

Endodontic Considerations in Contemporary Orthodontic Practice- A Review

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ABSTRACT

Introduction: With increase in number of adult orthodontic patients, the orthodontic- endodontic related patients are also expected to rise. There are number of clinical dilemma where both the specialties need robust guideline for clinical decision making. The effect of orthodontic force is expressed in different way in different patients and teeth which need to be understood by clinicians. On the contrary, the tooth movement of endodontically involved teeth demands careful evaluation of the tooth and its surrounding tissue, quality of root treatment, presence or absence of peri-apical pathologies, previous history of trauma etc. Management of external apical root resorption following orthodontic therapy might be challenging some time. Orthodontic extrusion of fractured teeth is one of the viable prosthetic rehabilitation options where orthodontic, endodontic and prosthodontics specialties are involved. So this review article will focus on reviewing current level of evidence on orthodontic- endodontic interface.

KEYWORDS: Endodontic, External apical root resorption, Orthodontic, Pulp, Trauma

INTRODUCTION

Orthodontic correction of malocclusion by modern orthodontic means dates back to more than one hundred years. Over the century, the orthodontic treatment philosophy has evolved a lot. The fundamental of every orthodontic therapy is amount of force and duration of force delivery to conduct orthodontic tooth movement. The amount of force necessary to conduct different orthodontic teeth movement is not same. The highest amount of force is needed for translation and torque whereas minimal amount of force is needed for intrusion¹. However it is important to know that because of difference on root surface area of teeth, same amount of force can be ideal for large rooted teeth and deleterious for small teeth such as central and lateral incisors¹. The mechanism of tooth movement occurs by continuous remodeling of bone with resorption on pressure side and deposition on tension side. However

this mechanism is not as simple as described. Pressure and tension side can be on either side of the periodontal ligament which is controlled by continuous cellular mechanism in response to force². Two types of bony remodeling has been explained in orthodontic literature, frontal and hyalinized (rearward)^{3,4}. From Angle era till today, it has been established that heavy orthodontic forces are deleterious to tooth movement⁵. Because of heavy forces, it is believed that blood vessels adjacent to periodontal ligament get completely occluded leading to necrosis. This necrosis creates glass like appearance known as hyalinized area which need to be resorbed by immune system to start the tooth movement. The area near to hyalinized tissue start bone remodeling hence moving teeth in stepwise fashion. This episode of necrosis and repair is an aggressive phenomenon which might be associated with iatrogenic consequences such as teeth hypersensitivity, pulp necrosis, external apical

root resorption, ankylosis and peri-apical abscess^{6,7}. The clinical decision making is difficult while doing orthodontic therapy of traumatized teeth, endodontically treated teeth or teeth in need of endodontic therapy. Orthodontic force remodels the Periodontal Ligament (PDL) and alveolar bone surrounding root. Root canal treated teeth do not have vitality of the pulp. The apical foramen and entire root canal are sealed with sealer and gutta-percha. Though the periodontal ligament is unaffected in root canal treated teeth, it is important to know how the endodontically treated teeth behave with orthodontic tooth movement. In addition to this, orthodontic therapy on traumatized teeth might be challenging many times. Additionally, a teeth treated with surgical endodontics might not behave in a same way as normal teeth. In this review the first the effect of orthodontic force on teeth will be discussed. Then detail review of current evidence on orthodontic tooth movement of endodontically related teeth and traumatized teeth will be elaborated.

Effect of orthodontic force on pulp:

The reported effect of orthodontic force on pulp are vacuolization, congestion, circulatory changes, hemorrhage and fibrinolysis^{6, 8-10} These effects are more obviously expressed with heavy forces and during intrusive mechanics. There are conflicting reports on effect of force on pulp vitality. Though very few studies suggested that heavy forces can lead to loss of tooth vitality but there are not enough evidences to support this fact¹¹. Most of the other studies have shown that there might be changes in pulpal blood flow, hyperemia or oxygen saturation but no long term effect on pulp vitality^{9, 12-14} The study has shown that even with heavy intrusive force there is no change in vitality of dental pulp in normal teeth but teeth having history of previous trauma are more susceptible to pulpal necrosis¹⁵. Traumatized incisors, especially maxillary lateral incisors have high chance of pulpal necrosis during orthodontic intrusion than normal teeth¹⁵. Usually heavy forces are applied on teeth while doing orthopedic treatment of jaws such as maxillary expansion, head gear and reverse pull head gear therapy. Force equivalent to capillary blood pressure is taken as ideal orthodontic force which ranges from 10 mm HG to 22 mm HG¹. In one of the article explaining history of orthodontic tooth movement, Will has mentioned that "Oppenheim showed some signs of severe pulpal degeneration in all human cases using a labiolingual expansion appliance"¹⁶. Oppenheim, one

