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ORTHODONTICALLY INDUCED INFLAMMATORY ROOT RESORPTION: A REVIEW

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ABSTRACT

Orthodontically induced inflammatory root resorption (OIIRR) is a pathological or physiological irreversible loss of an apical section of a tooth root commonly associated during orthodontic treatment which results when Orthodontic pressure exceeds capillary pressure in the periodontium, leading to collapse and regional blood supply loss.

This research was done using electronic databases of English literature including PubMed, Scopus, Web of sciences, Cochrane, Google scholar as well as a manual search was performed from 1975 to 2024. To ensure a successful orthodontic treatment, it is essential to have a thorough and precise knowledge about the OIIRR. This article gives a review on the history, grades, classification, etiological factors, diagnosis, clinical considerations & recent advances in root resorption from an overview of systematic reviews.

KEY WORDS: Root resorption, Classification, Orthodontic treatment, recent advances, Aligners

INTRODUCTION

External apical root resorption is one of the most commonly reported iatrogenic side effects of orthodontic treatment. Root resorption is characterized as a physiological or pathologic process that causes the loss of cementum and dentine. ^[1,2]

This research was done using electronic databases of English literature including PubMed, Scopus, Web of sciences, Cochrane, and Google scholar as well as a manual search was performed from 1975 to 2024.

Orthodontically induced inflammatory root resorption (OIIRR) results when Orthodontic pressure exceeds capillary pressure in the periodontium, leading to collapse and regional blood supply loss. This subsequent ischemic necrosis in the periodontal ligament results in the destruction of the protective outer layers of the tooth (hyalinized zone). The loss of pre-cementum and its cementoblast layer activates cementoclastic cells, leading to root resorption with the removal of hyalinized necrotic tissue. ^[3]

Although the etiology of root resorption is multifactorial, it is believed that resorption is caused by a combination of mechanical causes, genetic susceptibility, and an individual's biological variability. ^[4]

HISTORY OF ROOT RESORPTION

Table 1: History of root resorption

1856	Root resorption was first described by 'Bates' The first author to use radiography to describe root resorption was 'Ketcham'. ^[4]
1914	Ottolengui-A study of apical root loss concerned primarily with orthodontic procedures. ^[4]
1932	Becks and Marshall introduced the term "resorption" to the field of orthodontic literature.
1944	Oppenheim's - damage to the cementum, periodontal tissues, alveolar bone, and pulp was unavoidable after orthodontic therapy. ^[4]

CLASSIFICATION OF ROOT RESORPTION ^[5]

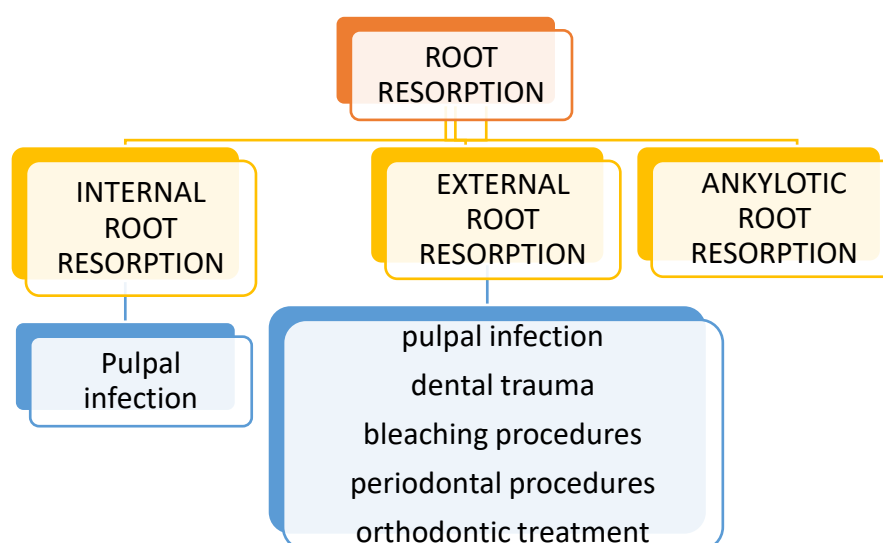


Figure 1: Representing classification of root resorption

GRADES OF ROOT RESORPTION

Malmgen et al. (2012) offered a visual depiction of this phenomena and was further modified by Beck and Harris (1994).^[6,7,9]

