Orthodontic Tooth Movement in Space

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Abstract

Orthodontic tooth movement leads to both bone formation and removal of bone for proper placement of teeth in the dental arch. This mechanics of bone formation due to orthodontic tooth movement can be taken to our advantage and can be used in formation of new bone in areas of bone deficit. Aim of this study was to see for alveolar bone regeneration in regions where there was no bone with the help orthodontically tooth movements.

Keywords: Dentigerous Cyst , Alveolar Bone Deficiency, Orthodontic Tooth Movement.

Introduction

Movement of teeth through alveolar bone by orthodontic forces has been performed since the ancient times. Orthodontic tooth movement can lead to the creation of bone. As a tooth is moved orthodontically through the alveolus, remodeled bone forms behind the root, and this bone is retained along the width of the tooth that has moved. This principle is true even when the alveolus is narrow.[1] Adaptive biochemical response to applied orthodontic force is a highly sophisticated process. Many layers of networked reactions occur in and around periodontal ligament and alveolar bone cells that change mechanical force into molecular events and orthodontic tooth movement. Osteoblast and osteoclasts are sensitive to genomic and environmental factors there by capable of restoring system homeostasis disturbed by orthodontics mechanics.[2] Therefore, when tension is applied to the periodontal ligament, periodontal fiber bundles are elongated, and osteoblasts are induced to deposit new bone in the areas of the alveolus where periodontal attachment exists. For example, forced orthodontic eruption of teeth is an alternative approach to bone graft surgeries to improve the hard and soft tissue contours at a future implant site. As described by Heithersay and Ingber, this technique has been used to correct isolated bone defects, reposition the gingival margin, and lengthen the crown.[3]

Various osseous defects are manifested in the oral cavity. Osseous defect are those which are formed as a result of destruction of the alveolar bone, it can be due to periodontal diseases, cystic lesions or congenital bone defects. Osseous grafts like heterogenous, homogenous, autogenous and bone like material have been used to treat the bony defect with varying degrees of success. Grafting, as well as other methods of treatment, has its limitations and must be used judiciously. Orthodontic tooth movement has been suggested as a method by which osseous defects may be eliminated or altered to provide a base from which surgical procedures can be performed. Geraci et al artificially created osseous defects of 2 and 3 wall varieties in Rhesus monkeys and shower that, by moving a tooth into an artificially produced defect can result in complete healing

and regeneration of bone. [4]

According to a study [5], orthodontic forces can be applied to a tooth that was previously associated with a dentigerous cyst after enucleation of the cyst. There are few to no studies to show that effective bone can be regenerated by orthodontic tooth movement, when moved through the treated osseous defect. The aim of this paper is to discuss the role of orthodontics in rehabilitation of alveolar bone in patents, with particular emphasis on the procedures used to treat bone defects.

Case Report 1 - Orthodontic Extrusion of A Tooth Post Enucleation of its Dentigerous Cyst

Diagnosis

A 17 year old female patient reported with the chief complaint of irregularly placed teeth and wanted to get orthodontic treatment for the same. On clinical examination the case was diagnosed with having a straight profile, orthognathic divergent and competent lip. Intra orally there was ectopically erupted mandibular left second premolar (35) with distally tipped 34 into the edentulous space of 35 (Figure1). The lateral cephalograph analysis showed a class I skeletal pattern with an average growth pattern. The panoramic radiographic examination revealed a radiolucency measuring of 6mm in diameter around the roots of 35 (Figure 2) for which the patient did not have any symptoms. An incisional biopsy was obtained from the cyst wall for histopathologic examination, which confirmed the initial diagnosis of a dentigerous cyst without evidence of any dysplastic changes.

Fig. 1 Intraoral pictures showing ectopic erupted premolar (35)

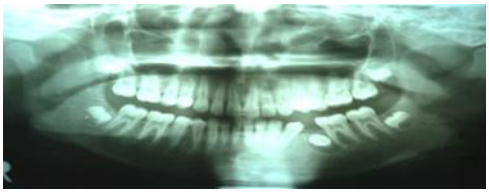


Fig. 2 OPG showing a radiolucency in relation to 35

Treatment Objectives and Plan

The treatment objectives were to excise the dentigerous cyst followed by orthodontic leveling and aligning all, including the teeth that was associated with the dentigerous cyst. One of the treatment plan was a non-extraction line of treatment. Where the cyst would be enucleated and followed by using pre-adjusted edgewise straight wire appliance (fixed orthodontic biomechanics) to extrude 35 into the arch. Alternative treatment was to enucleate the cyst alongside with extraction of 35 and later provide prosthesis in 35 region. Patient was given the various options of prosthetic components that can be used, one being a fixed bridge unit involving 34 and 36 and the other being an endosseous implant. The patient was not ready for the extractions and wanted to proceed with the non extraction mode of treatment plan.

