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Orthodontic Root Resorption

(Review)

A project submitted to

The Collage of Dentistry, University of Baghdad, Department of Orthodontic in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the supervisor

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Dedication

To my great mother

To my great father

God bless them

To my brothers

To everyone who helped me one day

With love

Acknowledgment

I would like to express my gratitude to Prof. Dr. Raghad abdulrazaq Al-Hashimi, Dean of College of Dentistry for providing me this opportunity to study.

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List of Abbreviations

Abbreviation	Description
DPSCS	Dental Pulp Stem Cells
ECRR	External Cervical Root Resorption
EIRR	External Inflammatory Root Resorption
HF	Heavy Force
ICRR	Invasive Cervical Root Resorption
IL-IP	Interleukin-I Peta
IOPAR	Intra-oral periapical radiographs
OCPS	Osteoclast Precursors
OERR	Orthodontic External Root Resorption
OF	Orthodontic Force
OIIRR	Orthodontically Induced Inflammatory Root Resorption
PDL	Periodontal Ligament

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Introduction

Root resorption is a common pathological procedure that is believed to be the result of various factors such as pulpal necrosis, trauma, periodontal treatment, orthodontic treatment **(Bansode *et al*., 2019).**

It may be categorized by location (either internal or external), distribution (localized or generalized) and affected teeth (primary, secondary, or both) **(Krishnan, 2005).**

Most studies on root resorption and its relationship with orthodontic treatment have found that there are multiple factors associated with root resorption; Age, gender, nutrition, genetics, the type of appliance, the amount of force used during treatment, extraction or non-extraction, duration of treatment, influence on root resorption. Generally, the causes and mechanism of resorption are still unclear **(Baumrind *et al*., 1996; Jiang *et al*., 2001).**

The process of root resorption is attributed to the activity of osteoclast together with other cell like microphage and monocyte, Osteoclasts are large multinucleated giant cells associated with the removal and resorption of mineralized bone **(Xing *et al*., 2005).**

Most resorption is clinically insignificant, but if severe, root resorption threatens the longevity of the teeth. With the improvements in orthodontic techniques and the increase in patient expectations, orthodontists need to be aware of this issue **(Lindskog, 1985).**

AIM OF STUDY

The aim of this review is to explain and clarify the process of root resorption as well as its causes, complication , in addition to prevention and management.

Review of Literatures

1.1 Definitions:

Root resorption is defined as destructive process of the tooth structures; cementum and/or dentine layers of the root caused by activity of the clastic cell that result in a subsequent resorption and lossin root structure, Root resorption may be physiological or pathological process. During transition to the permanent dentition, the Physiological root resorption described as naturally occurring process in deciduous teeth when permanent teeth start eruption process. It also may occur to a limited amount in the permanent teeth associated with physiological tooth movement **(Vlaskalic *et al*., 1998).**

Orthodontically induced inflammatory root resorption (OIIRR) is term to describe the type of root resorption that occurs during orthodontic treatment process. **(Brezniak and Wasserstein, 2002).**

Pathological root resorption may occur in association with orthodontic tooth movement, many pathological condition trauma, and when adjacent teeth undergo ectopic eruption **(Shah, 2017).**

1.2 History and classification:

Root resorption was first known in **1856**, when **Bates** first discussed the Absorption' phenomena of permanent teeth. Using radiographic method in **1927**, **Ketcham** first demonstrated the distinctions between root shape pre and Post OT. Soon after, an assortment of histologic, clinical, physiologic and biological research on root resorption during OT, were published, all of which were well-received by the orthodontic field **(Ketcham, 1927).**

Andreasen, put forward a widely-acknowledged classification system in **1970**, in which the condition is classified by location, type and etiological features.

A multitude of classification systems and terminologies have been Proposed since then, with various researchers trying to discover clinically-related ones to ameliorate communication among clinicians and researchers in addition to assisting diagnosis and treatment plans of this pathological state **(Andreasen, 1985; Tronstad, 1988; Patel and Ford, 2007).**

Later, OIIRR is classified as Progressive External Inflammatory Root Resorption by **(Brezniak and Wasserstein, 1993b)**, who then sorted it into three groups according to severity:

1) Cemental surface resorption with remodelling: resorption of outer cemental layers only, which later on completely regenerated or remodelled, that similar to remodelling of trabecular bone.

2) Dentinal deep resorption with repair: where the outer layers of the dentin as well as the cementum itself are resorbed and repaired with cement material. The final shape of the root could or could not look like the original form after this resorption and formation process.

3) Circumferential apical root resorption: where the hard tissue constitutes of the root apex are completely resorbed, and reduced root length is thus clear. It is certainly possible there are different degrees of apical root shortening.