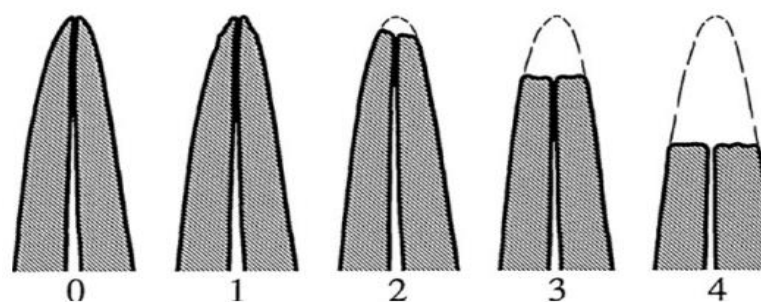


Figure 2: Diagrammatic representation of grades of root resorption

Table 2: Tabular column representing grades of root resorption

Grade 0	No resorption
Grade 1	mild resorption, root with normal length and only displaying an irregular contour
Grade 2	moderate resorption, small area of root loss with apex exhibiting almost straight contour
Grade 3	accentuated resorption, loss of almost one-third of root length,
Grade 4	extreme resorption, loss of more than one third root length

DEGREES OF SEVERITY OF ROOT RESORPTION^[10]

Table 3: Representation of degrees of severity of root resorption

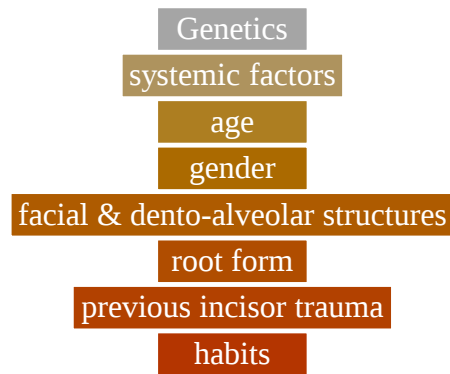
<u>Cemental or surface resorption</u>	<u>Dentinal resorption with repair</u>	<u>Circumferential apical root resorption</u>
Outer cemental layers resorbed which are regenerated later	Resorption of cementum & outer layers of dentin	Marked shortening of the roots and complete resorption of the hard tissue components of the root apex.
Resembles trabecular bone remodelling	Following the process of remodelling, final shape of root may or may not resemble original form of root	

ETIOLOGY OF ROOT RESORPTION ^[11,12,13]

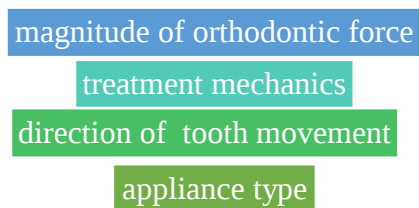
Ever since the introduction of oral roentgenography, the causes of external root resorption have remained a mystery to the dental profession. Many researchers have linked a variety of etiologic causes to root resorption occurring during orthodontic treatment.

Various etiological factors are:

a) Patient-related factors



b) Treatment-related factors



a) Patient-related factors

I. Genetics:

Highly strong evidence linking the putative gene to the clinical presentation of external apical root resorption was found, indicating a 5.6-fold increase in the probability of resorption more than 2 mm in individuals homozygous for the gene. ^[11]

Etiologic and genetic heterogeneity are quite likely, even though definitive genetic conclusions cannot be made. It is conceivable for inheritance to be polygenic, autosomal recessive, or autosomal dominant. ^[14]

II. Systemic factors: ⁽¹⁴⁾

The history of root resorption has been of particular interest when it comes to the role of systemic factors.

According to Becks, quite a few of his patients with root resorption reported metabolic and endocrine disorders. ^[14]

Wilkin and Gardner stated that hypothyroidism is a highly common systemic finding that happens infrequently and has quite comprehensive symptoms.

Additionally, Becks and Marshal asserted that malnutrition was also one of the contributing factors for root resorption even though the experimental findings were inadequate.^[14]

III. Age

About age 11, there appears to be a widespread shift in the prognosis regarding apical root resorption.^[15]

According to some authors, the pre-dentin layer of immature roots has a protective role in root resorption, hence people who had orthodontic treatment at or before the age of eleven had a lower rate of tooth root resorption.^[16]

If orthodontic tooth movement is done prior to root's final development, this resorption can be prevented.

