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Surgical considerations in periodontally accelerated osteogenic orthodontics with platelet-rich fibrin: A series of 2 case reports

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Abstract
One of the surgical methods created to speed up orthodontic therapy is the periodontally accelerated osteogenic orthodontic (PAOO) tooth movement process. Numerous studies have documented a significant acceleration of orthodontic tooth movement after a combination of PAOO and bone grafting surgery, with the latter which helps in expansion of tooth movement and sustained improvement of the periodontium. The technique and surgical principles of PAOO for accelerating orthodontic tooth movement are highlighted in the following case reports.

Keywords: Corticotomy, Periodontally Accelerated Osteogenic Orthodontics, PAOO, selective alveolar decortication, platelet-rich fibrin

Introduction
For a very long time, many clinicians and researchers have concentrated on reducing the time required for orthodontic tooth movement. Köle in 1959 first described the technique known as alveolar corticotomy, where vertical buccal and lingual corticotomies and apical horizontal osteotomy connecting cuts were given creating blocks of bone. He found that segments of bone with the embedded teeth could be moved rapidly [1]. Over the past few years, numerous variations of this fundamental technique have emerged in the field of dentistry. In accordance with their own preferences, writers have changed the nomenclature to include terms like corticotomy, Wilckodontics®, corticotomy-facilitated orthodontics, selective alveolar decortication, accelerated osteogenic orthodontics, PAOO and Piezocision®.
Dr. Henry Frost introduced the idea of "regional acceleratory phenomenon" (RAP), whereby intentional surgical disruption of the alveolar cortical bone causes an alteration in bone metabolism that leads in a transient osteopenic state which hastens tooth movement. RAP manifests itself within 2-3 days of injury and peaks within 1-2 months. Usually lasting for four months, this impact may take six to twenty-four months to entirely subside [2].
The term "accelerated osteogenic orthodontics" (AOO), which was later changed to "periodontally accelerated osteogenic orthodontics" (PAOO) in 2001, was first used by Dr. William Wilcko and Dr. Thomas Wilcko. They perfected the surgical-orthodontic therapy by combining corticotomy surgery with alveolar grafting [3].
The rationale of PAOO surgery is to speed up tooth movement, reduce apical root resorption, address alveolar insufficiencies with bone augmentation, prevent the development of bony dehiscence/fenestration, lessen the likelihood of gingival recessions, increase stability of orthodontic treatment, and expand the range of safe tooth movement [4].
The aim of this report is to highlight the technique and surgical considerations of PAOO for rapid orthodontic tooth movement.

Case 1
This case report presents a 21-year-old female patient with class I malocclusion along with a thin periodontal biotype and buccal plate deficiency who received PAOO for rapid orthodontic

tooth movement for extraction space closure along with particulate bone grafting using a combination of Freeze-Dried Bone Allograft (FDBA) and Demineralized Freeze-Dried Bone Allograft (DFDBA) mixed with autologous platelet-rich fibrin (PRF).

Intraoral examination revealed Angle's Class I molar relation with bimaxillary protrusion. Assessment of soft tissues revealed a thin gingival biotype in relation to maxillary and mandibular anterior teeth. Patient was systemically healthy and maintained good oral hygiene. Correction of bimaxillary protrusion and dental relationship were the orthodontic treatment objectives. To attain the objectives, a treatment plan was designed involving extraction of the upper and lower first premolars as well as corticotomy-assisted retraction space closure to correct the proclined teeth. The aims of this interdisciplinary regimen was to align the teeth, stabilize occlusion and to promote a favourable microenvironment of soft and hard tissues.

Radiographic examination using cone beam computed tomography images (CBCT) demonstrated different levels of buccal bone deficiency in the mandibular anterior teeth. Root length of teeth adjacent to extraction space was measured from the crest of bone to determine the length of vertical corticotomy cuts.

The patient was explained regarding the procedure and consent was obtained for surgery.