The OIIRR can also be called 'Periapical Replacement resorption which develops when there is persisting pressure. This causes more marked a blunting of the apex or even extreme root length loss in the more difficult cases as showed in **(Figure 1),** which could be caused by the combination of external inflammatory resorption around apical cementum and internal inflammatory

resorption of apical pre-dentine, ensuing in periapical replacement resorption **(Bender, 1997).**

Figure 1: Orthodontic apical root resorption after 2years of fixed orthodontic treatment. A: Before treatment; B: after treatment (Cho and Kim, 2013).

1.3 Incidence and prevalence:

Due to heterogeneity in most published studies, it is strenuous to estimate a reliable rating of OIIRR incidence in the subjects' teeth **(Killiany,1999)**.

Mostly detected OIIRR is ranged to be minor to moderate in orthodontic patients according to graded scales assessment of severity (using either periapical or panoramic radiographs) **(Peltola, 2007).**

Previous studies have also shown that a reverse relation between incidence values and OIIRR severity. Recent systematic reviews and meta-analysis were conducted to qualify and identify the incidence and severity of OIIRR pre- and post -comprehensive OT in the studies using CBCT, and the results showed that the anterior maxilla was showing the greatest amount of OIIRR followed by the anterior, posterior, mandible, and finally the posterior maxilla **(Deng *et al*., 2018).**

The applied OF in previous studies have been of different types, magnitudes and durations with small samples. Using different orthodontic treatement techniques, both single and multi-rooted teeth at different root development stages have been compared. With respect to certain selection criteria and evaluations of the root resorption, various methodologies for resorption detection have been applied in the studies. As the majority of studies have been non-randomized, retrospective, and was inconclusive of all systemic or local risk factors **(Roscoe *et al*., 2015; Currell *et al*., 2019).**

1.4 Internal root resorption:

In transient internal inflammatory root resorption, pulpal inflammation compromised the integrity of the odontoblasts attached to the root canal wall. As a result, no more predentin is formed in the damaged area. With the elimination of pulpal inflammation, this transient resorptive process can be self-limiting and requires no clinical treatment. In most cases, the loss of intraradicular dentine is permanent and progressive because the inflammatory processes in the root canal are difficult to be contained. Pulpal infection is often associated with internal inflammatory root resorption; however microbial stimuli alone do not initiate this resorptive activity. For the progressive resorption to occur, the clastic cells must be recruited and activated. The clastic cellsadhere to the mineralized dentin in the resorptive site, where the anti-invasive non- mineralized structures (odontoblasts layer and predentin) are disrupted and the mineralized tissues are resorbed. **(Tronstad, 1988).**

The origin of the metaplastic tissue may be dental pulp stem (DPSCs) which are able to generate reparative dentine-like tissue on the surface of cells human dentine **(Batouli *et al*., 2003).**

Internal resorption is initiated by damage or loss of odontoblast layers and protective pre-dentin and is associated with long lasting pulpal inflammation/infection dental trauma, restorative procedures, cracked tooth, pulpitis, orthodontic treatment and developmental anomaly are the predisposing factors contributing to internal root resorption.This type of resorptive defect is associated with low-grade inflammation of the pulp. Histologically, lamellar bone-like structures substituted the resorbed dentine with entrapped osteocyte-like cells **(Patel *et al*., 2010).**

Clinically, internal inflammatory root resorption may be asymptomatic in early stages. When the infection occupies the entire root canal and progresses to the extraradicular region, periapical symptoms such as pain on biting may be reported.A classic sign of internal inflammatory resorption taking place in the pulp chamber is called the Pink tooth of Mummery. **(Figure 2)** showed A pink-hued area on the crown of affected tooth. The origins of the resorption of internal inflammatory root resorption (from the pulp tissue) and invasive cervical root resorption (from periodontal tissue) are different. Clinically, Pink tooth of Mummery shows pink discoloration within the clinical crown under the intact enamel **(Tronstad,1988).**

