

REVIEW ARTICLE

ROOT RESORPTION AFTER ORTHODONTIC TREATMENT: A LITERATURE REVIEW

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ABSTRACT

One of the most feared complications after orthodontic treatment is the external root resorption. Root resorption leads to shortening of root and thus, the integrity of teeth arch is broken down. Both the cervical and apex zones of the roots can be affected by it due to orthodontic forces involved in the tooth movement. The future of the teeth involved may also be compromised due to orthodontic treatment. It is necessary that the patient is pre-informed about the root resorption's risks as a result of orthodontic treatment. It is possible to detect the orthodontic-induced root resorption both during the active phase of treatment and after the orthodontic treatment. The degree and severity of orthodontic-induced root resorption are dependent on a number of factors involving environmental factors and the host himself. The paper talks about the root resorption, its degree of severity, mechanism, detection methods, and significant correlation with individual susceptibility, tooth structure, fixed appliance treatment, orthodontic tooth movement, orthodontic force, and treatment duration.

Keywords: Root resorption; orthodontic appliances; orthodontic tooth movement; biological factors of root resorption; mechanical factors of root resorption.

INTRODUCTION

The clinical condition which is linked with a pathological or physiological process resulting in the loss of bone structure, cementum, or dentin is known

as resorption.¹ In orthodontics, the restructuring of cementum, periodontal ligaments, and bone take place mainly due to therapeutic procedures. In all the orthodontic treatment, reversible and self-limiting micro-resorptions of cementum and root are involved.

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Histologically, root resorption refers to induced inflammatory resorption in which the hyalinized areas and teeth undergo orthodontic forces and therefore, they are removed in the periodontal area. The removal of cementum also takes place as the removal of hyalinized tissues takes place.²

In some cases, when there is a disturbance with the repair of cementum, the process does not remain self-limiting. The odontoclasts make their way to dentin lying under the surface of cementum. The process is thus pathological as it keeps on moving in an irreversible manner because the dentin has been affected. In this process, both the neck as well as the tooth at the apex are affected. Dentin cannot be reconstructed in the case of non-infected apical resorption but the resorbed area can be covered by cementum that has been newly formed.³ The root is shortened by resorption.

In cervical root resorptions, a predisposition is created at the resorption site to the bleeding bacteria. Thus, the formation of new cementum is prevented in this situation because of its invasive nature.⁴ Therefore, it is important that these pathological resorptions should be prevented and hence, before initiating any treatment, all the conditions and risk factors should be carefully considered by orthodontists.

In case, there is a failure of preventive strategy and invasive inflammatory root resorptions still appear, there should be an accurate and early detection of the same. The earlier the detection of resorption, the easier is the treatment solution to protect teeth.

Degrees of Root Resorption's Severity

As mentioned by Brezniak (2002),⁵ there are three distinguished degrees of root resorption's severity which are as follows:

- Surface or cementum resorption in which only outer layer of cementum is resorbed. The layer is remodeled or regenerated later on.
- Deep resorption i.e. resorption of dentin with the repair. In this, the outer dentin layer and cementum are resorbed. In this process, there is irreversible resorption because regeneration of only cementum takes place. After this remodeling and resorption, the root of the tooth may be altered or it may stay the same.

- Surrounding apical root resorption in which there is an observation of the root shortening due to full resorption of hard apical tissues of the root.⁶ There is no regeneration of the root tissues as root apical tissues are lost under cementum. The outer surface is repaired in the cementum layer. Gradual leveling of the sharp tooth edges takes place later on.

Figure 1 below shows the degree of root resorption. 1A shows irregular root contour. 1B shows that the apical resorption of the root is less than 2mm. 1C shows the apical resorption of root lies between 2mm to one-third of the initial length of the root. 1D represents the apical root resorption more than one-third of the initial length of the root.³

