is anchored on the permanent teeth.[30,31] The use of deciduous teeth as anchors during RME was previously shown by Garib et al[18] to minimize the periodontal bone changes on anchor teeth that, especially in the permanent first molars, might damage the cortical bone or cause unwanted root resorption.[3,8,9] Incidences of dehiscence at the maxillary permanent first molars were reported to be between 2.5% and 55% after RME.[32,33] Before treatment, a minimal amount of buccal alveolar bone supporting the teeth might play an important role in predisposing the patient to dehiscence. The amount of expansion at the permanent first molars is not the same if they are included in the appliance. Previous studies have suggested that the crowns of the maxillary permanent molars spontaneously expand and follow 60% of deciduous molar (and screw) expansion during the active phase when maxillary expanders are used on deciduous teeth.[34] The amounts of expansion of the screw were different, since the subjects in group E needed greater expansion to obtain the same dental overcorrection as did the subjects in group 6, even though the 2 groups had the same pretreatment maxillary deficiency. The screws were activated 20 ± 5 turns (mean opening, 5 mm) in group 6 and 30 ± 3 turns (mean opening, 7.5 mm) in group E. Nevertheless, the amounts of expansion at the permanent first molars were comparable in the 2 groups, thus confirming that when expansion is performed on deciduous teeth, the permanent molars do not follow the expansion of the screw with the same amount as when the expansion is performed on permanent teeth.

These results showed significant reductions on the buccal bone plate thicknesses of the maxillary permanent first molars between 0.73 and 1.25 mm when the permanent teeth were used as anchors for the RME appliance. This result agrees with that of Garib et al,[18] who evaluated buccal bone plate thickness on permanent teeth with RME on deciduous teeth. Nevertheless, there were 2 main differences in our study compared with the previous findings related to a comparison group and the appliance design.[18] A comparison group in our sample with RME on the permanent dentition was investigated without considering other studies with different methodologies and settings for the evaluation. Moreover, regarding the appliance design, in the previously cited study, a maxillary expander with bands on the deciduous molars was used, but it had a palatal wire extension at the permanent first molars that probably produced a further orthodontic effect in this region, even though the results showed that the buccal bone plate of the permanent first molars had no changes.[18] In our investigation, the appliance was not in contact with the maxillary permanent first molars, thus reducing orthodontic effects related to the appliance on these teeth. The maxillary first molars are subjected to occlusal contacts that, after correction of the crossbite, might produce changes in the buccolingual inclination and rotations on the maxillary permanent first molars that are free to move, since they are not involved in the appliance.[31,35] Favorable spontaneous changes of the permanent first molars, with buccal uprighting of the mandibular molars and palatal uprighting of the maxillary permanent molars (in the opposite direction of the expansion), were observed.[31,35,36] The palatal wire extension on the permanent first molars might have influenced the spontaneous palatal uprighting of these teeth, thus influencing the extent of buccal bone plate thickness after treatment. The mesial roots of both right and left permanent molars were the only measurements showing no significant differences between the 2 groups, indicating a decrease in the buccal bone plate thickness also in group E when RME was performed with deciduous molars as the anchor teeth. The possible explanation for this result is related to the maxillary first molars changing their positions due to occlusal contacts when overcorrection is obtained. Distal rotation of the crown might explain a decrease of the buccal bone plate thickness only for the mesial root in both sides associated with changes in the buccolingual inclination.[15,31,35]

Moreover, the evaluated time interval was shorter in previous investigations compared with our study, where the interval between the time points also comprised the retention phase.[8,9,18,24] Garib et al[18] made the final observation in a short-term period (posttreatment CT was 30 days after the end of the activation phase), thus excluding data from the retention period. During the retention period, residual forces of the midpalatal suture might cause the bone moving through the teeth for relapse forces, as suggested by Haas,[37] and if the permanent first molars are stuck by the wire extension, then buccal bone plate thickness might be lost on the buccal side of these teeth due to these relapse forces. On the contrary, the time intervals for this study were 8 ± 2 months for group 6 and 9 ± 1 months for group E, thus considering the active phase and retention period that are suggested to be at least 6 months after RME.[38] According to previous evidence, a significant decrease in buccal bone plate thickness of the first premolars, second premolars, and permanent first molars occurs when RME was performed in the permanent dentition; this agrees with our results when only maxillary first molars were considered.[18,24]