Surgical procedure

After profound anaesthesia (under lignocaine with 1:80,000 adrenaline), incision was given on the crest of the ridge in extraction space using a no. 15 Bard-Parker surgical blade preserving the gingival margin of adjacent teeth in maxilla and extending as sulcular incisions in mandible. Vertical releasing incision was given on the line angle, one tooth away from the extraction site in maxilla for better access and easier flap reflection. Vertical incision was avoided in the mandible to avoid injury to mental nerve. Elevation of a full-thickness mucoperiosteal flap extending 3-4 mm beyond the mucogingival junction was done. With the help of surgical bur No. 6, under copious cold saline irrigation, vertical grooves were placed in the extraction space, midway between the root prominences in the alveolar bone on either side which were given from a point about 2-3 mm away from the alveolar bone crest to a point about 2 mm past the apices of the roots.

The vertical cuts were deepened to a depth of approximately 1.5-2 mm extending to spongiosa. Considering the close approximation of roots of lower incisors, indentation corticotomy in the form of perforations were made in the inter-radicular space centered between the root prominences in the alveolar bone.

Preparation of PRF

A sterile tube without anticoagulant was used to collect 10 ml of intravenous blood from the antecubital vein for the PRF, which was then immediately centrifuged at 2700 rpm for 12 minutes. Three layers-a red blood cell base at the bottom, acellular plasma at the top, and a potent PRF clot in the middle-appeared in the tube after centrifugation. The PRF clot was removed from the tube using sterile tweezers, and the RBC base was divided using scissors.

After bleeding control of the surgical site, a combination of FDBA and DFDBA mixed with PRF (Approximately 0.5-1 cm^3 of particulate bone graft for each tooth-bearing segment) was placed and the flap was repositioned without tension and secured with interrupted sutures in maxilla and continuous sling suture in mandible.

Antibiotic Novamox 500 mg capsules thrice daily and analgesic Zerodol-P tablets twice daily for 5 days were prescribed. The patient was given instructions to rinse her mouth twice daily with 0.2% chlorhexidine mouthwash and to refrain from brushing the operated region for a week. Sutures were removed after 10 days postoperatively. The active orthodontic treatment was begun within 1 week after surgery.

Subsequent to surgery, healing was clinically favorable. At 3 months followup, periodontal tissue was stabilized and showed increase in the thickness of keratinised tissue.

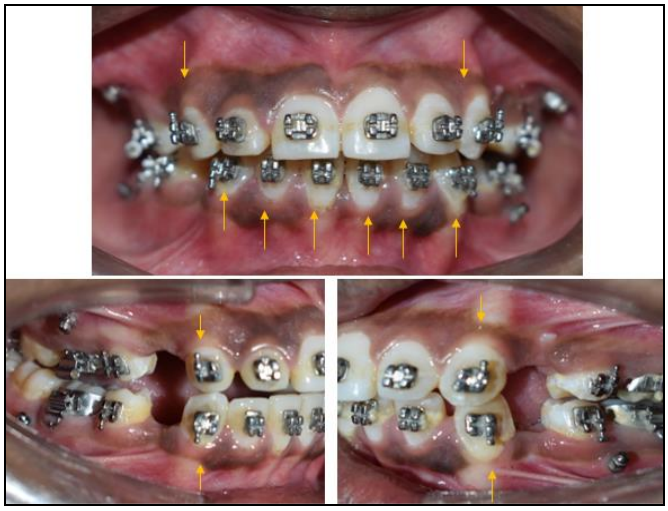

Fig 1: Pre-treatment intraoral photographs: Thin gingival biotype (indicated by orange arrows)

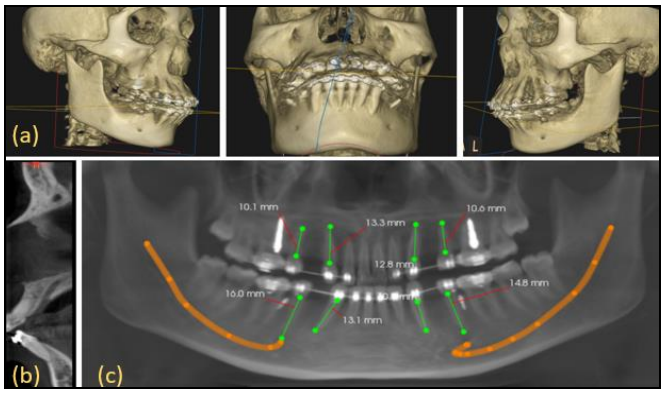

Fig 2: Radiographic examination (a) Pre-treatment 3-Dimensional CBCT images. (b) Buccal bone plate deficiency in association with lower anterior teeth. (c) Measurement of root length from crest of bone and determination of position of mental nerve