of the pioneer in orthodontic biology recommends using light and intermittent force to reduce iatrogenic effects and allow PDL to repair in between. Laser Doppler flowmetry and pulp oximetry are used to check the pulpal vitality by analyzing pulpal blood flow and oxygen concentration respectively. It has been shown that pulpal blood flow (PBF) increases in first few weeks of orthodontic therapy followed by decrease in PBF^{14,17}. The changes in pulpal environment can be determined by evaluating different inflammatory markers expressed by pulp. Some of the pulpal markers are Aspartate Aminotransferase (AST), Alkaline phosphatase (ALP), various growth factors such as epidermal growth factor (EGF), platelet derived growth factor (PDGF), vascular endothelial growth factor (VEGF), fibroblast growth factor-2 (FGF-2) and transforming growth factor beta (TGF- β) in pulpal tissues¹⁸. Number of researchers have found that orthodontic force application increases the inflammatory and angiogenic markers in pulp which proves that orthodontic force has certain effect in pulp which might be hyperemia followed by repair^{7,11,12,14,17,19,20}. It has been reported that orthodontic intrusion increases the fibrin content and stone in pulp²¹. Few studies have reported pulp vacuolization and osteoblast disruption without necrosis as well²²⁻²⁴. Effects of orthodontic forces on PBF are associated with various factors including patient's age, size of apical foramen, dentinogenic activity and not only the magnitude and duration of the force applied.

Orthodontic tooth movement and root resorption:

According to the Glossary-Contemporary Terminology for Endodontics, resorption is defined as a condition associated with either a physiologic or a pathologic process resulting in a loss of dentine, cementum, and/or bone²⁵. There are different reasons for three different types of resorptions explained in literature; External root resorption, Internal root resorption and Replacement resorption²⁶⁻²⁸. Internal root resorption occurs because of ongoing pulpal pathologies whereas external root resorption are associated with trauma and orthodontic tooth movement. Replacement root resorption occurs following heavy trauma. There are some reports that ankylosis can be seen during or after orthodontic therapy^{29, 30}. However this is not the common effect of orthodontic therapy. External Apical Root Resorption (EARR) occurs most commonly following long term orthodontic therapy^{10,14,20,31-35}. Various factors associated with EARR are genetic predisposition, systemic factors, nature and duration of tooth

movement, alveolar and root morphology etc.³³. On an average 2 mm of EARR following orthodontic therapy is regarded as normal which appears as blunting of apex of root. Over 80% of the patients undergoing orthodontic therapy has mild EARR(36). EARR is divided into mild, moderate and severe. Apical root desorption of 2 mm or less is regarded as mild whereas up to 4 mm is moderate and more than 4 mm is classified as severe³⁷. The loss of periodontal ligament in apical region is less detrimental than that in cervical region. Generally 3 mm of apical root resorption is equivalent to 1 mm of alveolar bone loss in cervical region³⁸. It has been found that even after the loss of 4 mm of apical root, tooth will be vital and serve for many years³⁶. However we should not forget the fact that EARR causes reduced crown root ratio which might have increased mobility and more chance of avulsion in case of trauma³⁶. EARR seem to be less when interrupted and intermittent forces are applied to move teeth as it will have more time for cemental repair. Cementoblast has less reparative capacity compared with osteoblast¹⁶.

EARR appears within 6-9 months of active orthodontic therapy. If root resorption does not appear on this time, further root resorption is unlikely to occur. If there is appearance of EARR, active orthodontic force should be suspended for 2-3 months to allow for cemental repair. If root resorption continues even after repair phase, then orthodontic treatment plan should be reviewed and modified³⁹. In some instances, orthodontic treatment should be even discontinued. If EARR continues even after suspending orthodontic therapy, careful endodontic therapy should be started. First the inflammation should be controlled with calcium hydroxide dressing. Tronstad advocated the use of calcium hydroxide as a temporary intracanal medicament in the management of root resorption⁴⁰. According to him, the high alkaline pH will neutralize the lactic acid secreted by osteoclasts and the demineralization process will cease. In case of endodontic therapy in a root resorption, it is always better to use thermoplastic gutta-percha as it might have ability to seal root canal 3 dimensionally³⁹.