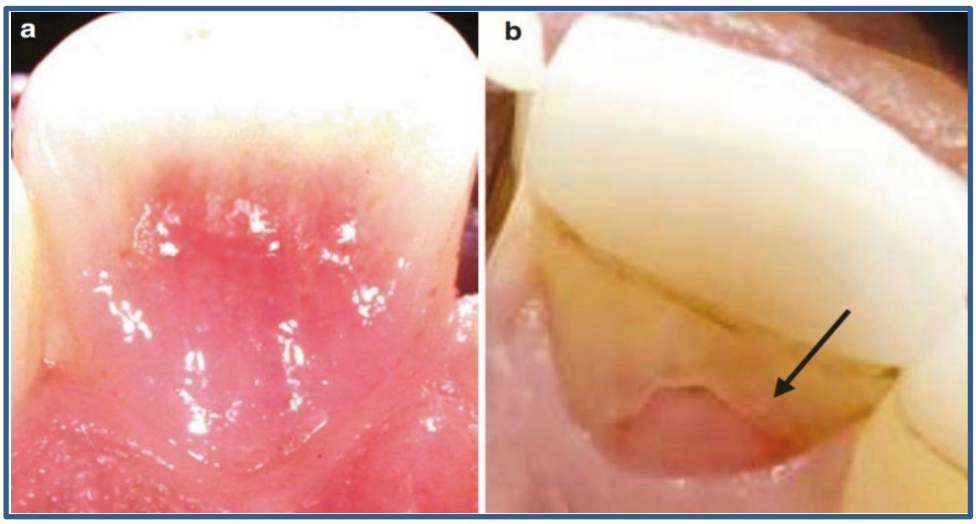

Figure 2: Internal cervical root resorption, pink discoloration in inflammation of PDL in maxillary central incisor (Tronstad, 1988).

Radiographically, the appearance of the lesion is described as well a circumscribed, symmetrical , oval, or circular-shaped radiolucency , and the outline of the radiolucency is continuous with the shape of the root canal showed in **Figure (3)**, When the resorptive lacunae can be detected by routine radiographs, immediate endodontic treatment is often required to eliminate the source of infection **(Gulabivala, 2014).**

Figure 3:radiographic appearance showed extensive internal resorption on maxillary central incisor (Gulabivala, 2014).

The mechanism of the subsequent deposition of metaplastic tissue is similar to the formation of reparative tertiary dentine by odontoblast- like cells after the elimination of odontoblasts in pulpal infection. Radiographically, internal replacement root resorption displays an irregular enlargement of the root canal space with distortion of the normal root canal outline **(Patel *et al*., 2010).**

1.5 External Root Resorption:

External root resorption is commonly associated with dental trauma orthodontic treatment, and periapical periodontitis. Andreasen has classified external root resorption into surface, inflammatory and replacement resorptions. The location of the external resorption usually involves the apical, lateral and cervical regions **(Andreasen ,1985).**

1.5.1 External Inflammatory Root Resorption:

This type of root resorption is caused by persistent inflammation of PDL sustained by mechanical, infective, and pressure stimulation. Clinically external inflammatory root resorptions (EIRR) are commonly seen in patients with traumatic injury, orthodontic treatment, root canal infection, and tooth impaction **(Tronstad ,1988).**

1.5.1.1 External Inflammatory Root Resorption after Traumatic Injury:

EIRR is a severe complication after dental trauma, especially after tooth avulsion. A meta-analysis demonstrated that the occurrence of EIRR in a pooled 1656 avulsed teeth was 23.2% **(Andreasen and Kristerson, 1981).**

An animal study conducted by Andreasen indicated that EIRR can initiate in 1 week after replantation of avulsed tooth in green vervet monkeys. Four prerequisites were proposed by Andreasen for this type of resorption to occur **(Andreasen, 1985).**

1) Injury to PDL, either from mechanical injury from avulsion, luxation, intrusion and root fracture or from physical (i.e., extending drying time after avulsion) or chemical (improper storage solution, for avulsed tooth) damage of the PDL.

2) Exposure of dentinal tubules of the injured area by damaging the protective cementum/cementoid, in order to ensure osteo-/odontoclastic activity directly on dentine surface.

3) Communication between the exposed dentinal tubules and the necrotic pulp tissue or leucocyte zone harboring bacteria, in order to have bacteria an bacterial -endotoxins pass through dentinal tubules to root surface to amplify osteo-/odontoclastic activity.

4) Avulsed tooth is immature or young matured.

Clinically, patient with EIRR may report no symptoms unless the infection becomes acute to show signs and symptoms as acute apical abscess **(Figure 4)**, The radiographical characteristics are a distinctive hollow or blunt surface on the shorten root and a radiolucency in the root surrounding bone **(Heithersay, 2007).**

