Original Article

Clinical and Radiographic Comparative Evaluation of Buccal and Palatal Corticotomy with Buccal Corticotomy in Periodontally Accelerated Osteogenic Orthodontics with Surgical Bur

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Abstract

Background: Periodontally accelerated osteogenic orthodontics is a clinical procedure that combines selective corticotomy, particulate grafting, and application of orthodontics. It reduces treatment time, increases stability of teeth, and prevents relapse of orthodontic tooth moment. The present study was aimed to explore the clinical and radiographic comparison of bone density changes, retraction time differences in buccal and palatal corticotomy with buccal corticotomy which was done by surgical bur. **Materials and Methods:** A split-mouth was designed in 16 patients and divided into right (buccal and palatal corticotomy) (Group I), left (buccal corticotomy) (Group II) sides. In both groups, decortication was done with surgical bur. Clinical parameters such as gingival bleeding index and probing pocket depth were recorded at baseline, 1 month, 3 months, and 6 months. Bone density changes were measured by computed tomography at baseline and after 6 months after surgery and also used for evaluating differences in bone density changes between two groups. Retraction time differences were also measured in both groups. **Results:** In both groups, there was significant difference between bone density changes at baseline and 6 months after surgery. However, the difference between two groups was not significant. The difference in clinical parameters between two groups was not significant. The difference in retraction time differences was not significant. **Conclusion:** Within limits of the study, it may be concluded that there was difference between bone density changes before and 6 months after surgery. Difference in total treatment time found to be no significant between two groups.

Keywords: *Corticotomy, orthodontic tooth movement, periodontally accelerated osteogenic orthodontics*

Introduction

Malpositioned teeth are responsible for esthetic and occlusal aberrations in many adults. Patients often avoid orthodontic treatment because of its long duration. Traditional orthodontic movements result into periodontal ligament (PDL) compression, activate the dynamics of crestal bone resorption and apposition. Thus, orthodontic movement is considered a "periodontal phenomenon" because all the periodontal tissues are involved. For this reason, the preservation of the integrity of the periodontium is generally difficult to achieve and is associated with a long duration of treatment.[1] Lengthy orthodontic treatment time has been linked to an increased risk of root resorption, gingival inflammation, decalcification, and dental caries. Therefore, reducing the treatment time is an appropriate goal, which requires increasing the rate of tooth movement.[2]

To meet the constant demand to shorten the treatment time and to maintain the integrity of periodontal structures, an alternative clinical procedure has been popularized, known as corticotomy or accelerated osteogenic orthodontics (AOO) and more recently, the periodontally AOO (PAOO). It is a clinical procedure that combines selective corticotomy, particulate grafting, and the application of orthodontic forces. It reduces 1/3–1/4 of the total treatment time when compared to conventional orthodontic treatment.[1,3]

G-Graft is made of natural low crystalline hydroxyapatite with collagen, both derived from natural sources, i.e., bovine origin.[4] Hydroxyapatite is a highly crystalline form of calcium phosphate procured through

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a high-temperature reaction. It exhibits a chemical resemblance with the mineralized phase of bone, and this similarity elucidates the excellent biocompatibility and osteoconductive capacity of this ceramic. Collagen when used in conjugation with other osteoconductive carriers like hydroxyapatite or tricalcium phosphate, acts as an osteoinductive material. The composite of hydroxyapatite and collagen (G-Graft) may lead to earlier bone regeneration and the greater density of the mature bone. Studies have shown that collagen type I and hydroxyapatite enhance osteoblast differentiation, but in combination, they accelerate osteogenesis. A composite matrix embedded with human-like osteoblast cells showed better osteoconductive properties compared to monolithic HA and produced calcification of identical bone matrix.[5]

Materials and Methods

In this 6-month follow-up interventional study, a total of 16 systemically and periodontal healthy controls between 20 and 40 years of age requiring orthodontic treatment were selected from Department of Periodontics, and the orthodontic treatment was undertaken in the Department of Orthodontics, Kamineni institute of dental sciences, Narketpally (Telangana).

The inclusion criteria were individuals with Angle's Class I and Class II molar relation and 1st premolar extraction. Patients with bleeding disorders and any other systemic diseases which will interfere with the treatment outcome, uncontrolled diabetes, smokers, pregnant and lactating mothers, those were using corticosteroids and drugs which effect on bone metabolism were excluded from this study.

The research protocol was accepted by Institutional ethical committee, Kamineni institute of dental sciences, Narketpally (Telangana). After ethical approval, all patients received verbal information regarding participation and written informed consent obtained for participation in the study.