Fig 3: Preparation of platelet-rich fibrin (a) Digital Centrifuge machine at 2700 rpm for 12 min. (b) Obtained PRF clot

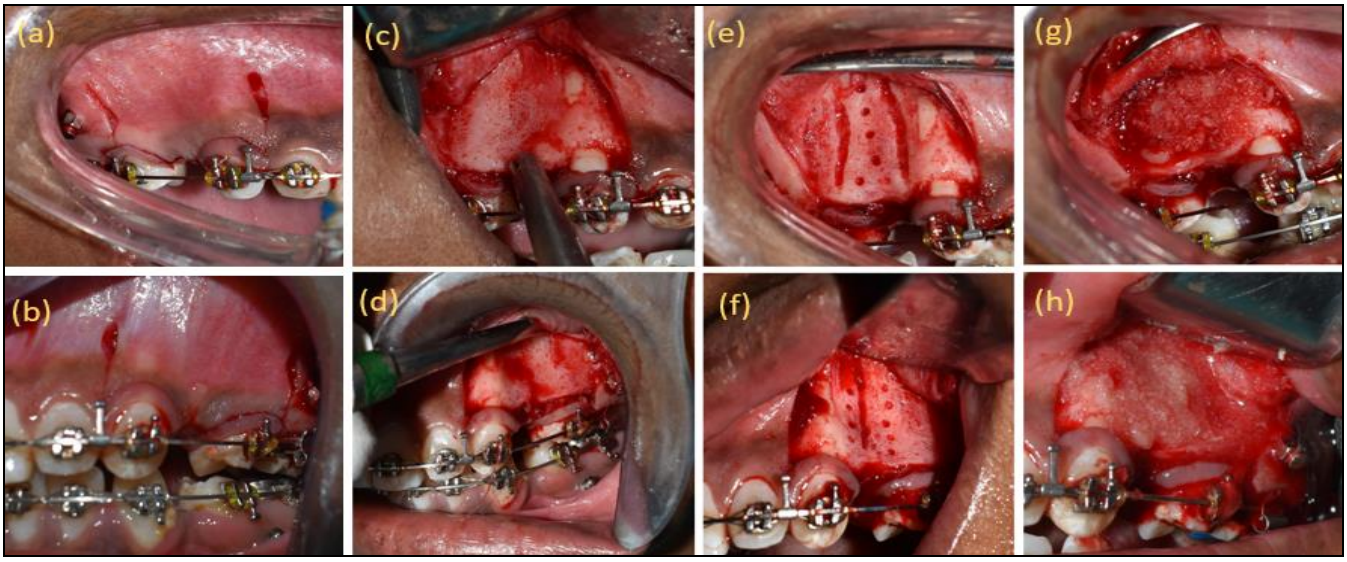

Fig 4: Surgical procedure in maxilla (a), (b) Incision given preserving gingival margin of adjacent teeth and vertical incision given along the line angle. (c), (d) Full thickness mucoperiosteal flap raised exposing the alveolar bone. (e), (f) Combination of vertical cuts and indentation corticotomy in the first premolar extraction site region. (g), (h) particulate grafting with FDBA+ DFDBA mixed with PRF.