Treatment Progress

First the cyst was enucleated under local anesthesia. A BIPP (bismuth iodoform paraffin paste) gauze pack was inserted into the cyst cavity and secured with a suture for healing. One week after the procedure, the site was irrigated with povidone iodine and replaced with a fresh BIPP gauze pack, which was kept in place for another week. After 2 weeks the pack was removed. The empty cavity of the cyst persisted. Orthodontic treatment was initiated.

The bracket prescription was 0.022 X 0.028 inch slot MBT. The maxillary arch was strapped and a lingual button on 35.A lingual arch in the mandible was used as the anchor unite to extrude 35 by extending an elastic chain from the lingual arch to the premolar (Figure3a). This continued for 8 weeks with changing the elastic chains

every 3 weeks. The wire sequence for maxillary arch was 0.014, 0.016, and 0.016 X 0.022 nickel titanium wires followed by 0.017 X 0.025 and 0.019 X 0.025 stainless steel wires. The entire mandibular arch was strapped up after two months of initiation of extrusion of 35. The leveling and aligning of the remaining teeth in the arch took place with 0.014'', 0.016'' nickel titanium wires followed by the stiffer wire of 0.016X0.022'' stainless steel. Once on this wire, a 0.014'' nickel titanium wire was used as piggy back from the bracket of 35 to extrude the tooth into the arch (Figure3b). Eventually the tooth was bought into the arch and final de-rotation of 35 was done with super elastics nickel titanium wires (Figure3c,d). The entire duration of treatment was for 18 months (Figure3e).

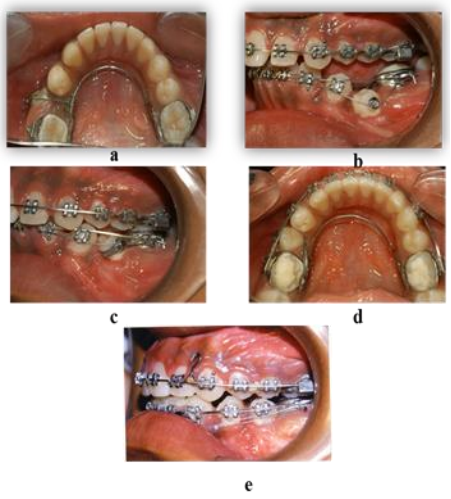


Fig. 3 Fixed mechanotherapy a- lingual arch with extrution of 35, b- piggy back wires, c d derotation mechanics, e- post leveling

Treatment Results

Post treatment panaromic radiographs showed that bone was formed in the previous cystic cavity region (Figure 4). It proved that without any bone augmentation, orthodontic tooth movement can aid in bone formation in a cystic cavity region.

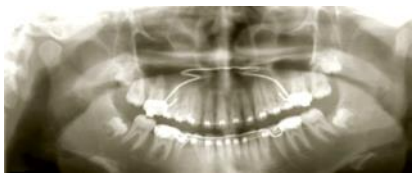


Fig. 4 Panaromic radiograph post leveling and aligning

Case Report 2- Regeneration of Bone by Dentoalveolar Distraction Osteogenesis

Diagnosis

A 26 year old male patient reported to the department with the chief complaint of spacing in the lower anterior tooth region. On clinical examination the case was diagnosed having a straight profile, orthognathic divergence and competent lip. Intra oral examination showed mild spacing in the lower anteriors and an asymptomatic swelling in the right maxillary quadrant in the premolar region. On Radiographic OPG examination revealed a cyst in the right canine-premolar region. With further CBCT examination revealed the extent of the cyst which measures 1.5 cm wide and 1cm long extending from the right maxillary canine, first premolar and the second premolar root apices (Figure 5). He was diagnosed with ossifying fibroma of with well defined solitary radiolucencies and scattered radio-opaque foci.

Fig. 5 Panaromic radiograph & CBCT images

Treatment Objectives and Plan

The treatment objectives were to remove the pathology follower by regeneration of bone in the region for prosthetic rehabilitation. Treatment plan was to extract 13,14 & 15 which were in association to the pathology and to form bone in the region of the cavity by mild orthodontic tooth movement by the dentoalveolar distraction osteogenisis and followed by orthodontic

leveling and aligning and placing endosseous implants in the region of 13,14 &15. The second treatment plan was to extract the affected teeth, orthodontic leveling and aligning of teeth followed by removable partial denture in the extraction site. Patient opted for the first treatment plan as he was not willing to use a removable partial denture.