After Phase I therapy, patients were divided randomly into Group I (Piezo) and Group II (Surgical bur). Each group was further divided into right (buccal and palatal corticotomy) and left (buccal corticotomy only).

Clinical parameters

Clinical parameters such as gingival bleeding index (GBI)[6] and probing pocket depth (PPD) were recorded with periodontal probe.

Retraction time also recorded at baseline and end of the retraction space closure in both groups with the help of study models, Vernier Caliper and Scale.

Radiographic parameters

The computed tomography (CT) assessment was carried out at the Department of Radiology in Kamineni institute of medical sciences, Narketpally (Telangana). CT was used for evaluating the changes in the bone density before and after the surgical intervention.

For each tooth, the density of the labiolingual alveolar plates was measured to the nearest 0.2 mm. Meaurements were taken at the crestal level of 3rd slice of CT by joining of adjacent crestal mid points. The mid point of these lines on the buccal side was taken as S1, palatal side was taken as S3 respectively. The midpoint of line formed by joining of S1 and S3 gave S2. At the beginning of treatment, 3 measurements for each tooth were taken (P1 Preoperative). The same measurements were repeated between 6 and 7 months after incisor retraction was completed (depending on the case) (P2 postoperative). The evaluation of radiographic density (HU) was done by Syngofast DICOM image software.

For evaluating the changes in alveolar bone density, the sites (Interdental septum) between the following teeth were evaluated: central and lateral Incisors; canines and lateral incisor, between the central incisors and in the extraction space. Measurements in the areas between the teeth were density of buccal cortical, palatal cortical, and cancellous bone together.

Surgical procedure

The surgical procedure was performed using surgical carbide bur. After profound anesthesia, full thickness mucoperiosteal flap was then elevated extending 3–4 mm beyond the mucogingival junction. With the help of surgical carbide bur no. 2, under proper cold saline, vertical grooves were placed in the interradicular space, midway between the root prominences in the alveolar bone from the distal surface of extraction space on one side to the distal surface of extraction space on the other side. These grooves extended from a point 2–3 mm away from the crest of the bone to a point approximately 2 mm beyond the apices of the roots. Semilunar corticotomy cuts were made joining these vertical cuts beyond the apices of the roots.

On the right side of palate, vertical corticotomies performed 2–3 mm away from the crest of the alveolar bone. These vertical corticotomies were connected by semilunar corticotomy cuts.

After the placement of the corticotomy cuts, G-graft (particle size 0.9 mm–1.9 mm) was placed with an effort not to place an excess amount. The decorticated bone helped to retain the graft material. The flap was adapted to normal position without tension and suturing was done by nonresorbable silk suture. The sutures were left in place for 7–8 days [Figure 1a-f]. Capsule novamox 500 mg 1 tablet every 8 h for 5 days was prescribed as an antibiotic. Tablet Ultracet, 2 tablets daily for 5 days was prescribed as analgesic. The participants were instructed not to brush the operated area for 1 week and to rinse the oral cavity twice a day with Chlorhexidine (0.12%) mouthwash daily. Sutures were removed after 10 days postoperatively.

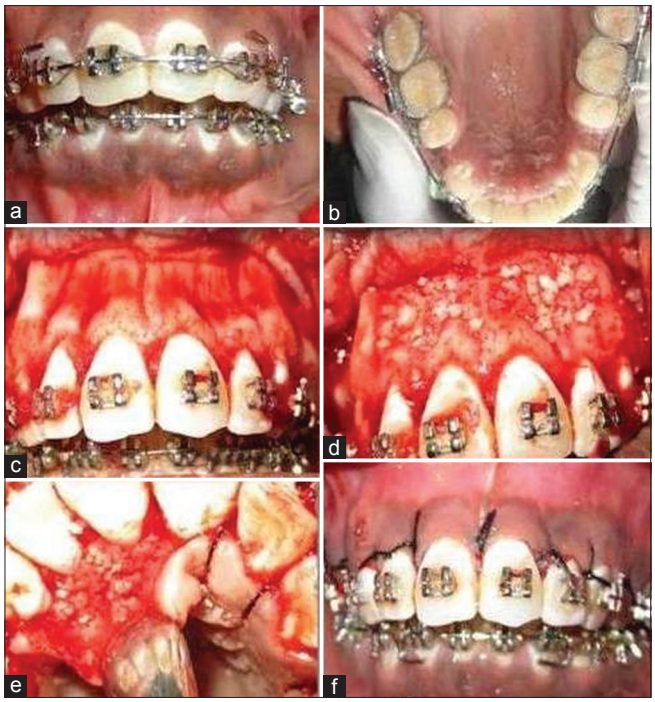

Figure 1: (a) Preoperative frontal, (b) preoperative palatal, (c) full thickness flap elevation and corticotomy, (d) particulate grafting with G-graft, (e) palatal side bone grafting, (f) sutures placed

Orthodontic treatment was started within 2 weeks after surgery. 250 g of force was applied on both sides in two groups, and appliance activation was done every 2 weeks.