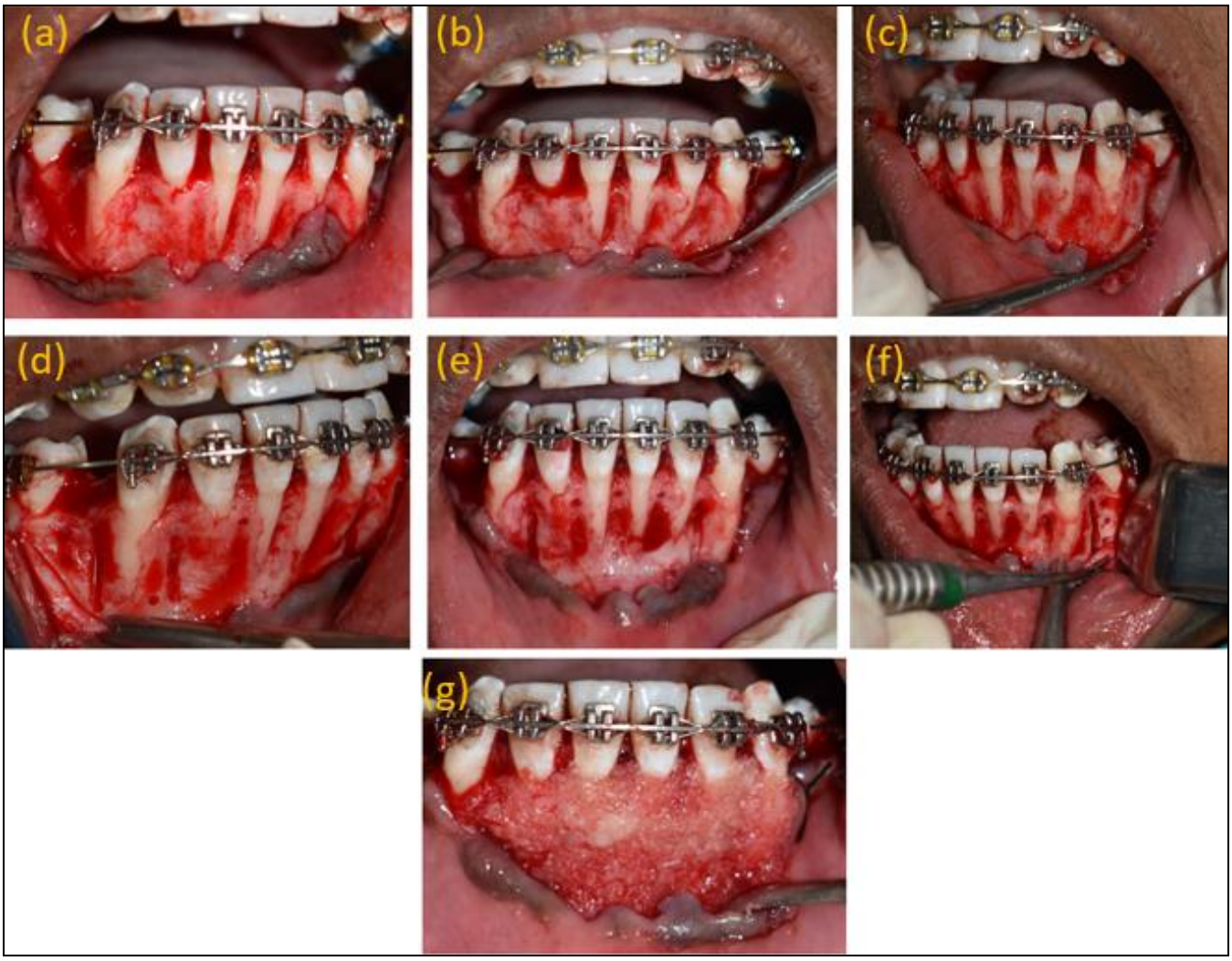

Fig 5: Surgical procedure in mandible (a), (b), (c) Sulcular incision given and full thickness mucoperiosteal flap raised. (d), (e), (f) Vertical cuts in the first premolar extraction site region and indentation corticotomy in the inter-radicular space. (g) Particulate grafting with FDBA+DFDBA mixed with PRF

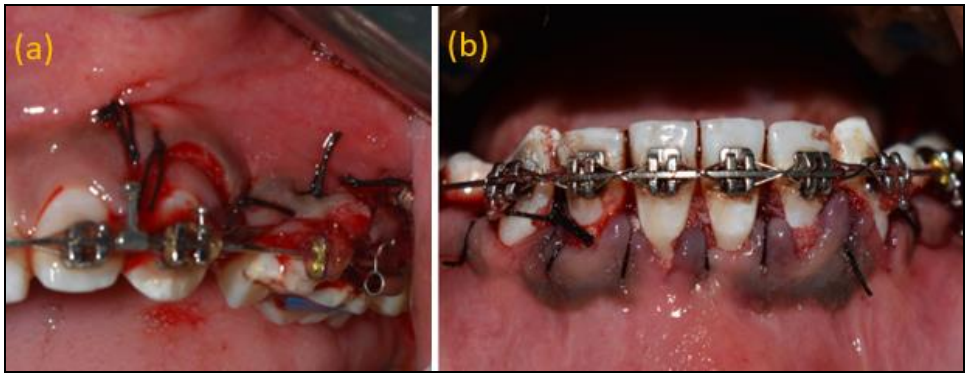

Fig 6: Suturing with 4-0 Black Silk (a) Interrupted sutures in maxilla. (b) Continuous sling suture in mandible