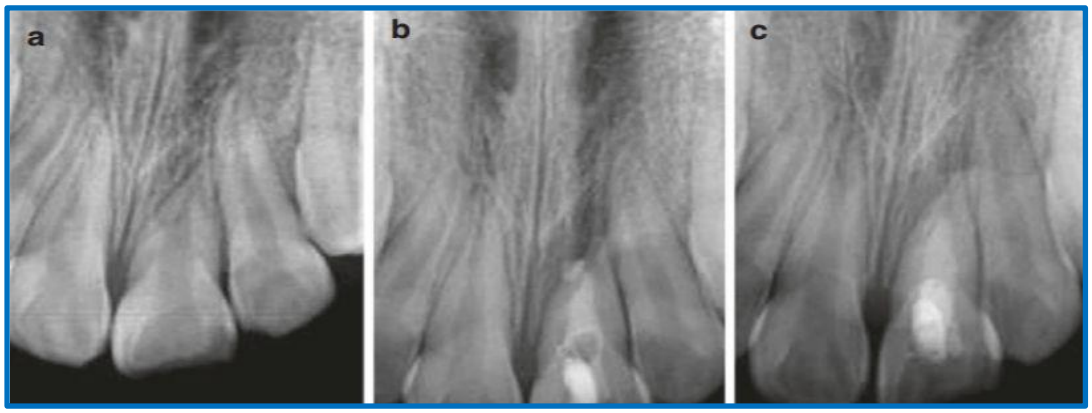

Figure 4: (Heithersay, 2007)

(A) A Radiographs of maxillary central incisor have luxation radiolucency around right central incisor with shortened root. (B) Medicated with calcium hydroxide, extrusion of intracanal dressing was noticed in the periapical region. (C) Extruded calcium hydroxide paste was resorbed by surrounding tissue

1.5.1.2 External Inflammatory Root Resorption in Orthodontic Treatement (Pressure):

During orthodontic treatment, the blood flow in the compressed PDL is disturbed, leading to hyalinization of periodontal tissues. The anti-resorptive barrier on the root surface is eliminated by macrophages, and the exposed cementum can be easily accessed and attacked by clastic cells in the favored resorption-promoting environment around a hyalinized area. The resorptive process can be arrested when the orthodontic forces are discontinued **(Rygh, 1977).**

Although most OERR involved teeth remain asymptomatic, the occurrence of moderate and severe resorption would certainly require clinical attention. An estimated 1/3 of the patients who have undergone orthodontic treatment showed more than 3 mm OERR, and 5% of the patients had a resorption more than 5mm **(Killiany, 1999).**

EIRR sustained by orthodontic treatment, or orthodontic external root resorption (OERR), is an undesirable iatrogenic consequence in orthodontics. maxillary anterior teeth are the most venerable and commonly affected teeth The by OERR.Understanding the predisposing factors of OERR will facilitate clinicians to precaution potential root resorption during orthodontic treatment. Some of the commonly known predisposing factors include dilacerated and pointed teeth **(Sameshima and Sinclair 2001a).**

Sameshima and Sinclair concluded that first premolar extraction therapy, horizontal displacement more than 1.5 mm and longer treatment time are significantly associated with OERR **(Sameshima and Sinclair, 2001b).**

Clinically, the involved teeth can maintain vital pulp and remain asymptomatic.**Figure (5)** showed a radiographic appearance shows normal PDL space and surrounding alveolar bone despite shortened root **(levander and malmgren, 2000).**