Clinical parameters were measured at baseline, 3 months, and 6 months. CT measurements were measured at baseline and 6 months after surgery in both groups [Figure 2a-f].

Statistical analysis

The results were averaged (mean ± standard deviation) for each clinical and radiographic parameter at each time interval. For intergroup variations, Wilcoxon signed-rank test was performed. For comparison between the intragroup variations, Mann–Whitney U-test was performed.

Results

In both groups, percentage of change in GBI, PPD scores was statistically significant between baseline to 1 month, baseline to 3 months, baseline to 6 months, 1 month to 3 months, 1 month to 6 months. In both groups, percentage of change in GBI, PPD scores between 3 months to 6 months was statistically nonsignificant. Intragroup comparison in GBI, PPD scores was statistically nonsignificant at any study intervals [Tables 1 and 2].

The difference in mean treatment time closure between 2 groups was 5.75 ± 1.75 and 6.50 ± 0.75, respectively, and the difference between two groups was found to be nonsignificant [Table 3].

The bone density changes between pre- and post-surgery in both groups were found to be statistical significant (except for S3). The mean difference of densities between right (R) and left side (R) of Group I and II (I-I S1, LI-LLS1, LI-LC S1, ES S1, I-I S2, LI-LLS2, LI-LC S2, ES S2, I-I S3, LI-LLS3, LI-LC S3, and ES S3) were statistically nonsignificant [Table 4].

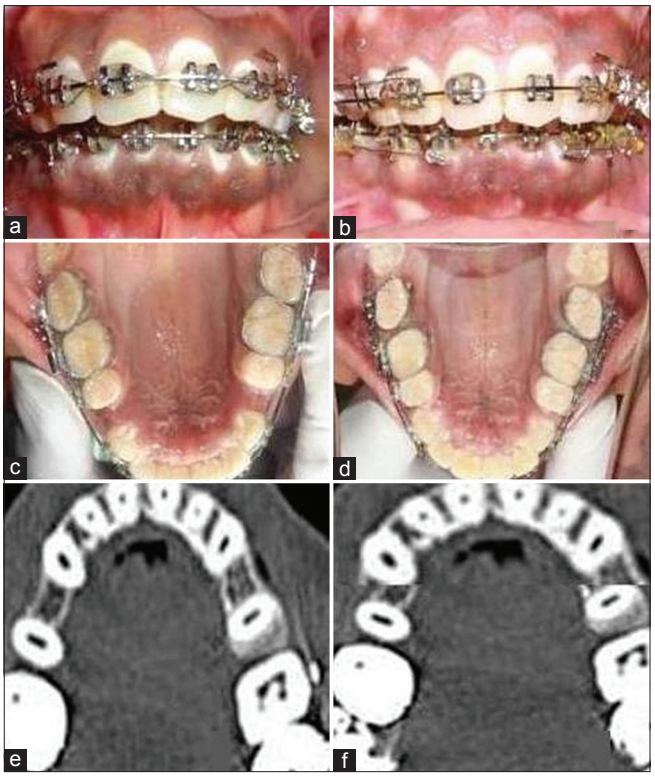

Figure 2: (a) Preoperative frontal, (b) postoperative frontal after 6 months, (c) preoperative palatal, (d) postoperative palatal after 6 months, (e) preoperative computed tomography, (f) postoperative computed tomography after 6 months

Discussion

The tissue reaction to the application of an orthodontic force is the result of the interaction between the mechanical perturbation generated by the orthodontic appliance and the modeling and remodeling of the alveolar bone. The tissues that are affected by the mechanical loading comprise the root surface, the PDL, and the alveolar bone. Each tissue has its own cellular and extracellular elements and mechanical properties, and behavior is controlled by both local and systemic factors. Orthodontic tooth movement is a type of mechanical loading as the force is transmitted to the alveolar bone through PDL.[7]

External root resorption is a known phenomenon associated with orthodontic treatment.[8,9] An increased risk of problems such as caries, periodontal disease, and root resorption are associated with prolonged treatment time. Reducing orthodontic treatment time is one of the primary goals for orthodontists as it leads to increased patient satisfaction. Attempts to shorten the treatment time can be divided into different categories.[10,11]