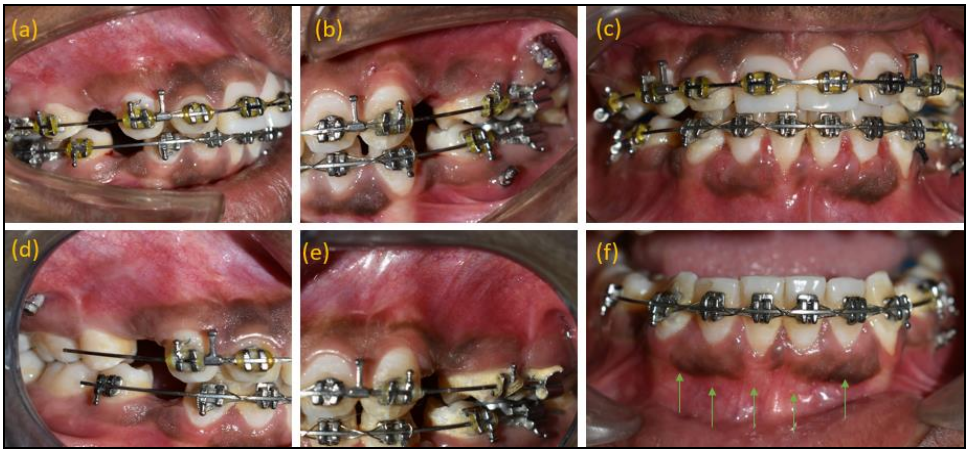

Fig 7: Follow up (a), (b), (c) At 21 days. (d), (e), (f) At 3 months. (f) Improvement in gingival biotype (Indicated by green arrows)

Case 2:

This case report presents a patient with class III malocclusion along with buccal plate deficiency who received PAOO for rapid orthodontic tooth movement along with particulate bone grafting using xenograft (Osseograft) and Alloplast (Sybograf).

A 22-year-old male patient was referred from the Department of Orthodontics, for corticotomy procedure to facilitate accelerated orthodontics. Clinical examination revealed Angle's class III malocclusion with generalized spacing in upper anterior sextant. Soft tissue examination revealed presence of adequate width of attached gingiva and thick gingival biotype. Oral prophylaxis was performed and surgical treatment (corticotomy) was planned. Medical history was non-contributory and routine hemogram was normal.

Cone beam computed tomography was taken involving maxilla and mandible. Root length of all the teeth involved in surgical area from right upper first molar to left upper first molar was measured from the crest of bone, to determine the length of vertical corticotomy cuts.

Informed and written consent was obtained from the patient prior to surgery.

Surgical procedure

After achieving adequate anaesthesia, modified papilla preservation flap was performed in anterior region, where horizontal incision was given on buccal keratinized gingiva at the base of the papilla connected with mesio-distal buccal intrasulcular incisions. Crevicular incision was given extending in premolars and molars. Vertical releasing incisions were given in the distal line angles of first molar on both sides. Full thickness mucoperiosteal flap was reflected from distal line angle of right first molar to distal line angle of left first molar. Adequate flap reflection is performed extending 2-3 mm more than the apical extent of the root. Indentation corticotomy were made using surgical round bur No. 6, simultaneously with copious saline irrigation in the inter-radicular space, between the root prominences in the alveolar bone in the anterior region. In the posterior aspect, as there was sufficient distance between the roots, vertical grooves were made 2 mm from the crest of alveolar bone and extending up to 2 mm beyond the apices of the roots. The depth of the cuts were made such that the bur extended from cortical bone to cancellous bone about 1.5 to 2mm. After performing decortication, particulate bone grafting using a combination of xenograft (Osseograft) and Alloplast (Sybograf) mixed with autologous PRF was done. Flap was adapted back to its original position and sutured using (4-0) vicryl sutures.

