ORTHODONTICS AND ROOT RESORPTION: A REVIEW

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ABSTRACT
This review describes the literature on the orthodontic tooth movement and root resorption which might occur as an undesirable effect during the course of the treatment. There are different types of root resorption having different etiological factors. Concise diagnosis and implementation of the treatment is important in such consequences. In most root resorption studies, it is not always possible to compare the results because of various factors and methods of studies. Further research in this field is necessary.

KEYWORDS: Orthodontic, Root resorption.

INTRODUCTION
Root resorption is a common complication associated with orthodontic treatment. Root resorption may be pathologic or physiologic in nature and it may also occur in association with orthodontic tooth movement. Physiological resorption occurs during the exfoliation of the primary dentition and mesial drifting in the permanent dentition.\textsuperscript{[1]} The mineralized tissues of the permanent dentition are not normally resorbed. Pathological resorption occurs subsequent to a traumatic injury, pathological disease process or iatrogenic causes. The consequences of root resorption range from slight tooth mobility due to small amounts of root loss to complete tooth loss from excessive amounts of resorption. Radiographically, the resorption may appear as either an apical root blunting, lateral root resorption or in rare cases...
excessive root loss. Internal root resorption is initiated from within the pulp while external root resorption arises from the periodontium affecting the external surface of the tooth.

At present, it is unknown how orthodontic treatment factors influence root resorption. The etiologic factors are complex and multifactorial, but it appears that apical root resorption results from a combination of individual biologic variability, genetic predisposition, and the effect of mechanical factors. Root resorption is undesirable because it can affect the long-term viability of the dentition, and reports in the literature indicate that patients undergoing orthodontic treatment are more likely to have severe apical root shortening. Patient factors such as genetics and external factors including trauma are also thought to be associated with increased root resorption.

Orthodontically induced inflammatory root resorption occurs as a result to the inflammatory process involved in orthodontic tooth movement. It occurs on the cemental surface of the tooth root. Although cementum is more resistant to resorption relative to bone it is still possible for both the cementum and dentine to resorb as a result of this inflammatory process.

MECHANISM OF ROOT RESORPTION
Mechanism of root resorption is not completely explored. According to Brudvik and Rygh, inflammatory root resorption induced by orthodontic treatment is a part of process of elimination of hyaline zone.\[2\] It is considered that occurrence of root resorption can be induced by the strong force through orthodontic treatment and hyalinisation of periodontal ligaments induced by increased activity of cementoclasts and Osteoclasts.\[3\] During tooth movement, areas of compression (where osteoclasts are in action inducing bone resorption) and areas of tension (where osteoblasts are active inducing bone deposition) are formed. Thus a tooth moves towards the side of bone resorption. An imbalance between bone resorption and deposition, losing protective characteristics of cementum may contribute to the cementoclasts/osteoclasts resorbing areas of the root.\[4\] When hyaline zone forms, tooth movement will stop. Upon regeneration of periodontal ligament, hyaline zone is removed by mononucleus cells similar to macrophages and by multinucleus gigantic cells and a tooth starts to move again. During removal of hyaline zone an outer tooth root surface consisting of the layer of cementoblasts may be damaged, exposing the underlying highly dense mineralized cementum. It is possible that a force occurring during orthodontic treatment may directly damage outer root surface. Tooth root surface under the hyaline zone resorbes just after a few days, when a repair process is already happening in the periphery. On the grounds
of the literature data it can be stated that the resorption process is completed after removal of the hyaline zone, and/or when orthodontic force decreases.\cite{2,4}

**DIGNOSIS**

Following are the various radiographic techniques used as diagnostic aids for assessing root resorption:

1) Periapical bisecting angle.
2) Periapical paralleling.
3) Orthopantomogram.
4) Cephalogram.
5) Lamiogram.
6) Computed tomography.
7) Cone Beamed Computed tomography.

**THE CLINICAL ASPECTS OF ORTHODONTIC ROOT RESORPTION**

summary of clinical steps that should be considered by the orthodontist as they relate to Orthodontically induced inflammatory root resorption.

**BEFORE TREATMENT**

**General considerations.** The patient/parents must be informed about the risk of Orthodontically induced inflammatory root resorption as a consequence of orthodontic treatment. Root resorption should be discussed during consultation.\cite{5} Every informed consent form signed by the patient/parents.\cite{6}

**Familial considerations.** A recent study\cite{7} has confirmed previous results concerning the strong familial association of Orthodontically induced inflammatory root resorption. When treating a new patient whose close sibling was previously treated, orthodontists should try to obtain the final diagnostic records including the radiographs.