Table 1: Comparison of different time points in Group I and Group II with respect to gingival bleeding index (%) scores

Groups	Time	Mean±SD	Percentage change	*P*
Group I	Baseline	67.81±5.78	56.68	0.0117*
	1 month	29.38±5.94		
	Baseline	67.81±5.78	23.32	0.0117*
	3 months	52.00±3.00		
	Baseline	67.81±5.78	21.94	0.0117*
	6 months	52.94±3.63		
	1 month	29.38±5.94	−77.02	0.0117*
	3 months	52.00±3.00		
	1 month	29.38±5.94	−80.21	0.0117*
	6 months	52.94±3.63		
	3 months	52.00±3.00	−1.80	0.2367
	6 months	52.94±3.63		
Group II	Baseline	64.00±1.75	55.47	0.0117*
	1 month	28.50±4.22		
	Baseline	64.00±1.75	22.79	0.0117*
	3 months	49.41±4.14		
	Baseline	64.00±1.75	15.20	0.0117*
	6 months	54.28±4.42		
	1 month	28.50±4.22	−73.38	0.0117*
	3 months	49.41±4.14		
	1 month	28.50±4.22	−90.44	0.0117*
	6 months	54.28±4.42		
	3 months	49.41±4.14	−9.84	0.1614
	6 months	54.28±4.42		

P<0.05*. SD: Standard deviation

Table 2: Comparison of different time points in Group I and Group II with respect to probing pocket depth scores

Groups	Time	Mean±SD	Percentage change	*P*
Group I	Baseline	2.39±0.07	18.61	0.0117*
	1 month	1.94±0.11		
	Baseline	2.39±0.07	13.84	0.0117*
	3 months	2.06±0.06		
	Baseline	2.39±0.07	10.27	0.0117*
	6 months	2.14±0.09		
	1 month	1.94±0.11	−5.86	0.0117*
	3 months	2.06±0.06		
	1 month	1.94±0.11	−10.24	0.0117*
	6 months	2.14±0.09		
	3 months	2.06±0.06	−4.14	0.0747
	6 months	2.14±0.09		
Group II	Baseline	2.38±0.08	18.64	0.0117*
	1 month	1.94±0.04		
	Baseline	2.38±0.08	12.55	0.0117*
	3 months	2.08±0.06		
	Baseline	2.38±0.08	10.97	0.0173*
	6 months	2.12±0.09		
	1 month	1.94±0.04	−7.48	0.0117*
	3 months	2.08±0.06		
	1 month	1.94±0.04	−9.42	0.0117*
	6 months	2.12±0.09		
	3 months	2.08±0.06	−1.80	0.2936
	6 months	2.12±0.09		

P<0.05*. SD: Standard deviation

Table 3: Comparison of Group I and Group II with respect to total treatment time (months)

Groups	Mean±SD	*P*
Group I	5.75±1.75	0.356
Group II	6.50±0.75	

P<0.05. SD: Standard deviation

The PAOO technique was reduced one-third to one-fourth of the total time which is normallyt required for treating the same type of the case with traditional orthodontics, and borderline orthognathic cases could be improved or even precluded entirely.[3]

The facilitated tooth movement is due to regional acceleratory phenomenon(RAP)[12] which is the mechanism that alters the bone density(mass per unit volume). PAOO must maintain a thin layer of bone over the root en face, the surface in the direction of the intended tooth movement.[1] In the absence of alveolar augmentation, there may be a net loss in bone volume in the adult that justifies that the bone grafts compensate for matrix deficiency during mechanotherapy.[13]

Participants suffering from any active periodontal disease or taking corticosteroids or bisphosphonates were excluded from the present study as these drugs impair the bone turnover and metabolism.[14] Only systemically and periodontally healthy controls were selected for the present study. Patients not showing optimum oral hygiene during the Phase I therapy were not considered for the study since plaque control and oral hygiene status definitely influence the outcome of any therapy.

After the placement of orthodontic appliances, the patient experiences some difficulties in the oral hygiene maintenance. This had a definite influence on the bleeding scores; therefore, GBI was recorded. Furthermore, this indexing system is more simple, easy to record, and reproducible. According to Zachrisson, conventional orthodontic treatment has negligible effects on periodontal health if oral hygiene procedures are maintained during treatment.[15]

There was little difference in the pocket depth in the present study. The similar results were seen in the studies conducted by Wilcko *et al*.[1,16] The data of these studies showed that corticotomy procedure was not excessively damaged to the periodontal tissues, also reported only minimal gingival recession and no attachment loss of clinical significance, with posttreatment attachment levels in 88% of the sites within 1 mm of the pretreatment values with preserved interdental papillae. This was because corticotomy was performed 2 mm away from interproximal labial and palatal alveolar crest.