Effect of orthodontic force on previously traumatized teeth:

The pulp response of traumatized teeth is not same as normal teeth. As a result of impact of trauma, the pulpal blood flow and cellular content is altered^{12,14,22}. It has been found that orthodontic force has potential to damage the vitality of previously traumatized teeth

as compared to normal teeth. We need to be more cautious on amount of force applied and nature of tooth movement. Intrusive movement is more traumatic to dental pulp followed by extrusion and tipping^{15,19}. The history of tooth trauma may be the factor which might lead to pulpal necrosis during orthodontic tooth movement.

Can root filled teeth be moved safely as normal teeth?

With the advancement of technology, material sciences and public awareness, the orthodontic treatment is not only the treatment of adolescent now a days. More and more number of adult patients are seeking orthodontic therapy. A contemporary orthodontic practice has in average 25-45% of adult orthodontic patient load⁴¹. Adult patients have other dental problem in mouth and obviously they need interdisciplinary approach. One of the speciality which is closely related to orthodontic therapy is endodontics. A good endodontically treated tooth will behave in the same way as normal tooth. However many times, the inadequately root filled teeth also need to be moved by orthodontic therapy. There is a clinical dilemma whether non symptomatic inadequately root filled teeth can be moved safely or not? Huettner and Young are pioneer in doing comparative research on effect of orthodontic force on vital and non-vital teeth⁴². Before their research, non-vital teeth were thought to have inflammatory reaction in response to orthodontic force. However the study of Huettner and Young has proved that both vital and endodontically treated teeth behave in a same way. The histological reaction and root resorption was same in both the groups. The study of Wickwire et al has found that endodontically treated teeth move as normally as vital teeth but the amount of root resorption is more in endodontically treated teeth⁴³. A study from Spurrier has revealed the fact that endodontically treated teeth have less EARR than the vital teeth⁴⁴. This fact is supported by the study of Mirabella and Artun et al^{45,46}. An interesting question lies ahead: what will happen to the root filling material if endodontically treated teeth goes into EARR? There are number of theories on the fate of root filling material. There is a chance that these root filling materials will either be embedded into the alveolar bone, or get resorbed or hang on the tooth itself³⁸. Often these materials may act as source of infection and there might be sinus tract in relation to such teeth. The chance of infection is high if it endodontically treated teeth are subjected to coronal leakage.

Orthodontic Extrusion of traumatic teeth:

The most common teeth subjected to trauma are upper and lower anterior. Angle's Class II div 1 malocclusion patients are more prone to have dental trauma than other subjects⁴⁷. Depending upon the severity of trauma and level of fracture, some teeth might need orthodontic extrusion. After successful endodontic therapy of fractured teeth, a healing period of 3 weeks is recommended before starting orthodontic traction⁴⁷. During the healing period, orthodontic attachments can be placed and interim restorations can be placed but active force should be avoided. The amount of extrusion depends upon the available root structure. The general consensus is that at least 1:1 crown root ratio need to be mentioned for prolong prognosis. The advantage of extrusion is that, it brings bone along with teeth. So even after extrusion, prosthesis is not possible in same tooth, extrusion can create good alveolar bone structure for implant prosthesi⁴⁸. The retention of extruded tooth structure is equally very important. The duration of extrusion should be the duration of minimum retention period⁴⁹.

Surgical endodontics and orthodontic tooth movement

The common indications for undergoing surgical endodontics are failing attempts of non-surgical methods of root canal therapy, apical overextension of filling materials, broken instruments and non-healing periapical pathologies among many⁵⁰. The objective of surgical endodontics is to completely debride the peri-apical area and portion of the root apex so

that favorable environment is created for healing. Orthodontic therapy in such teeth is possible. However there should be healing period during which active orthodontic force is avoided. Complete 3 dimensional debridement of peri-apical area is very important⁵¹. If there is source of infection, that might act as focal site during orthodontic tooth movement. Root resected teeth has shorter root compared with normal tooth. So orthodontic biomechanics need to be modified as the center of resistance move cervically in such situation.

CONCLUSION

There is pulpal reaction to orthodontic therapy which is expressed as pulp hyperemia initially followed by pulpal repair. Pulpal necrosis following orthodontic tooth movement is very rare to occur. External apical root resorption is inevitable consequence of orthodontic therapy which does not need any endodontic intervention. Previously traumatized teeth have more chance to have pulp necrosis and root resorption with orthodontic therapy. Good endodontic therapy and sufficient healing time is necessary before starting orthodontic tooth movement. Orthodontic extrusion of traumatized teeth can be a good alternative to implant prosthesis.

Conflict of Interest: None

OJN

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