IV. Gender

Another risk factor for tooth root resorption is gender, with men more likely than women to experience root resorption. Nevertheless, according to other scientists, gender has no bearing on the nearby affected teeth's root resorption.^[16]

V. Facial & dento-alveolar structures

The amount of apical root shortening following treatment has a weak correlation with the pretreatment parameters of dentoalveolar and facial structures that were evaluated.^[17]

Apical root shortening is proved to be more severe in smaller roots.^[17]

VI. Root form

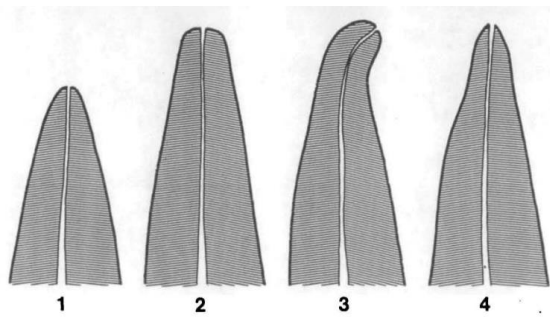


Figure 2: Illustration of four different types of root forms

4 types:

- a) Short root
- b) Blunt root
- c) Root with apical bend
- d) Root with apical pipette shape

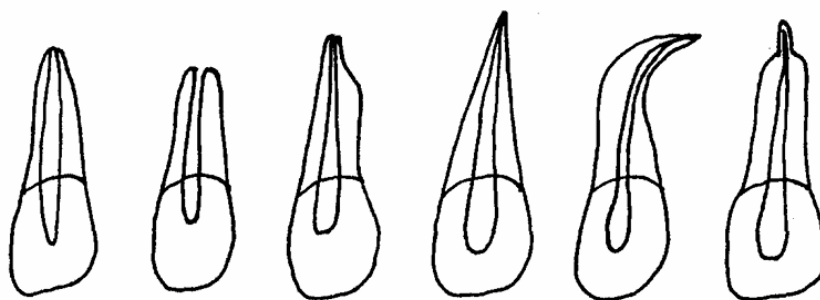


Figure 3: Illustration of six different types of root forms

- a) normal
- b) blunt
- c) eroded
- d) pointed
- e) bent
- f) bottle shaped ^[8]

It was concluded that, teeth with blunt roots have a moderate risk of root resorption, whereas those with pipette-shaped roots have a high risk for resorption. ^[18,7]

VII. Previous incisor trauma

Previous incisor trauma has been frequently reported in which apical resorption is seen after several months. ^[15]

VIII. Habits

Increased apical root resorption during orthodontic treatment could not be linked to persistent habits, but generally speaking, treatment will not be started until harmful habits are stopped. ^[15]

b) Treatment related factors

I. Magnitude of orthodontic force

According to King and Fischlschweiger's (1982), light forces caused teeth to move more quickly while causing less cemental cratering, but intermediate or strong forces caused longer displacements and a large amount of root resorption. ^[19] Owman mol et.al (1996) conducted a study evaluating the effects of a force of 50 cN and a doubled force magnitude of 100 cN on tooth movements and unfavorable tissue reactions. Study showed that increasing the force magnitude had no discernible effect on tooth movements or the degree of root resorptions ^[19] Stenvik and Mjor (1970), showed that a four-fold increase in force magnitude significantly increased tooth movement without significantly altering the frequency or severity of root resorption. ^[19]

II. Treatment mechanics

Stanley A Alexander (1996) -The amount of root resorption in continuous arch wire technique was compared with segmental arch wire technique. When compared, similar amounts of root resorption were observed & higher risk for resorption was not seen in both the methods. ^[20]

Malmgren et al- compared Begg's & standard edgewise technique & discovered that when the Begg approach was used to intrude on traumatized maxillary incisors, the frequency of root resorption was significantly higher (48%) than it was with the edgewise technique (43%). ^[14]

III. Direction of tooth movement

Over the past few decades various types of tooth movement have been associated with root resorption.

Dr. shields found that intrusion is one of the causative factors for root resorption ^[21] & proved to be successful in reducing overbite ^[22]

IV. Appliance type

Comparison of edgewise straight wire brackets & speed brackets- no difference was found in root resorption ^[2]

Compared to the patients who received fixed appliance treatment, the removable appliance group showed noticeably reduced root resorption. In certain cases, patients who received treatment solely through removable appliances experienced root shortening. ^[23,15]

RME with cervical traction- severe root resorption observed in maxillary first molar. ^[14]

DIAGNOSIS OF ROOT RESORPTION

After undergoing orthodontic treatment, root resorption is being monitored for many years using conventional radiographs- (IOPAR, digital radiography, OPG, and lateral cephalograms), light microscopes, and scanning electron microscopes.