Table 4: Comparison of right and left side with respect to different parameters at pre- and post-test and their difference scores

Variables	Right side			Left side			*P*
	Pretreatment	Posttreatment	*P*	Pretreatment	Posttreatment	*P*	
I-I S1	780.00±25.63	795.00±22.68	0.0117*	780.00±21.34	795.00±22.68	0.0117*	1.000
I-L S1	774.38±28.96	788.13±26.31	0.0117	770.63±27.31	780.00±24.93	0.0177*	0.1415
L-CS1	811.88±24.78	822.50±21.71	0.0117*	798.75±27.48	801.25±29.97	0.0117*	0.1893
ES1	613.75±68.02	623.13±67.66	0.0500*	606.25±69.42	621.25±87.86	0.0117*	0.0831
I-I S2	516.25±59.75	528.13±62.90	0.0117*	516.25±59.75	530.63±61.90	0.0117*	0.5995
I-L S2	510.63±57.60	523.75±61.57	0.0117*	512.50±60.94	520.00±59.46	0.0117*	0.1036
L-CS2	526.88±57.94	539.38±64.28	0.0357*	513.75±54.23	521.88±55.67	0.0117*	0.3446
ES2	438.75±35.63	450.00±38.54	0.0180*	440.63±51.44	448.13±49.49	0.0117*	0.1415
I-I S3	776.25±25.46	790.63±28.59	0.0117*	776.25±25.46	790.63±28.59	0.05135	1.000
I-L S3	768.75±28.00	781.25±29.00	0.0117*	761.88±24.78	772.50±25.50	0.0929	0.6744
L-CS3	798.13±25.90	810.00±24.93	0.0117*	789.38±29.33	790.50±29.59	0.2367	0.2480
ES3	624.38±32.01	662.50±68.23	0.0117*	584.38±86.66	585.25±86.80	0.0517	0.2272

P<0.05*. SD: Standard deviation

Several reports mentioned the adverse effects of corticotomy on periodontium which was ranging from no problems to slight interdental bone loss, loss of attached gingiva. Some reports even showed periodontal defects in cases which showed short interdental distance between the teeth,[17-19] but no such changes were observed in the present study.

The present study showed that there was little difference between corticotomy on both sides, i.e. buccal and palatal/lingual corticotomies to the corticotomy on single side, i.e., buccal side. Contrary to the present study, Kole[3], Wilcko *et al*.,[16] and Skountrianos *et al*.[20] compared corticotomy cuts on both alveolar surfaces, i.e., both buccal and palatal/lingual sides and concluded that corticotomy cuts on both alveolar surfaces, i.e., buccal and lingual/palatal sides showed radiographic bone density changes after particulate bone grafting, decreased treatment time, and increased postorthodontic stability.

In the present study, G-GRAFT was used for particulate grafting which showed increase in radiographic bone density after 6 months of the surgical procedure and the difference between pre-and post-treatment radiographic changes was statistically significant. According to Murphy *et al*.,[2] no objective data were existing to compare one grafting material with another in terms of superiority.

The present study confirms the dental CT scanning utility in diagnostic imaging of the buccal, palatal, and interdental bone. According to Misch,[21] bone density measurements by CT scanning offer more precise results compared to radiologic evaluation. Therefore, bone density measurement by this method can offer more valuable data than other methods.

The present study showed that there was significant difference in bone density between pre- and post-treatment in both groups which offer better orthodontic stability. Same results were observed in a study which was conducted by Bhattacharya *et al*.[22]

In the present study, we did not notice any loss of tooth vitality and observed good preservation of papilla, no gingival recession, and no periodontal defects. Same results were observed in a study which was conducted by Hernández-Alfaro and Guijarro-Martínez.[23]

In the present study, there was nonsignificant difference between two groups in the retraction treatment time. To date, none of the studies compared bone density changes and retraction treatment time between right (buccal and palatal corticotomy) and left (buccal corticotomy) sides.

Conclusion

To the best of our knowledge, this study is the largest randomized clinical controlled trial to compare the effect of buccal and palatal with buccal corticotomy on total treatment time and bone density changes. There was no difference between right and left sides with regard to bone density changes and retraction treatment time. However, a large sample and long-term follow-up study are needed to explore the bone density changes and retraction treatment time within group and also between both groups.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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