

Root resorption in orthodontics: A review of literature

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ABSTRACT

External apical root resorption is one of the most common iatrogenic sequelae of orthodontic treatment. It is usually seen on the external periapical surfaces of single-rooted teeth, especially if the root is pipette-shaped or apically bent. The current studies have focused on the factors that may cause or affect root resorption occurring during orthodontic treatment and possible means for limiting apical root resorption. Periapical radiographs and panoramic radiographs have been used in most of these studies which often show distortion and magnification due to lack of standardization. The future studies should be performed using 3D imaging technologies. Identification of "at risk" patients is desirable from quality of service and medico-legal perspectives.

Introduction

Root resorption occurs when pressure on the cementum exceeds its reparative capacity and dentin is exposed, allowing multinucleated odontoclasts to degrade the root substance. Orthodontically induced root resorption begins adjacent to hyalinised zones and occurs during and after elimination of hyaline tissues. Bates discussed root resorption of permanent teeth in 1856. Rudolph observed that resorption typically attacks the root tip and travels coronally which is termed as 'shed roof effect'. [1] Albert Ketcham suggested that apical resorption is a common and occasionally severe iatrogenic consequence of orthodontic treatment. [2,3]

In 1932, Becks and Marshall concluded that "in all cases in which formed tissues are destroyed and taken up by the blood or lymph stream, one should, in medical or dental literature, speak only of resorption." [4] This was followed by a wide range of histologic, clinical, and physiologic research on root resorption and orthodontic treatment. Wehrbein et al found that orthodontic force applications induce a local process that includes all of the characteristics of inflammation. [5] Therefore, orthodontic force-induced root resorption should be termed as orthodontically induced inflammatory root resorption (OIIRR).

Classification

Andreasen described three types of external root resorption types: surface resorption, inflammatory resorption and replacement resorption. Later, Tronstad characterized two kinds of inflammatory resorption: transient inflammatory resorption and progressive inflammatory resorption. Histologically, there are three degrees of severity of OIIRR: cemental or surface resorption with

remodelling, dentinal resorption with repair (deep resorption) and circumferential apical root resorption.

Mechanism of Root Resorption

Root resorption after orthodontic treatment is surface resorption, or transient inflammatory resorption. It is believed that the uncalcified mineral tissues, osteoid, precementum, and predentin are resistant to resorption and may initially prevent loss of root structure. However, continuous pressure will eventually lead to resorption of these areas. According to Jones and Boyde, the osteoclast is responsible for both demineralization of the calcified tissue through proton production and acidification of the ruffled border and degradation of the organic matrix after demineralization through Cysteine proteinases. [6,7] According to Schwartz, when pressure decreases below the optimal force (20 to 26 g/cm²) root resorption ceases which was supported by Reitan and Rygh. [8,9]

Measurement Methods

Root resorption can be defined operationally as the degree a root has shortened from its original (or expected) length by clastic activity. Visually-assessed grades of resorption (ordinal scale data), measurements with calipers or some computer-aided device (ratio scale data) on radiographs, light or electron microscopy and recently 3D imaging technologies have been used to quantify resorption. Sjien and Zachrisson described a method of correcting for tooth and crestal bone height due to X-rays divergence and Dermaut and De Munck suggested formulae that correct for angulation of a tooth relative to the x-ray film compared to a prior film. [10,11]

Factors Affecting Root Resorption

Age: An increased prevalence of root resorption is seen in adults undergoing orthodontic treatment. Massler and Malone claimed that the incidence of root resorption increases with age even without orthodontic treatment.[12]

Gender: Females are more susceptible to root resorption compared to males.[13,14]

Genetics: A genetic component for shortened roots has been suggested and autosomal dominant, autosomal recessive and polygenic modes of inheritance are possible.

Tooth structure: Short roots, blunt roots, apically bent roots and pipette shape roots are the most susceptible root form for root resorption.[15]

Alveolar bone density: Reitan found that a strong continuous force on less dense alveolar bone causes the same root resorption as a mild continuous force on highly dense alveolar bone. It has also been suggested the amount of root resorption occurring during orthodontic treatment increases with the increase in the density of the bone and vice versa.