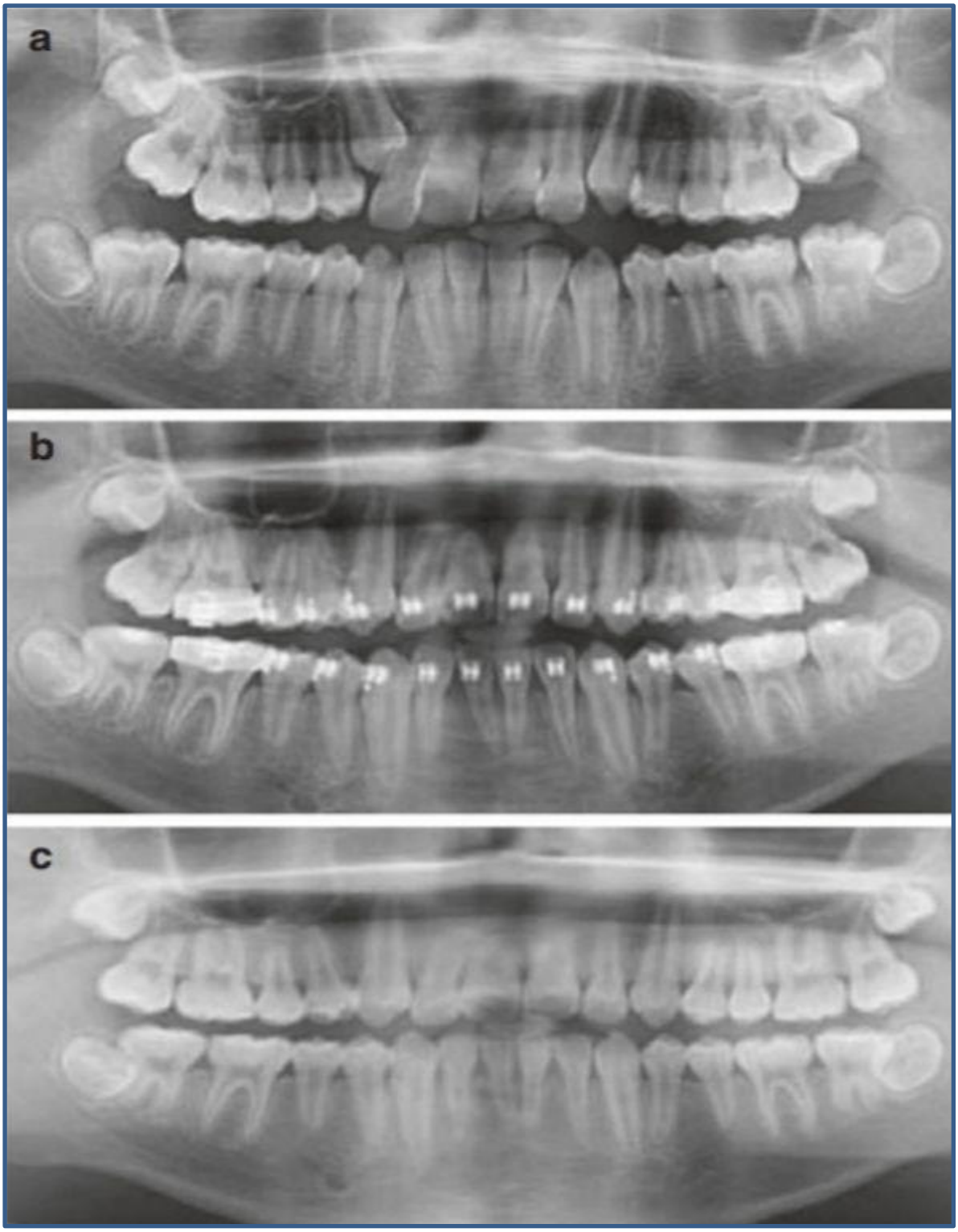

Figure 5: (a–c) Progressive external resorption of maxillary anterior teeth in mid- and post- orthodontic treatment (levander and malmgren, 2000).

1.5.1.3 External Inflammatory Root Resorption Induced by Root Canal Infection (Tronstad, 1988):

Apical persistent external inflammatory resorption is a complication of root canal. Microorganisms and their by-products in the infected and necrotic pulp cause inflammatory reactions in PDL adjacent to the exposed dentine in the apical region. Hard tissue resorption stimulators such as macrophage-chemotactic factor, osteoclast-activating factor and prostaglandins are released to initiate the resorptive process**.**

Clinically, the involved tooth is usually non-responsive to pulpal vitality test. The affected tooth may present signs as symptomatic apical periodontitis or chronic apical abscess. Mobility of tooth may be noticed in case of extensive resorption. A typical sign on radiograph is periapical radiolucency around shortened root of involved tooth. “Extrusion” of root canal filling material can be noticed in unsuccessful endodontic treatment cases due to the resorption of dental tissue in apical portion of the root.

1.5.1.4 Orthodontic Induced External Root resorption of Endodontically Treated Teeth:

Compare to vital pulp teeth, whether endodontically treated teeth are more susceptible to orthodontic induced external root resorption remains controversial. Bender *et al*. reported one case that orthodontically treated maxillary incisors exhibited severe apical resorption, while little apical resorption was observed in the endodontically treated maxillary central tooth. The reasons might be the loss of the pulpal immunoreactive neuropeptides due to the removal of pulp tissue during root canal treatment and the application of long-term used calcium hydroxide that can create an alkaline environment in the periapical region **(Bender *et al*., 1997).**

Orthodontically treated teeth can be subjected to external root resorption, the especially maxillary anterior teeth **(Sameshima and Sinclair, 2001a).**

Recently, A meta-analysis including seven prospective and retrospective controlled clinical trials was conducted, and the result indicated that orthodontic-induced external root resorption was less in endodontically treated teeth compared to their contralateral vital pulp teeth. Clinical trial might not be applicable at this moment when determining whether endodontic treatment increases the risk of orthodontic induced external root resorption **(Alhadainy *et al*.,2019).**