Treatment Progress

During extraction of 13, 14 and 15, an osteotomy cut was given mesial and distal to the lateral incisor in the buccal cortex to mobilise the segment. Palatal cortex remained intact for adequate blood supply to that region. After a latency period of 4-5 days, the distraction procedure was started to distalise the lateral incisor till it reaches to the mesial surface of the molar on the same side, to help bone formation in the defect created by the extraction. An expanded jack screw was soldered to the lateral incisors and the molarbands (Figure6) and for the distraction phase the screw was turned 90 degree every day for 3 week to the patient.

Treatment Results

In the post treatment OPG there was radio-opacity indication of bone formation post orthodontic tooth movement (Figure 7).

Discussion

In this study we found that there was bone formation when a tooth was moved orthodontically through an empty space with no alveolar bone. One of the greatest specialists in this domain, professor Birte Melsen satated; when teeth have to be moved into areas with an atrophic alveolar process due to extraction of teeth, a balance between resorption and

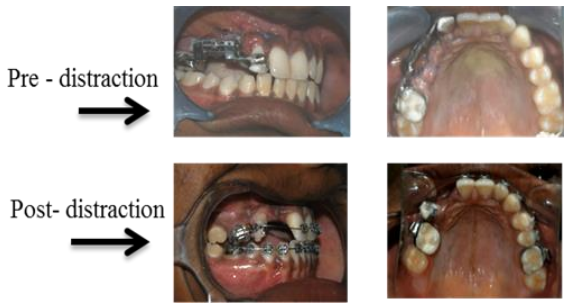
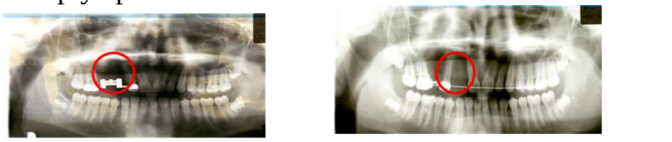


Fig. 6 Distraction mechanics with the help of jack screw

apposition has to be kept, and the tooth is, so to speak, "carrying its alveolus along". [6] The orthodontic extrusion merely relocates the existing attachment in a coronal direction. The relationship between the cementoenamel junction and the bone crest is maintained and the bone simply follows the tooth.[7] Despite advances in the materials and technologies used to fabricate prosthesis, the cements used to retain them, failure and the need to replace crowns and bridges occurs.[8] Added to this there would have to be



a-pre retraction with visibal radiolucent region in the region of 13,14 &15

b-post retraction with visible radio-opaque region of bone formation in the region of 13,14 &15

Fig. 7 Panaromic radiographs a-pre retraction with visibal radiolucent region in the region of 13,14 and15,b-post retraction with visible radio-opaque region of bone formation in the region of 13,14 and 15

intentional crown cutting of the adjacent healthy teeth to support the pontic. Success rates of endosseous implants depend on the site of the implant, patient factors, the skill and judgment of the surgeon, and the type of implant placed. The literature suggests, in fact, that all of these factors interact and determine success or failure. There is no 100% success rates on an endosseous

implants.[9] Hence to save a teeth from extractions would be the best way to preserve the integrity of the arch. In the first case represented there was bone formed in the previously occupied cystic cavity. One study showed a case report where a molar was passively allowed to erupt after removing the dentigerous cyst that was associated with it[5].

A variety of surgical procedures have been proposed to augment the local bone volume of deficient sites, such as: autogenous bone grafts, guided bone re- generation and alveolar distraction osteogenesis. However, despite a relevant number of publications reporting favorable results with these different surgical procedures, considerable controversy still exists as far as the choice of the most reliable technique is concerned; this is frequently due to the lack of comparative studies. These techniques are associated with a relevant morbidity and the resorption of a significant part of the graft or its exposure is two of the most frequently reported complication. One of the study stated that orthodontic tooth movement into areas filled with

synthetic bone substitute may be associated with an increased risk of root resorption.10 In 2001, Iseri and Kisnisci introduced a new technique named dentoalveolar distraction (DAD), which achieves rapid tooth movement using the principles of distraction osteogenesis to form new bone. With this new technique, osteotomies are made around the tooth for rapid tooth movement within the dentoalveolar segment using the principles of distraction osteogenesis. The tooth is moved within the alveolar segment, the risk of harmful side effects on the surrounding hard and soft tissues is eliminated. Therefore, no clinical and radiographic evidence of root fracture, root resorption, ankylosis, soft tissue dehiscence, or loss of vitality was observed in the teeth at the end of DAD and orthodontic treatment.11 Hence formation of bone with mild orthodontic forces and movement is of a more natural way of creating bone.

Conclusion

From the presented case reports we found that alveolar bone can be formed with orthodontic tooth movement through a region of alveolar bone deficiency. There are few to no studies that have been performed to test the same. Further investigation with a larger sample size would build up evidence to successfully use orthodontic tooth movement in empty spaces of alveolar bone region.

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