**Gender.** Most studies have not found a consistent association between gender and Orthodontically induced inflammatory root resorption. In a group of adult (aged .20 years) orthodontic patients, Baumrind et al\cite{8} found a greater prevalence of Orthodontically induced inflammatory root resorption in men than in women. In contrast, Kjar found a greater prevalence of Orthodontically induced inflammatory root resorption in girls than in boys.
**Age.** Since all recent studies with the exception of two studies have found no relationship between Orthodontically induced inflammatory root resorption and chronological age, chronological age may not be a significant factor in the occurrence of orthodontic root resorption.

**The malocclusion.** Dental as well as skeletal malocclusions should be considered cautiously with respect to Orthodontically induced inflammatory root resorption. No malocclusion is immune to Orthodontically induced inflammatory root resorption.

**DURING TREATMENT**

1. The new light-force rectangular wires that are used in treatment as initial wires have become very popular in the last decade. According to Proffit and Fields [9], use of these wires might increase the jiggling movements during the first stage of treatment, exposing the root to more Orthodontically induced inflammatory root resorption. We therefore suggested proceeding with this initial step with caution, until more definitive data are published.

2. Longer intervals between activations remain strongly recommended.

3. Do extractions of teeth serve as an important factor in the occurrence of Orthodontically induced inflammatory root resorption. Unfortunately, no definitive conclusion has been drawn in reference to this controversial issue.

4. A possible correlation between the duration of active treatment and the incidence and extent of orthodontic root resorption is an open controversy. Most conclusions have been obtained from clinical studies, whereas a single short-term animal-based study rejected the association between the duration of active treatment and Orthodontically induced inflammatory root resorption. [10]

5. After 6 months of treatment, periapical radiographs of the teeth involved in this treatment should be obtained. Since, in most published papers, the incisors are the teeth that tend to be most affected, the changes in their root shape might project on the overall phenomenon. When Orthodontically induced inflammatory root resorption is detected in the six-month periapical radiograph, treatment should be halted for two to three months with passive archwires. This suggestion can actually be applied to any extensive orthodontic procedure on a mandatory basis. Halting treatment for three months in one
arch while working on the other is a practical solution that can be implemented without changing the treatment protocol.

6. When the treatment is durable, periapical radiographs should be obtained, with the following consideration. When minimal Orthodontically induced inflammatory root resorption is present, the aforementioned procedure is sufficient. However, when severe resorption is identified, the treatment goals should be reassessed with the patient; for example, alternative options might include prosthetic solutions to close spaces, releasing teeth from active arches if possible, stripping instead of extracting, and early fixation of resorbed teeth. Orthognathic surgery can also be considered in extreme cases, yet it cannot be relied on to prevent Orthodontically induced inflammatory root resorption.

AFTER TREATMENT

1. Final records including radiographs are recommended and are even mandatory. If orthodontic root resorption is present on the final radiographs, the patient/parents should be informed. Final records and radiographs will be useful for the future orthodontic treatment of siblings.[11]

2. For teeth with severe resorption, follow-up radiographic examinations are recommended until Orthodontically induced inflammatory root resorption is no longer evident. In cases of extreme resorption, endodontic treatment may be considered as well. It should be noted that cemental repair or termination of the active processes of Orthodontically induced inflammatory root resorption occurs naturally after the removal of bands and brackets.[12, 13]

3. Several anecdotal reports have demonstrated the stability of teeth with severe resorption over the years. However, the use of teeth with severe resorption as abutment teeth should be reconsidered.[14]

4. Retaining the teeth with fixed appliances should be done with caution. Occlusal trauma of the fixed teeth or segments might lead to extreme Orthodontically induced inflammatory root resorption.[15]

CONCLUSION

After orthodontic treatment, all permanent teeth may show microscopic root resorption that is clinically insignificant and radiographically undetected. Root resorption of permanent teeth is
a probable consequence of orthodontic force and active tooth movement. The incidence of reported root resorption during orthodontic treatment varies widely among investigators. Most studies agree that the root resorption process ceases once the active treatment is terminated. Root resorption of the deciduous dentition is a normal, essential, and physiologic process. Permanent teeth have the potential to clinically undergo significant external root resorption when affected by several stimuli. This resorptive potential varies in persons and among different teeth in the same person. This throws doubt on the role of systemic factors as a primary cause of root resorption during orthodontic treatment. Tooth structure, alveolar bone structure at various locations, and types of movement explain these variations. The extent of treatment duration and mechanical factors definitely influence root resorption. In most root resorption studies, it is not always possible to compare the results because of various factors and methods of studies. Further research in this field is necessary. The question if there is any ideal (optimal) force to move teeth without root resorption and whether root resorption is predictable remains unanswered.

REFERENCES


