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RESEARCH ARTICLE

EXTERNAL ROOT RESORPTION IN ORTHODONTICS- REVIEW OF LITERATURE

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ABSTRACT

One of the complications of orthodontic treatment is root resorption, which is mainly caused by the treatment mechanics used during orthodontic treatment that includes, type and magnitude of the orthodontic force, duration of force, method of force application and factors related to treatment such as the type of tooth movement, severity of malocclusion etc. The clinical importance of root resorption is directly related to its detectability. Orthodontic and biological factors that can cause root resorption should be evaluated using various imaging techniques available in these days and managed accordingly. In this review article, root resorption in orthodontics was considered from different viewpoints.

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INTRODUCTION

Root resorption is basically a pathological process, resulting in shortening of the dental root. Generally this condition is asymptomatic, missed in diagnosis, can result in tooth mobility and if not diagnosed properly can result in tooth loss[1]. Force application in orthodontics can result in inflammatory process, which inturn is the fundamental component behind the root resorption process. Orthodontically induced inflammatory external apical root resorption (OIIEARR) is an undesirable but unavoidable pathological consequence of orthodontic tooth movement[2]. Orthodontic forces, can trigger an inflammatory response within the periodontal ligament (PDL) and surrounding tissues. This inflammation activates osteoclasts, specialized cells responsible for bone resorption, which can inadvertently target the root surfaces, leading to root resorption. Molecular signals such as RANKL (Receptor Activator of Nuclear Factor Kappa-B Ligand) and osteoprotegerin (OPG) play crucial roles in regulating osteoclastic activity[3]. Hence, it is mandatory to assess the treatment related and patient-related factors resulting to EARR during orthodontic treatment, in order to avoid serious complications and to decrease root resorption incidences. This review article explains the etiology, classification, mechanism, diagnosis and treatment methods of external root resorption.

Etiology of root resorption[4,5]: The etiology of root resorption is multifactorial; which include individual biologic characteristics, genetic predisposition and the effect of orthodontic forces.

Risk factors for ARR can be categorized as patient-related and treatment-related factors. Patient-related factors include; genetics, systemic factors, asthma and allergies, chronic alcoholism, the severity of malocclusion, tooth-root morphology, a previous history of root resorption, alveolar bone density, root proximity to cortical bone, endodontic treatment, and patient age and sex. Orthodontic treatment-related risk factors include; the treatment duration, magnitude of applied force, direction of tooth movement, amount of apical displacement, and method of force application.

Classification of root resorption[6,7,8]

ACCORDING TO SHAFER, HINE AND LEVY

- External root resorption.
- Internal root resorption.
- EXTERNAL ROOT RESORPTION: -
    - Periapical inflammation
    - Reimplantation of teeth
    - Tumors or cysts
    - Excessive mechanical or occlusal forces
    - Impaction of teeth
    - Idiopathic.

INTERNAL ROOT RESORPTION

Idiopathic

NAPHTALI BREZNIAK et al. have published three types of external root resorption originally given by Andreasen:-

- Surface resorption
- Inflammatory resorption
- Transient inflammatory resorption
- Progressive inflammatory resorption
- Replacement resorption

ACCORDING TO PROFFIT, shortening of roots after orthodontic treatment occurs in three distinct forms that must be distinguished when the etiology of resorption is considered.

- Moderate generalized root resorption
- Severe generalized root resorption
- Severe localized root resorption

ACCORDING TO FUSS Z, TSESIS I AND LINS

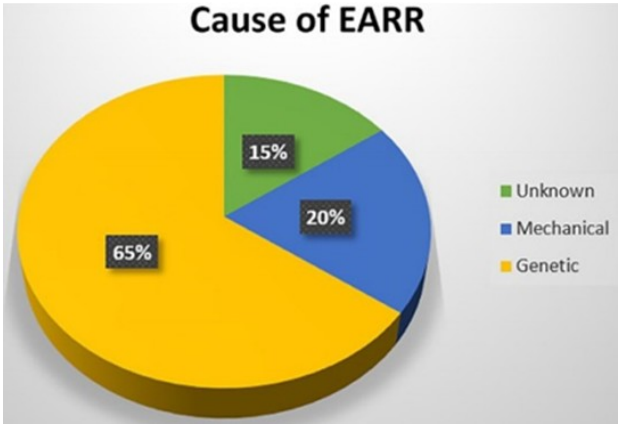
- Pulpal infection root resorption.
- Periodontal infection root resorption.
- Orthodontic pressure root resorption.
- Impacted tooth or tumor pressure root resorption.

Mechanism of root resorption[9,10] : Orthodontic tooth movement is based on force application, magnitude of force and duration of force application. It act as a physical agent capable of inducing inflammatory reaction in the periodontium. When a tooth moves, periodontal ligament o n the pressure side will get necrosed, resulting in the formation of a cell-free hyaline zone. This results in the osteoclast resorption of the neighbouring alveolar bone and osteoblasts induced bone apposition on the tension side. The resorption process of dental hard tissues seems to be triggered by the activity of some cytokines. Immune cells migrate out of the capillaries in the periodontal ligament and interact with locally residing cells by elaborating a large array of signal molecule.

Application of force
↓
Dilation of blood vessel
↓
Packing of erythrocytes along the platelets and follicular material between the cellular elements. (The cell walls appear to be intact at this stage)
↓
Part of the endothelial walls disappears along with the basement lamina, allowing communication between the lumen of the blood vessels and the perivascular space
↓
Crystallization of the erythrocytes in periodontal ligament Cementoblasts, fiberoblasts and osteoblast exhibit various stages of disintegration
↓
Interacellular swelling and cellular dilation of the endoplastic
reticulum, swelling of the mitochondria Rupture of cell membrane
↓
Seperation of the nucleus from cytoplasm
↓
Decomposition of the nucleus
↓
Cell death occurs in the cytoplasm and nucleus disintegrates

Diagnosis[11,12,13]

OPG: Normal anatomical structures can appear as radiolucent or radiopaque shadows superimposed over the teeth as either real or actual shadows or as a ghost or artifacts which can degrade the quality of the final image. Also roots may get magnified or foreshortened in markedly class II or class III patients.