Determining the precise amount of root resorption becomes more challenging especially when the tooth is tipped or torqued.

Periapical paralleling technique has been the most favorable & common method in assessing the extent of root resorption. Despite the limitations there are certain advantages of this technique which includes less radiation, distortion & superimposition errors. ^[14]

In recent years, computed radiography, micro-CT & CBCT have been in the forefront.

Conventional methods can detect and quantify the shortening of the root length, but not the location, depth, or width of resorption in different regions of the root.

Cone beam computed tomography (CBCT) has changed the paradigm from two-dimensional to three-dimensional technologies by allowing for the visualization of the craniofacial region.

CLINICAL CONSIDERATIONS RELATED TO ROOT RESORPTION

- It is important to inform the patient or his parents that orthodontic treatment may result in apical root shortening (root resorption). ^[14]
- As periapical radiographs are considered to be an essential aid in orthodontic treatment, it is recommended to take radiographs after 6 months from the start of treatment ^[3] & specifically of the patients who are at risk of root resorption.
- Orthodontic treatment timing: Since developing teeth have less root resorption and younger individuals have better muscle response to occlusal alterations, orthodontic therapy should start as soon as possible. Adults require mechanical forces that are more rigid and long-lasting because they are less adaptable.
- Detailed medical & familial history to be recorded in patients with severe root resorption
- Light & intermittent forces should be applied. ^[14] Using heavy gauge wires in beginning of treatment & skipping wires sizes should be avoided. ^[3]
- The end goals need to be re-evaluated if root resorption is seen during active treatment, that is either to stop the treatment or to dis-occlude using a bite plane.
- Patients with tongue thrusting or nail-biting habits are prone to have higher chances of root resorption.
- Intrusion is most detrimental to cause root resorption when compared to other tooth

movements.

- Occlusal trauma & jiggling forces also leads to root resorption.
- Treatment should be completed in a short period of time adhering to other principles.
- Traumatized teeth should be treated carefully as there are higher chances of root resorption.
- Upon completion of orthodontic treatment, radiographic assessment should be repeated to rule out root resorption. ^[3]

ALIGNERS AND ROOT RESORPTION

In contrast to pre-adjusted edgewise appliances (PEA), aligners have gained popularity in recent years due to its invisibility, easier oral hygiene maintenance, removable & better periodontal health. ^[24]

Some studies compared root resorption rate of aligners to PEA & found that root resorption was comparatively less in the patients undergoing CAT therapy with non-extraction line of treatment.

John F et al (2010) investigated the root resorption in CAT therapy using both 2D & 3D methods, in which he found that root length was about 2.6mm under peri apical radiographs (2D) 0.3mm under CBCT (3D) respectively. ^[24]

Therefore, it is recommended to use CBCT to assess root resorption after orthodontic treatment.

CONCLUSION

Orthodontically induced inflammatory root resorption is one of the most common iatrogenic problems associated with orthodontic treatment. Precautionary measures should be carefully considered when treating patients with high risk of OIIRR by recording proper medical history, an assessment of etiological factors, radiographic examinations for any alterations in root morphology and careful planning and execution of orthodontic mechanics may reduce the incidence of root resorption to an extent. A mid-treatment radiographic evaluation with IOPAR can identify teeth at risk. Further, the treatment in such patients should be performed with caution by applying light forces. In the light of orthodontist's liability, it is necessary to collect proper diagnostic records and informed consents from patients to avoid further risk.