Fig 8: Pre-treatment intraoral photographs

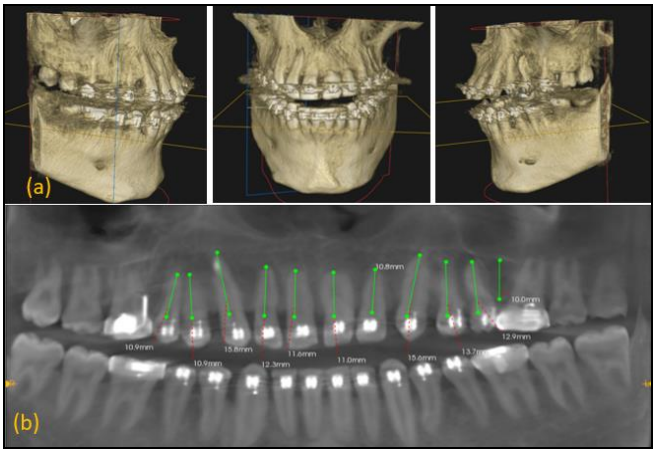

Fig 9: Radiographic examination (a) Pre-treatment 3-Dimensional cone beam computed tomography images. (b) Measurement of root length from crest of bone

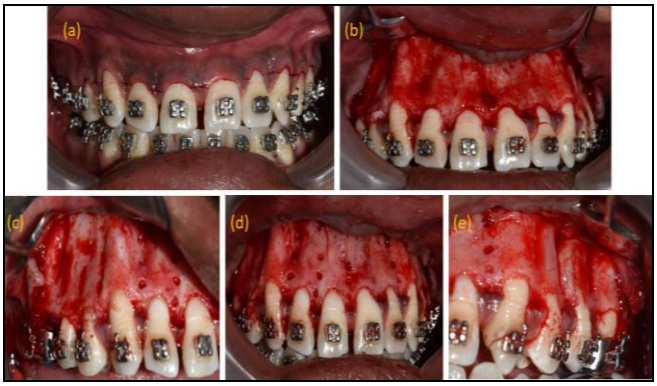

Fig 10: Surgical procedure (a) Incision for modified papilla preservation flap given. (b) Full thickness mucoperiosteal flap raised exposing the alveolar bone. (c), (d), (e) Combination of vertical cuts and indentation corticotomy

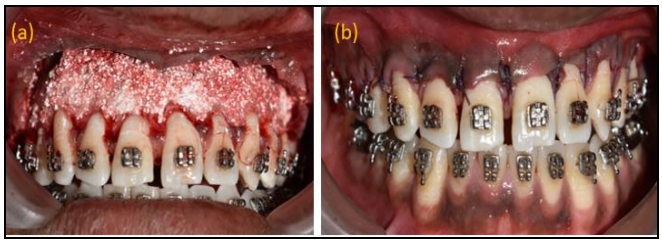

Fig 11: (a) Particulate bone grafting using xenograft (Osseograft) and Alloplast (Sybograf) mixed with PRF. (b) Interrupted sutures given with 4-0 Black Silk

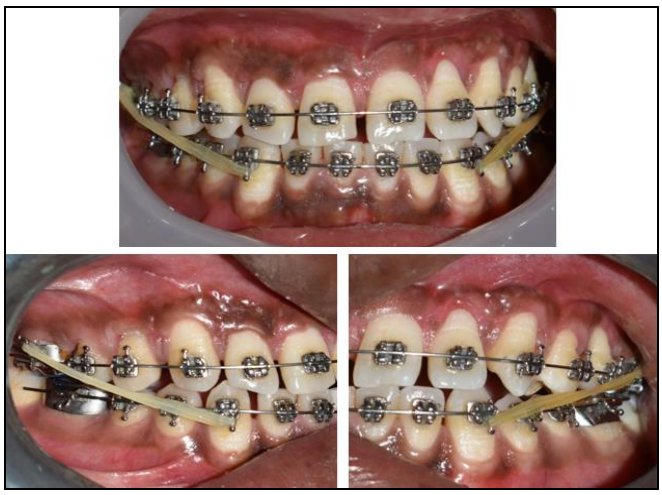

Fig 12: 1 Month Follow up

Discussion

Reducing the length of orthodontic treatment is seen as one of the most important goals in the treatment of malocclusions. The use of corticotomy as an orthodontic treatment option has been suggested for rapid tooth movement. Geramc observed that there was a dramatical reduction in the total time required for orthodontic treatment, 16 months in PAOO assisted orthodontic tooth movement in comparison to the average treatment time for extraction therapy which took about 31 months [5].