Endodontically treated teeth: A higher frequency and severity of root resorption of endodontically treated teeth during orthodontic treatment was reported.[16]

Systemic factors: Hypothyroidism, hypopituitarism, hyperpituitarism, hyperparathyroidism, hypophosphatemia, and Paget disease have been linked to root resorption. Later, it was suggested that hormonal imbalance does not cause but influences this process.

Habits: A statistically significant relation has been suggested between nail-biting, tongue thrust associated with open bite, and increased tongue pressure and root resorption.

Type of orthodontic tooth movement: The most detrimental tooth movement causing root resorption is intrusion but tipping, torquing, translation, expansion can also be implicated. According to Reitan, the stress distribution along the roots during bodily movement is less than the stress concentration at the apex resulting from tipping. Therefore risk of root resorption due to bodily movement should be less than that of tipping.

Degree of force: Harry and Sims found that higher stress causes more root resorption and the distribution of resorbed lacunae was directly related to the amount of stress on the root surface.[17]

Treatment duration: Rudolph and Levander and Malmgren reported increase in the amount and severity of root resorption during the course of orthodontic treatment.

Jiggling and occlusal trauma: The use of intermaxillary elastics or active removable appliances produces jiggling forces causing root resorption. Poorly aligned dental inclined planes produce occlusal trauma which can cause root resorption during orthodontic treatment.

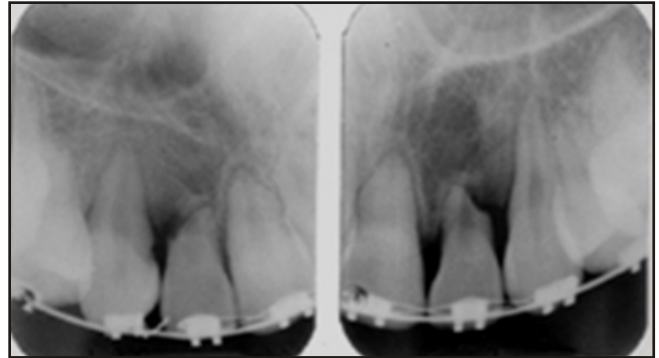


Fig: Orthodontically induced inflammatory root resorption

Clinical Significance

The patient or his parents must be informed that root resorption may be a consequence of orthodontic treatment. Some patients may experience a degree of root resorption necessitating that treatment plans be reviewed to avoid possibility of excessive tooth mobility and tooth loss which can aggravate when alveolar bone loss occurs in conjunction with or subsequent to root loss. Periapical radiographs are advisable before, during and after the treatment to detect root resorption. Orthodontic treatment should begin at an early age since there is less root resorption in developing roots and young patients show better muscular adaptation to occlusal changes compared to adults. The orthodontic force should be intermittent and light. It should also be recognized that routine orthodontic tooth movement can have anatomic and physiologic limitations.

Limitations

The difficulty in accurately assessing the incidence and prevalence of apical root resorption in the general population lies in the fact that radiographs or histological sections are required to detect the condition. Morphological scales are easy to use but there are inter and intra-examiners errors because of inaccuracies in defining and discriminating between grades of resorption. The key to measuring the amount of root resorption is standardization of the radiographs to eliminate problems of magnification and distortion. Panoramic radiographs are not well-suited for this because the focal trough is not identical to the shape of the individual's dental arch.

Future Scope

The recent advances in 3D imaging technology and histopathological techniques have promised new vistas for research in this field. The future studies should use these techniques to quantify the amount of

apical root resorption and bone loss in the patients. Polymerase chain reaction analysis to analyze mRNA-encoded collagenolytic enzymes, matrix metalloproteinases and cathepsin K in root resorbing tissue research offers a new direction for research in this field. A specific cementum attachment protein (CAP) has been identified in human cementum which has the ability to bind to mineralized root surfaces with high affinity. Its role in apical root resorption needs to be investigated.[18]

Conclusion

A definite cause and effect relationship has not been established between root resorption and orthodontic treatment. Small sample size, poor study designs and faulty radiographic techniques are some of the drawbacks of the previous studies. The future studies should utilise newer research tools to assess root resorption and the effect of root resorption occurring during orthodontic treatment on the longevity of the teeth needs to be answered.

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