1.5.2 Invasive Cervical Root Resorption:

Invasive cervical root resorption (ICRR) or external cervical root resorption (ECRR) is characterized by an aggressively destructive invasion of the cervical region of the root **(Heithersay,1999a).** It is commonly considered as a subcategory under external inflammatory root resorption. The pathologic process involves a progressive resorption of cementum, enamel, and dentine by fibro-vascular tissues subsequent to the damage to the cervical attachment apparatus below the epithelial attachment**. (Figure 6)** showed A clinical classification of ICRR has been described by Heithersay based on the extensiveness of the resorption **(Heithersay, 2004).**

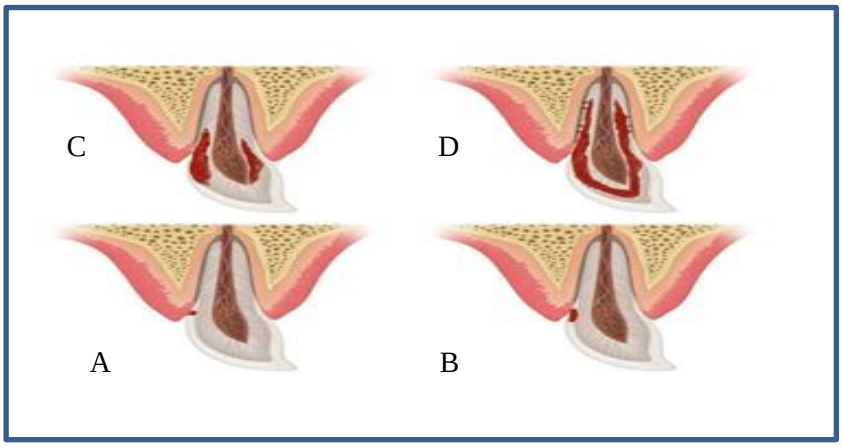

Figure 6: A clinical classification of invasive cervical root resorption (a) Class I. (b) Class II. (c) Class III. (d) Class IV (Heithersay,2004).

1) Class I: a small invasive resorptive lesion with shallow penetration into the dentine near the cervical area.

2) Class II: a well-defined resorptive lesion that has penetrated near the coronal pulp chamber but not extended into the radicular dentine.

3) Class III: a deeper penetration of resorptive lesion into dentine and extended to the coronal one third of the root canal.

4) Class IV: a larger and deeper penetration of invasive resorptive process extended beyond the coronal third of the root canal.

1.5.3 External Surface Resorption:

Surface resorption is a self-limiting and transient osteoclastic process followed by cementum healing and reattachment of PDL. It is a consequence of limited injury to the root surface or supporting periodontium, often seen in traumatic injuries and orthodontic treatment **(Andreasen, 1985).**

1.6 Risk Factors for Root Resorption:

Despite huge number of researches aimed to find out the causal basis of OIIRR, but they still failed to elucidate the aetiology. As these conditions multi- factorial; therefore orthodontic treatement effect is still elusive. Many studies were concluded that it is a result of the inter-relationship between patient and treatment-related factors. Unfortunately, till now no reliable measures to predict patients who are more susceptible to experience OIIRR and severity are currently available **(Brezniak and Wasserstein, 2018).**

1.6.1 Patient-related Factors:

Major factor to OIIRR aetiology and severity is patient susceptibility, and these are either systemic or local factors which are as follow **(Brezniak and Wasserstein, 2018).**

1) Genetics and Hereditary Factors.

2) Gender and Age.

3) Type of Malocclusion.

4) Pre-existing Root Resorption with or without Trauma.

5) Tooth/Root Morphology.

6) Occlusal trauma and Habits.

1.6.1.1 Genetics and Hereditary Factors:

In spite of genetic studies are ultimately heterogeneous, they found genetic variation in orthodontic patients of the OIIRR, thus suggested that genetic and hereditary play a crucial role for this susceptibility difference between patients to patients **(Al-gawasm *et al*., 2003).**

Studies in this field attempted to investigate genes that have mostly direct correlation with bone remodelling pathways (mostly interleukin-I Peta, IL-1p), and they found a close relation of genetic variation and OIIRR **(Abass and Hartsfield, 2007).**

A systematic review and meta-analysis was carried out by **(Nowrin *et al*., 2018)** to investigate the association between various gene Polymorphisms and their interaction with OIIRR. The consequence of this systematic analysis indicates that different gene polymorphisms may suggest the occurrence of OIIRR in some patients undergoing orthodontic treatement . In conclusion, rapid advance in genomic, proteomics and recently metabolomics application in this field improved the knowledge of genetic and their products on the process of resorption to be the major risk factor related to induce orthodontic root resorption as showed in **Figure(7).**