Periapical radiography: OPG overestimated the amount of root loss by 20% or more when compared with periapical radiographs. In cases where the apices are obscured or other factors are present that might suggest higher risk for root resorption periapical films should be taken.

Cone beam computed tomography: An average of 55-91% of teeth showed some degree of root shortening in class I malocclusion. 7% of patients had one tooth or more with root shortening exceeding 4 mm, Slanted root resorption was found in up to 15% of palatal root surfaces and could be evaluated only on tomographic images.

Dentine phosphoproteins: Dentine phosphoproteins (DPP) is measured in the GCF using an enzymelinked immunosorbent assay and there is a difference in the level of DPP between a group of patients with mild root resorption and a control group. 5. Elisa combined with electrochemistry: The electrochemical results extended the lower end of detection from 5 pg per milliliter (by spectrophotometry) to 0.5 pgper millilitre thus it is a reliable and sensitive method to detect dentine sialophosphoprotein in gingival crevicular fluid.

Mass spectroscopy analysis: The main goal was to identify novel biomarkers associated with root resorption and the protocol was able to identify 2789 and 2421 proteins in the control and resorption pooled samples, respectively.

Steps in the management of root resorption should follow mainly[14,15,16,17]

Imaging: Initial periapical or limited CBCT is essential in adult patients to properly examine the root morphology and location of the roots with clarity.

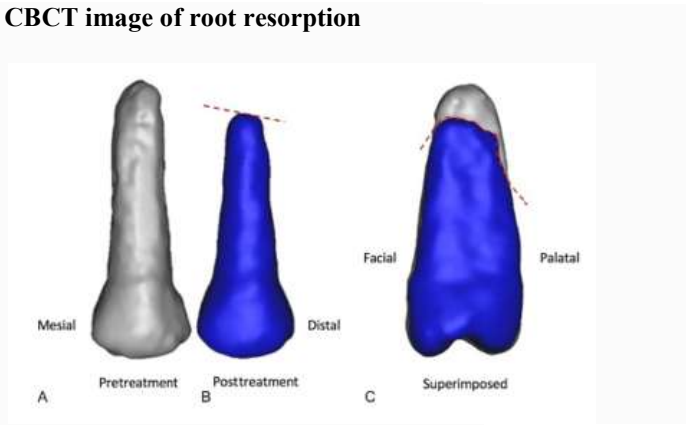
History: A careful history may suggest a possible etiology for root resorption. If a patient is at higher risk, especially for families, specific documentation of this additional level of risk must be included in the informed consent for treatment.

Progress Review: Documenting the progress for all cases is good clinical practice, but particularly important if risk factors for EARR. Before the start of orthodontic treatment, it is ideal to inform the patient regarding the possible risk factors rather than to later apologize. It is obvious if the orthodontist decides to initiate treatment after reviewing all of the relevant data collected, the expected esthetic and functional benefits far outweigh the minor root changes observed in most patients. From a medico-legal point of view, the importance of diagnostic records and thorough evaluation of them should not

be overlooked. The decision whether to continue active tooth movement depends upon planned further movement of the tooth, and the amount of resorption visible on the radiograph at the particular stage. It must be noted that there are no consensus standards on what constitutes severe EARR. If root resorption is noticed in progress visits, a temporary halt in orthodontic treatment for a period of 4 to 6 months is suggestable. In this period the resorptive process ceases and the reparative process starts. Ideally, the tooth should not be in hyperfunction, and no force applied, this usually means the placement of a passive archwire to hold the teeth exactly where they are. After this rest period, treatment can continue. If severe root resorption exists where the EARR is more than 4 mm is encountered midtreatment, the usual procedure is to discontinue appliance therapy. Alternative approaches for treatment must be chosen (either surgical or extrac-tion/prosthetic). Appropriate follow-up and necessary counseling should always accompany this approach.

The effect of hormones and cytokines in reducing resorption has been identified by previous studies. The main hormone attributed to this was L-thyroxine. It is assumed to increase the resistance of cementum and dentin elastic activity. The major cytokine found in correlation with the resorptive process was prostaglandin E_2. Though the previous studies confirmed its role in the process, a recent evaluation demonstrated little or no effect for this cytokine on either the depth or the number of resorption lacunae found in resorbed tooth roots. A recent report by Bialy et al. evaluated the effect of low-intensity pulsed ultrasound (LIPUS) on the healing process of orthodontically induced root resorption in humans. They found a significant decrease in areas of resorption and the number of resorption lacunae in teeth exposed to LIPUS. The result of this study is encouraging, as it demonstrates a non-invasive method to reduce root resorption in humans.

CBCT image of root resorption



CONCLUSION

The orthodontist must be aware of root resorption because even though no direct cause has been proven, orthodontic treatment has been identified as one of the most commonly associated factors. By far, there is no consistent evidence for the precise identification of the orthodontic patient who may develop root resorption, orthodontists should keep in mind the various indicators known and promote systematic radiography to monitor their patients.

To individualize the diagnosis, the possible risk factors for root resorption and treatment plan could mean the difference between the success and failure of orthodontic treatment. Mechanical forces and other environmental factors do not adequately explain the variation seen among individual expressions of root resorption. Extensive clinical research is required to gain a deeper knowledge of the aetiology and pathogenesis of the various types of root resorption.

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