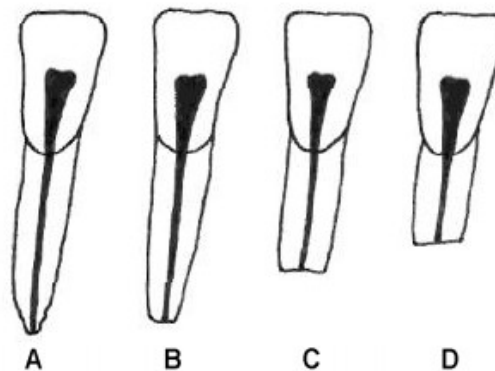


Figure 1: The Degree of Root Resorption³

Mechanism of Root Resorption After Orthodontic Treatment

As mentioned by Travess et al. (2004),⁷ fixed appliance treatment has some degree of association with external root resorption but the extent is not predictable. Resorption may be present on the lateral and apical surface of the roots, but only apical resorption is visible in radiographs to a limited extent. However, the mechanism of tooth resorption is still not clear. According to Lopatiene and Dumbravaite (2008),³ the inflammatory root resorption which is caused due to orthodontic treatment is because of the reduction of the hyaline zone. The increased activity of osteoclasts and cementoclasts during orthodontic treatment induces strong force which leads to the occurrence of root resorption and hyalinization of periodontal ligaments.⁷

During the movement of the tooth, areas of tension (i.e. induction of bone deposition due to more active osteoblasts) and compression (i.e. induction of bone resorption due to an action of osteoclasts) are formed. Therefore, the movement of the tooth takes place towards the bone resorption's side. Thus, an imbalance is created between the deposition and resorption of bone and hence, protective characteristics of cementum are lost. The result is the resorption of the root's areas due to osteoclasts or cementoclasts.⁸ The movement of the tooth is stopped when the hyaline zone is formed.

Lopatiene and Dumbravaite (2008)³ confirms that the removal of hyaline zone takes place by multi-nucleus gigantic cells and mononucleosis cells (same as macrophages) after the regeneration of periodontal ligament. After this, the movement of the tooth is started again. As the removal of hyaline zone takes place, the layer of cementoblasts present on the root surface of an outer tooth is damaged which exposes the highly dense mineralized layer of cementum lying under it.³

There are also possibilities that the outer root surface is directly damaged by the force exerted during orthodontic treatment. The root surface of the tooth lying under the hyaline zone is resorbed within some days when already there is a continuation of the repair phenomenon going on in the periphery. Thus, from the literature data, it can safely be said that after the orthodontic force is decreased and the hyaline zone is removed, the completion of the resorption process takes place.⁸

Predictive Factors for the Occurrence of Root Resorptions After Orthodontic Treatment

According to Mizrahi (2010),⁹ it has been mentioned that like other processes of dentistry, orthodontic treatment also exposes the dentist to possible legal consent. Before starting any orthodontic treatment, predictive factors for the occurrence of root resorption must be listed in the consent form that must be informed to the patient and signed by him/her. The risk factors for the occurrence of root resorption include mechanical, biological, and combined mechanical and biological factors along with other circumstances.

Biological Factors

Genetic Factors: As mentioned by Dindaroglu and Dogan (2016),² the presence of genetic factors increase the tendency for root resorption after orthodontic treatment. Everett and Hartsfield (2004)¹⁰ confirms that the severity and degree of external root resorption induced due to orthodontic treatment involve genetic factors accounting to around 50% of the variation. In a study conducted by Sameshima and Sinclair (2001)¹¹ on 868 patients, it was found that Asian patients were less susceptible to resorption in comparison to Hispanic patients.

Hartsfield (2009)¹² also mentioned that the occurrence of the resorption cells and activation of osteoclasts may be linked genetically. The literature review of all these articles proves that there are a number of findings that establish that genetic factors are linked to the occurrence of root resorption.

Systematic Factors: Lopatiene and Dumbravaite (2008)³ have established that there is an enhanced risk for root resorption in the group of allergic patients. Conditions like chronic asthma and different allergies can increase the chances of development of Orthodontically induced inflammatory root resorption (OIIRR).¹³ It has been proved in many researches that fast orthodontic movement of the tooth may be triggered by lack of estrogens¹⁴. Tooth Structure: It has been shown by many authors that there is a higher susceptibility to root resorption for roots that have an abnormal shape.²

Mechanical Factors

These factors include the use of orthodontic appliances, an influence of tooth extraction, type of movement of the orthodontic tooth, and orthodontic force.³