Regional acceleratory phenomenon (RAP) is a biologic condition that describes the initial reaction of bone following a traumatic injury. There is an increase in bone turnover transiently and a decrease in trabecular bone density [2]. Similar tissue remodeling is seen after a surgical osteotomy or a fracture.

Alveolar corticotomy is a surgical procedure involving only cortical bone that is incorporated into orthodontic treatment plan to aid in the treatment of complicated occlusal issues. The corticotomy cuts given generates a localized RAP at the site of injury. Bone regenerates faster at the site than the normal regional regeneration process [2]. The quicker tooth movement is caused by osteopenia, a localised and reversible loss in mineral bone density that starts at the beginning of RAP and decreases as it progresses. Following the completion of orthodontic tooth movement, a favourable environment for alveolar remineralization is produced [6].

Particulate grafting enhances bone thickness, reducing orthodontic tooth movement relapse and enhancing post-orthodontic stability. Use of bone grafts mainly provides the feature of combination of mechanical support and osteoconduction and in certain cases osteoinduction and osteogenesis. Osteoconduction entails osteoblast and osteoprogenitor cell adhesion, as well as their subsequent migration and ingrowth within the graft's three-dimensional structure. Osteogenesis, or rather differentiation and the subsequent formation of new bone tissues from donor cells derived from either the host or grafts, is further induced by osteoinduction, which calls for inducing the unspecialized, undifferentiated, and pluripotent cells in the development of the osteoprogenitor lineage.

Autogenous bone grafts are typically regarded as the gold standard. A combination of PAOO and autogenous bone harvested from the mandible in a 41-year-old male was initially documented by Nowzari *et al.* [7]. Although the biocompatibility and survivability of the transplanted osteogenic cells are crucially higher with this procedure, the harvest is accompanied by inevitable issues, such as secondary operation and quantity restriction. As an alternative, various biomaterials for bone regeneration, such allografts, xenografts, and artificial bone replacements, are also beneficial choices. Murphy *et al.* reported that there is no reliable evidence contrasting the superiority of various grafting materials [8].

In the aforementioned cases, PRF was prepared in accordance with protocol given by Choukroun *et al.* in 2000 for enhancing soft tissue and bone regeneration. PRF is a "second-generation" platelet concentrate having accumulated growth factors [9]. PRF effectively accelerates up wound healing, eases discomfort and edema, encourages cell migration and neovascularization, and triggers angiogenesis. Due to its "sticky bone" consistency and release of autogenous growth factors, PRF improves graft survival, bone regeneration and wound healing when combined with bone substitutes and applied to the surface of bone wounds.

The combination of PRF with PAOO in rapid orthodontic tooth movement has been utilised seldom, despite the practical benefits of PRF, such as simple preparation, improved grafting mixture stability and protection against exposure. In an observational cohort study, Munoz *et al*. used PRF with PAOO surgery to monitor the clinical outcomes for edema and pain [10]. This case report which combined application of PRF with PAOO in orthodontic patients with buccal bone deficiency and thin gingival biotype were shown to provide additional gain in the thickness of the gingiva.

There have been a number of reports detailing undesirable consequences following corticotomies on the periodontium including mild interdental bone loss, loss of attached gingiva and periodontal defects. Following extensive corticotomies, subcutaneous hematomas of the face and neck have been documented. However, the present case report did not show any such changes.

The PAOO procedure may be thought of as an integrative surgery for attaining periodontal regeneration and dentoalveolar bone formation. It is also capable of optimising dentoalveolar interactions and achieving a balance between the surrounding hard and soft tissues.

Conclusion

When compared to traditional orthodontic therapy, PAOO aid to shorten the length of the treatment. After treatment, PAOO enhances bone volume and covers the vital root surfaces, which improves postorthodontic stability and repairs alveolar dehiscence. To prevent complications and to expedite orthodontic tooth movement, the periodontist should take the alveolar topography into account while selecting an appropriate procedure. The PAOO method can be considered a promising treatment option given the rising demands for aesthetics and the need for quick treatment results.

Patient Consent

The authors confirm to having acquired all necessary patient consent papers.

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Conflict of interest: Nil.

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