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Root Resorption during Orthodontic Treatment - A Review on Significant Factors and Treatment Effects

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Abstract: ***Localized resorption is a continuous remodeling process occurs in response to complex multifactorial etiology agents such as age, gender, previous history of trauma, Para - functional habits, malocclusion, and mechanical factors during orthodontic treatment. Orthodontically induced external apical root resorption is often reversible and repair occurs immediately after the removal of orthodontic force without causing any serious destruction to the periapical tissues. However severe resorption associated with loss of teeth was also observed in several literature studies. Consequently understanding the relationship between orthodontic treatment and frequency of root resorption becomes essential in order to minimize the deleterious effects. Thus, the present literature review was aimed to discuss the role of orthodontic treatment in the prevalence of root resorption with emphasis on various influencing orthodontic factors along with diagnosis and resorption repair. Based on the literature studies and present observations it can be illustrated that heavy and intrusive forces over a long period of time specifically on the maxillary anterior and premolars have shown rapid destructive effects on the tooth. Hence several risk factors such as orthodontic tooth movement, nature, magnitude and duration of the force applied and treatment technique should be properly assessed using appropriate radiographic methods and intervention must be planned to ensure longevity of teeth.***

Keywords: Cone - Beam Computed tomography, Heavy Orthodontic force, Intrusion, Magnitude of force, Orthodontic root resorption, Short apex.

1. Introduction

Resorption of root is a physiological as well a pathological process resulting in loss of cementum and root dentin [1]. Localized resorption is a continuous remodeling process occurs in response to complex multifactorial etiology agents such as age, gender, previous history of trauma, systemic diseases, nutritional deficiency, psychological stress, para - functional habits, and morphology of the dento - alveolar structures, developmental tooth/root anomalies, malocclusion, endodontic procedures and mechanical factors during orthodontic treatment [2]. Apical Root Resorption (ARR) in orthodontics was first reported by Becks and Marshall in 1932 and later Oppenheim in 1944 described orthodontic treatment causes certain alterations in the pulp and periodontal complex due to several risk factors such as orthodontic mechanics, tooth movement, nature, magnitude and duration of the force applied, orthodontic appliance and treatment technique [3, 4].

External apical root resorption (EARR) is an induced inflammatory response initiated by odontoclasts cells during the removal of hyalinized tissues in the periodontal apparatus. Orthodontically induced EARR begins adjacent to these hyalinized zones and occurs during and after the removal of hyalinized tissue [5]. This process is often reversible and repair occurs immediately after the removal of orthodontic force without causing any serious destruction to the periapical tissues [6]. Literature studies have also shown 3mm of apical root loss produces similar effects that of 1mm crestal bone loss and severe ARR of more than 6mm resulted in complete loss of tooth structure from the root apex [7]. Thus it is essential to understand the relationship between orthodontic treatment and frequency of root resorption in order to minimize the deleterious effects

on the tooth. Hence, the present literature review was aimed to discuss the role of orthodontic treatment in the prevalence of root resorption with emphasis on various influencing orthodontic factors along with diagnosis and resorption repair.

2. Methodology

A structured literature search for articles written in the English language in PubMed/MEDLINE, EBSCOhost, Google Scholar, Scopus, and Web of Science databases was retrieved by using MeSH terms “Root Resorption” OR “Orthodontic therapy” AND “Dental”, “Dentistry” AND “Fixed appliance therapy” "Orthodontic treatment, Resorption" OR “Orthodontic movement”, “Intrusion forces”, “Heavy Orthodontic forces” OR “External Root resorption” OR "All Metadata" “Resorption”

3. Discussion

a) Magnitude, Duration and Type of Orthodontic forces:
Orthodontic forces have shown substantial effect on the incidence of ARR. It has been established that heavy orthodontic forces for a longer duration induces root resorption. Harris et al in a micro - computed tomography study observed heavy orthodontic forces induced root resorption at a faster rate compared to light intrusive forces [8]. Barbagallo et al [9], Cheng et al [6] in similar studies also observed increased resorption after 4 to 8 weeks of extensive orthodontic forces on the premolars. Paetyangkul et al reported that the amount of root resorption after 12 weeks of light force application produced comparable effects to that of the heavier forces of lesser duration [10]. Chan and Darendeliler specified that compressive forces cause more resorption than tensile forces [11]. The duration of force applied is directly associated with root resorption rate and increases significantly in extensive appliance therapy. Correspondingly, intermittent forces are often recommended in these conditions to prevent tooth loss. Segal et al showed that apical displacement of tooth was associated with active treatment duration and recommended 2 to 3 months of interval or Stationary phase between applications of forces [12]. Aras et al indicated that continuous forces produced higher resorption compared to intermittent forces over a period of 2 to 3 weeks [13]. Thus application of discontinuous or intermittent force allows the healing of resorbed cementum and prevents further resorption.