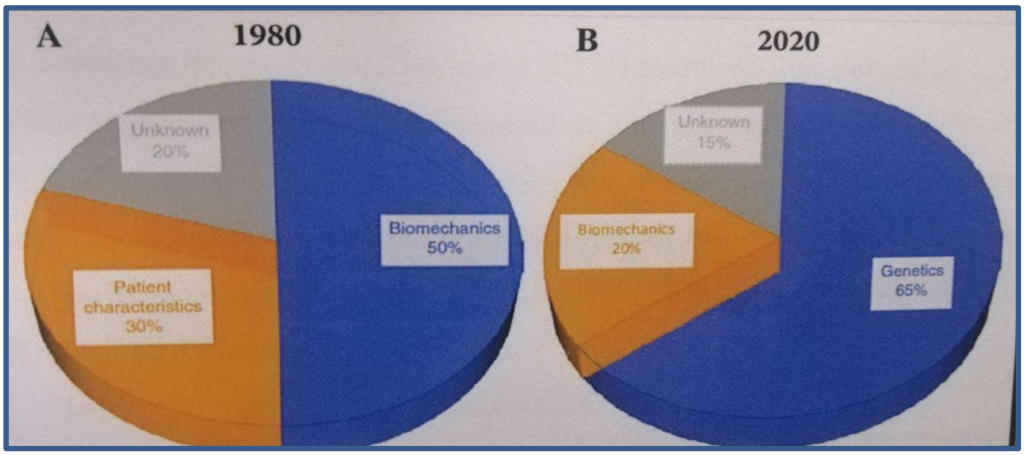

Figure 7: The majority of rapid advances in genetics in the last four decades, supposed the most diagnostic risk factor of OlIRR is genetics. (A): in 1980 no data available on genetic relation. (B): in 2020 genetic compromised 65% of risk factor to OIIRR (Sameshima, 2021) .

1.6.1.2 Gender and Age:

There is agreement that OIIRR is not consistently gender- related However, some studies found that the OIIRR was prevalent among either male or female. There were also controversial findings between studies **(Weltman *et al*., 2010).**

In the literature, the incidence of OIIRR was found to be increased in adult patient than adolescents. This is justified by age-related changes in periodontium and vascularity that got worse with increased age **(Picanço *et al*., 2013).**

1.6.1.3 Type of Malocclusion:

It was evident previously that the severity of root resorption increased with increased tooth movement distant; therefore, studies showed teeth experienced sever OIIRR in specific types of malocclusion than others. Increased overjet in Class II division 1 malocclusion patients who needed teeth extraction in the upper arch (mostly upper first premolars) and patients with anterior open bite **(Kuperstein, 2005; Preoteasa and Ionescu, 2011).**

1.6.1.4 Pre-existing Root Resorption with or without Trauma:

There was a close positive relation between resorption before orthodontic treatement (due to trauma or idiopathic) and after treatment completion **(Brezniak and Wasserstein, 2002b).**

1.6.1.5 Tooth/Root Morphology:

Pipette, pointed or dilacerated roots reported as abnormal roots shape diagnosed at a high risk level for resorption susceptibility **(Sameshima and Sinclair, 2001).**

1.6.1.6 Occlusal trauma and Habits:

Alveolar bone resorption could be associated with root resorption Occlusal trauma (either due to habits like bruxism or premature contact) showed to be resulting in alveolar bone loss, thus could encourage root resorption in the presence of OF application **(Sameshima, 2004).**

1.6.2 Treatment-Related Factors:

(Aras *et al*., 2012) stated that in addition to the existing body of scientific literature on OIIRR-related patients' factors, it fails to recognize a straightforward method that can be utilized by orthodontists to avoid OIIRR. Therefore, the investigators aimed to examine clinical data on therapeutic factors which can reduce irreversible destruction of the tooth structure**.** There are many treatment factors could be related to OIIRR, but the mostly related and the researchers main targeted are as follow:

1.6.2.1 Active Treatment Duration and Associated Loading Regimen

The effect of active versus passive treatment duration showed a strong and inverse relations with OIIRR, respectively. Previous studies showed resorption

initiation occur at the 3rd week of force application and if the force persist, it would get worsen **(Casa *et al*., 2006).**

Clinical studies showed a strong positive correlation between time and sever OIIRR. Studies evaluated continuous versus intermittent force regimen showed direct influence with increased OIIRR this could be related to the pause period that allowed the resorbed cementum repair **(Aras *et al*., 2012).**