Orthodontic Appliances: It has been observed that the use of fixed appliances more often leads to an induction of root resorption. The impact of treatment method on teeth roots was studied by Brin et al (2001).¹⁵ The results proved that children who had undergone 2-phase orthodontic treatment with fixed orthodontic appliances were found to have more chances of developing root resorption in comparison to children who had undergone the treatment with functional removable appliances first and with fixed appliances later on. It has been established by some

researchers that the application of the type of orthodontic arch and intermaxillary Class II elastics have no impact on the development of root resorption.³ Impact of extraction of tooth: It has been found that patients who have undergone several teeth extraction have higher rates of root resorption (0.43 mm) in comparison to people who have not experienced extraction of any of their teeth(0.31mm).⁷

Orthodontic Tooth Movement: Root resorption may be induced by any type of orthodontic movement of the tooth. Most of the cases of root resorption are observed after a tooth is anchored into an alveolar bone i.e. after an orthodontic intrusion. In comparison to teeth extrusion, intrusion causes root resorption by around more than four times. Also, tooth tipping movement results in the root resorption in apical and cervical part of the root. Bodily tooth movement leads to resorption in the root's middle part due to periodontal space's shape which is thinnest in root's middle part.¹⁶

Orthodontic Force: The application of orthodontic force leads to inflammation-related cells' activation and periodontal ligaments' microtrauma. It has been established by some of the researchers that the development of root resorption is directly related to the magnitude of the force, the higher the forces, the quicker are the chances of development of resorbed lacunae¹⁷. It has also been stated by Lopatiene and Dumbravaite (2008)³ that root resorption is more when orthodontic forces are more than 20-26 g/cm² because they lead to periodontal ischemia. The root resorption of the tooth is stopped when forces are decreased to less than 20 g/cm². It has been found that an optimal force of 7-26 g/cm² on the surface area of the root may cause orthodontic movement of the tooth but does not cause root resorption.¹⁸

It has also been established that higher levels of root resorption are caused by continuous forces rather than intermittent force because it allows the restoration of blood circulation when there is no active force.³

Combined Mechanical and Biological Factors

Orthodontic Treatment's Duration: It is an important factor that may lead to root resorption. It has been established in many studies that the duration of orthodontic treatment is directly related to the degree

of severity of root resorption. As verified by Mohandesan and Valaei (2007)¹⁹ in around 34% of teeth in which orthodontic treatment continued for six to nine months, root resorption was observed. Whereas, it increased to 56% in cases where orthodontic treatment continued for 19 months. It has also been stated that during the course of orthodontic treatment, the rate of root resorption is 0.9 mm per year.

Apajalahti and Peltola (2007)²⁰ maintained that the duration of treatment along with fixed orthodontic appliances is also found to add to the root resorption's degree. Patients experiencing longer orthodontic treatment with fixed appliances had considerably more chances of grade 2 root resorption. Without root resorption, the average length of treatment is 1.5 years while it is 2.3 years in the case of patients suffering from severe root resorption.

Root Resorption after the appliances is removed: After the orthodontic treatment is completed, root resorption related to orthodontic treatment is also stopped. Once the orthodontic appliances are removed, active root resorption takes around a week to last. The cementum repair takes around 5-6 weeks afterward after the orthodontic appliances are removed.²²

Detection of Root Resorption

Careful symptomatology is presented by root resorption clinically that may be completely absent in their development's initial stages. Evidence from the literature shows that root resorption induced due to orthodontic treatment is studied through CBCT i.e. Cone Beam Computed Tomography.²¹ Since early detection of root resorption is very important, it is necessary that regular radiographic examinations are conducted complementary. Severe root resorption can be avoided by taking control X-ray images after around 6 months of orthodontic treatment of all orthodontic patients. Detection of an irregular tooth root contour or minor root resorption during this time frame indicates that there are higher chances of occurrence of root resorption in near future.

CONCLUSION

In conclusion, root resorption is the induced inflammatory resorption in which the hyalinized areas

and teeth undergo orthodontic forces and therefore, they are removed in the periodontal area. The removal of cementum also takes place as the removal of hyalinized tissues take place. It is a proven fact that there are risks of induction of root resorption after orthodontic treatment. Therefore, it is important that the screen for resorption is done both after the orthodontic treatment and during the active phase of treatment. The main risk factor in orthodontic patients for root resorption is the individual susceptibility. In the cases of such susceptibility, it has been observed that root resorption starts in the orthodontic treatment's early stages. Therefore, the important elements involved in the management of cervical and apical root resorptions induced due to orthodontic treatment are risk evaluation, screening at regular intervals, accurate and early detection through CBCT, and finally, therapeutic treatments.

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