b) Direction, Extent and Orthodontic tooth movement:
Apical movements like Intrusive movements produce excessive force and create more pressure at the apical tooth region four times higher than the extrusive movements where resorption usually occurs at the interdental areas [14]. Buccal root movement induces minimal resorptive forces compared to lingual root that causes negative pressure leading to injurious effects on the tooth [15]. Han et al also stated Intrusive forces along with lingual root torque and translatory movement remain the most prominent factor for initiating severe ARR [14]. Li et al observed that root resorption was more at the middle third of the mesiobuccal root following molar mini - screw implant supported intrusion [16]. However these studies have also failed to demonstrate the impact of angular, translatory or bodily movements on root resorption.

c) Influence of Orthodontic appliance and treatment:
In case of fixed orthodontic appliances decrease in root length was observed both in straight wire appliance and conventional edge - wise appliance. Scott et al evaluated similar root resorption rate in self - ligating bracket as well as conventional brackets [17]. Barbagallo et al in a study demonstrated removable appliances also caused root resorption equivalent to fixed appliances generating lighter forces [9]. Marques et al noted higher incidence severe root resorption (14.5%) in orthodontic patients treated with the edgewise method [18]. Aman et al showed comprehensive orthodontic treatment with clear aligners resulted in minimal root resorption. Comparison between tooth - borne and tooth - tissue borne rapid maxillary expansion appliances showed heavy force induced root resorption [19]. Sameshima and Sinclair reported extraction sequence and pattern during early orthodontic phase was a significant contributing factor [20]. Topkara showed substantial increase in resorption during the final orthodontic treatment phase over a span interval of six years [7]. No significant relationship was observed between root resorption and sequence of arch wire nevertheless rapid sequence and proximity of root apices to the palatal cortical plate following treatment should be considered as a strong dependent factor in occurrence of ARR.

d) Tooth related Orthodontic factors:
Root shape, size and form determine the distribution of the orthodontic force along the axis of the tooth. Dilacerated maxillary lateral incisor root shows significantly higher rate of resorption compared to other tooth in the maxillary arch. Among all teeth, the maxillary incisors show the highest resorption rate, followed by the mandibular incisors and first molars [21]. Lund et al in a prospective CBCT study also observed root shortening was greater among maxillary incisors followed by palatal root of premolars [22]. Studies on endodontic therapy before orthodontic treatment showed dissimilar observations due to inadequate evidences on the role of pulpal neuropeptides or absence of pulp on root resorption process [3, 23]. Murata et al stated that use of calcium hydroxide as root canal filling material inhibited the resorption process [24]. Hypo - function of teeth in case of open bite accelerates the destruction process and increases the prevalence of resorption.

e) Diagnosis and Resorption repair:
Root resorption following orthodontic treatment can be diagnosed by using conventional and digital radiographs. An in - vitro study on detection of lingual root resorption by using intraoral radiographs showed root shortening occurred due to buccal or palatal surface resorption [15]. Resorption craters are identified using microscopic root surface analysis sections [25]. Over the years, cone - beam CT (CBCT) was frequently recommended to identify the depth of resorption. CBCT offers detection of root surfaces from all aspects with high accuracy. Evidence based clinical studies suggests strongly that complete orthodontic treatment causes increased ARR and heavy forces have rapid destructive effects on the tooth [26, 27]. Majority of root resorption cases requires functional and anatomical repair, a reversible

process that occurs after removal of excessive load or completion of orthodontic treatment. Cheng et al demonstrated continuous and consistent repair over a period of 4 weeks after the removal of heavy orthodontic force [6]. It is often recommended to apply light forces in orthodontic treatments and to leave longer intervals between appliance activations. In addition to this, severe ARR cases may require prosthetic rehabilitation along with orthodontic force intervention.

4. Conclusion

External apical root resorption is an active inflammatory process that can be reduced by proper diagnosis and treatment plan. Heavy and intrusive forces over a long period of time specifically on the maxillary anterior and premolars have shown rapid destructive effects on the tooth. Thus several risk factors such as orthodontic tooth movement, nature, magnitude and duration of the force applied and treatment technique should be properly assessed and appropriate intervention must be planned. It is recommended that orthodontic treatment should always include pre - treatment and post - treatment digital radiographs that allow identification and visualization of the roots for significant resorption.

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