Authors of a recent study evaluated peridental bone changes after orthodontic tooth movement with fixed appliances by means of CBCT and performed a complete evaluation of bone thickness, vertical loss, and angulation changes for every tooth.[39] In our study, neither vertical loss of bone nor angulation changes were included, even though changes in angulation of the maxillary first molars after RME were reported in previous studies with appliances similar to those we used. Rosa et al[35] evaluated the spontaneous buccolingual angulation changes of the maxillary permanent first molars after RME on deciduous teeth with CBCT and showed that both molars underwent palatal inclinations of about 3.5°. When maxillary expansion is needed, with or without a crossbite, maxillary first molars might tilt buccally to compensate for the skeletal discrepancy.[35] If expansion is performed on permanent molars in this case, the buccal inclination worsens, since it was reported to increase by about 3° to 4° toward the buccal side.[40] On the contrary, if RME is performed on deciduous teeth without a palatal wire extension, the permanent first molars are free to correct their axes toward the palatal side due to occlusal forces, thus allowing for greater skeletal expansion and avoiding the risk of scissorsbite of the maxillary molars.[18] The lack of vertical measurements and inclination changes might be considered a limitation of this study and will be the subject of future investigations.

The ages of the patients in our sample were not the same between the groups, and the treatments were carried out in 2 different settings; these may be some limitations of this retrospective study, even though the buccal bone plate thickness comparison showed no differences between groups before treatment, thus indicating that the 2 groups were comparable for the tested variable. The patients in group 6 were older, and this may have been a disadvantage when RME was performed in the permanent dentition, but changes in oral bone density or mineralization were suggested to be not significant during childhood and adolescence, if compared with adult ages.[41] Moreover, no measurements were performed to assess the loss of buccal bone plate thickness on the deciduous second molars and canines, which were the anchor teeth in group E. Furthermore, the consequences on the permanent tooth germs that would replace the deciduous teeth acting as anchor teeth during RME in the mixed dentition were not investigated, as in previous studies.[18] Furthermore, the different skeletal or muscular patterns were not considered in our patients, since these variables were thought to be negligible for the aim of our study.[42] RME using deciduous teeth as anchors was clinically effective for increasing the transverse maxillary diameters and preventing possible periodontal side effects on permanent teeth that were not involved in the appliance compared with RME on permanent teeth showing decreases in the buccal bone plate thickness.

A recently published systematic review suggested that even though the loss of buccal bone thickness was well documented in previous studies when maxillary expansion was performed with permanent teeth as anchors, its clinical implications are still unclear.[43] An important consideration should be the difference between the statistical and clinical significances of these results. Reduction on the buccal bone plate thickness of the maxillary permanent first molars with a range between 0.73 and 1.25 mm when the permanent teeth were used as anchors for the RME appliance was a finding in this study. From a statistical point of view, the comparison with the bone loss of group E was significant, but the clinical significance of the reported bone loss might be doubtful. It is important to study other factors that might play relevant clinical roles. Soft tissues might cover the bone defect created as fenestration more frequently in the maxillary alveolar ridge[44] or as dehiscence. Recession in these cases was suggested to be strictly related to gingival inflammation.[45] Then the first clinical recommendation should be to avoid using permanent molars as anchor teeth when deciduous teeth are suitable for the appliance. For this reason, timing has a fundamental role in not postponing maxillary expansion in the permanent dentition but preferring a 2-phase treatment as a valid alternative. For older patients whose deciduous teeth are no longer suitable, a careful evaluation of the gingival biotype should be performed before positioning bands of the appliance on the maxillary first molars, and perhaps using radiographic investigations with CBCT when the clinical investigation is doubtful. Then a follow-up during expansion with the clinical examination through touching the roots at the appointments and a rigid oral hygiene regimen should be mandatory. Another option when a large amount of expansion is needed in growing patients with a thin gingival biotype might be bone-anchored maxillary expansion.[46]

CONCLUSIONS

According to our results, the following conclusions might be drawn.

1. RME performed in the mixed dentition with the appliance anchored to deciduous teeth did not reduce the buccal bone plate thickness of the maxillary permanent first molars, except for the mesial roots in both sides.
2. RME in the permanent dentition caused a reduction of the buccal bone plate thickness of the maxillary permanent first molars when they acted as anchor teeth.
3. The range of reduction of the buccal bone plate thickness of the maxillary permanent first molars when they acted as anchor teeth showed statistically significant differences compared with the overall absence of bone reduction when RME was performed in the mixed dentition. Nevertheless, clinical significance of the bone loss (range, 0.73-1.25 mm) might be doubtful and is not strongly relevant.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.ajodo.2018.03.020.

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