REFERENCES

- 1) Sameshima GT, Iglesias-Linares A. Orthodontic root resorption. Journal of the World federation of orthodontists. 2021 Dec 1;10(4):135-43.
- 2) Blake M, Woodside DG, Pharoah MJ. A radiographic comparison of apical root resorption after orthodontic treatment with the edgewise and Speed appliances. American Journal of Orthodontics and Dentofacial Orthopedics. 1995 Jul 1;108(1):76-84.
- 3) Yassir YA, McIntyre GT, Bearn DR. Orthodontic treatment and root resorption: an overview of systematic reviews. European journal of orthodontics. 2021 Aug 1;43(4):442-56.
- 4) Dindaroğlu F, Doğan S. Root resorption in orthodontics. Turkish Journal of Orthodontics. 2016 Dec;29(4):103.
- 5) Aidos H, Diogo P, Santos JM. Root resorption classifications: a narrative review and a clinical aid proposal for routine assessment. European endodontic journal. 2018;3(3):134.
- 6) Remington DN, Joondeph DR, Årtun J, Riedel RA, Chapko MK. Long-term evaluation of root resorption occurring during orthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopedics. 1989 Jul 1;96(1):43-6.
- 7) Levander E, Malmgren O. Evaluation of the risk of root resorption during orthodontic treatment: a study of upper incisors. The European Journal of Orthodontics. 1988 Feb 1;10(1):30-8.
- 8) Mirabella AD, Årtun J. Risk factors for apical root resorption of maxillary anterior teeth in adult orthodontic patients. American Journal of Orthodontics and Dentofacial Orthopedics. 1995 Jul 1;108(1):48-55
- 9) Krishnan V. Root resorption with orthodontic mechanics: pertinent areas revisited. Australian dental journal. 2017 Mar;62:71-7.
- 10) Brezniak N, Wasserstein A. Orthodontically induced inflammatory root resorption. Part I: the basic science aspects. The Angle Orthodontist. 2002 Apr 1;72(2):175-9.
- 11) Ramanathan C, Hofman Z. Root resorption in relation to orthodontic tooth movement. ACTA MEDICA-HRADEC KRALOVE-. 2006 Jan 1;49(2):91.

- 12) Newman WG. Possible etiologic factors in external root resorption. American journal of orthodontics. 1975 May 1;67(5):522-39.
- 13) Vlaskalic V, Boyd RL, Baumrind S. Etiology and sequelae of root resorption. In Seminars in orthodontics 1998 Jun 1 (Vol. 4, No. 2, pp. 124-131). WB Saunders.
- 14) Brezniak N, Wasserstein A. Root resorption after orthodontic treatment: Part 2. Literature review. American Journal of Orthodontics and Dentofacial Orthopedics. 1993 Feb 1;103(2):138-46.
- 15) Linge BO, Linge L. Apical root resorption in upper anterior teeth. The European Journal of Orthodontics. 1983 Aug 1;5(3):173-83.
- 16) Heboyan A, Avetisyan A, Karobari MI, Marya A, Khurshid Z, Rokaya D, Zafar MS, Fernandes GV. Tooth root resorption: A review. Science Progress. 2022 Jul;105(3):00368504221109217.
- 17) Taithongchai R, Sookkorn K, Killiany DM. Facial and dentoalveolar structure and the prediction of apical root shortening. American journal of orthodontics and dentofacial orthopedics. 1996 Sep 1;110(3):296-302.
- 18) Lopatiene K, Dumbravaite A. Risk factors of root resorption after orthodontic treatment. Stomatologija. 2008 Jan 1;10(3):89-95.
- 19) Owman-Moll P, Kurol J, Lundgren D. The effects of a four-fold increased orthodontic force magnitude on tooth movement and root resorptions. An intra-individual study in adolescents. European Journal of Orthodontics. 1996 Jun 1;18(3):287-94.
- 20) Alexander SA. Levels of root resorption associated with continuous arch and sectional arch mechanics. American journal of orthodontics and dentofacial orthopedics. 1996 Sep 1;110(3):321-4.
- 21) Dermaut LR, De Munck A. Apical root resorption of upper incisors caused by intrusive tooth movement: a radiographic study. American Journal of Orthodontics and Dentofacial Orthopedics. 1986 Oct 1;90(4):321-6.
- 22) Costopoulos G, Nanda R. An evaluation of root resorption incident to orthodontic intrusion. American Journal of Orthodontics and Dentofacial Orthopedics. 1996 May 1;109(5):543-8.
- 23) Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root resorption associated with

orthodontic tooth movement: a systematic review. American journal of orthodontics and dentofacial orthopedics. 2010 Apr 1;137(4):462-76.

- 24) Zhang M, Zhang P, Koh JT, Oh MH, Cho JH. Evaluation of Aligners and Root Resorption: An Overview of Systematic Reviews. Journal of Clinical Medicine. 2024 Mar 27;13(7):1950.