1.6.2.2 Force Properties

Force magnitude and direction also evaluated on the basis of risk resorption factors. It was evident that HF application(in most of experimental clinical studies a 225 vs 25g of force magnitude was compared) results in increased resorption incidence **(Weltman *et al*., 2010; Roscoe *et al*., 2015; Currell *et al*., 2019).**

Particularly, force direction correlations could affect root resorption severity, as shown in **Figure (8)**. The intrusive forces showed fourfold increase in OIIRR compared with extrusion force followed by root torqueing **(Casa *et al*., 2006 Bartley *et al*., 2011)** buccal tipping **(Ahuja *et al*., 2017)** and finally, rotation **(Wu *et al*., 2011).**

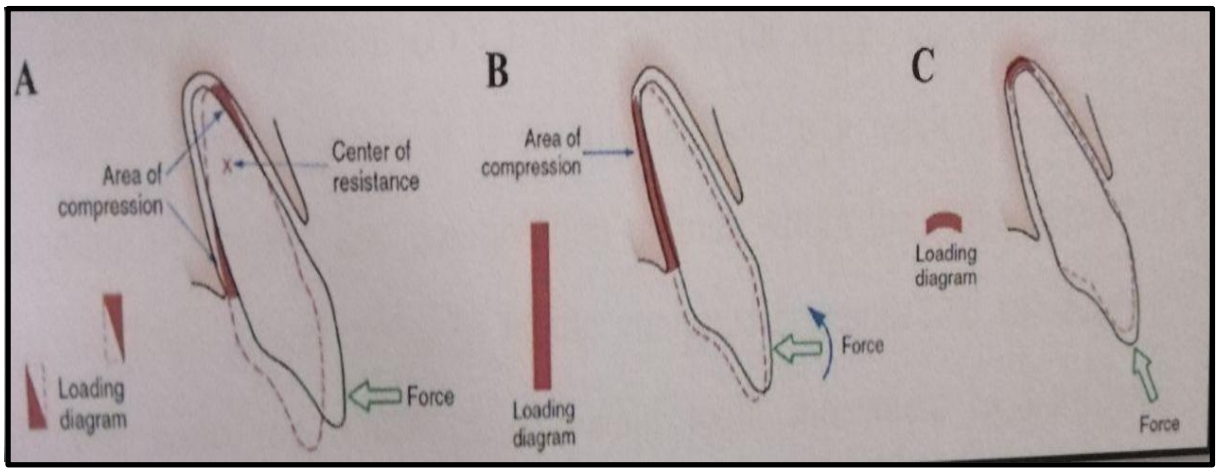

Figure 8: Orthodontic force direction effects on root resorption. (A): Tipping, (B) Translation.(C): intrusion (Profit *et al*., 2019).

1.6.2.3 Appliance Design

Orthodontic bracket types, prescription, systems and ligation method with different wire types and sequencing, were investigated for their correlation with OIIRR. Surprisingly, no statistical significant correlation with an increase or decrease in OIIRR **(Weltman *et al*., 2010; Roscoe *et al*.,2015 and Currell *et al*., 2019).**

1.7 Treatment options:

Justus in 2015 stated that the key to understanding treatment options lies in understanding risk factors, educating the patient and dentist, and determining the best plan for the patient. This may involve compromises or alternative plans. stated that there were five ways to prevent or circumvent EIRR**.**

1.Growth modification to correct severe skeletal Class II malocclusions.

2.Early interception of maxillary canines that have mesial eruption paths.

3.Serial extraction to modify eruption paths (guidance of eruption).

4.Correction of anterior open bite with a palatal tongue spur appliance.

5.Orthognathic surgery to avoid moving teeth large distances and against cortical plates.

There are many treatment options such as no treatment no appliances on at-risk teeth, avoid root movement and short treatment time.

1.7.1 No Treatment:

Sometimes the best treatment is no treatment or no orthodontics. Veneers or other restorative solutions may be preferred. Extraction of short-rooted teeth in itself is not a justification for implants; however, in certain situations it may be the best course **(Sameshima, 2001).**

1.7.2 No Appliances on At-Risk Teeth:

Do not band or bond any brackets or attachments on teeth at high risk, if for the possible treatment entirety, if not then for as long as necessary for alignment and space closure. Brackets must be placed precisely, so no tweaking with wire bends or repositioning becomes necessary **(Sameshima, 2001).**

1.7.3 Avoid Root Movement:

The orthodontist must limit apical displacement including torque and bodily movement. Rotation and tipping on a limited basis with no round tripping is acceptable. Patient must be forewarned for the need of more frequent radiographs **(Sameshima, 2001).**

1.7.4 Short Treatment Time:

Treatment time must not exceed the normal treatment duration for the type of case. Treatment goals may have to be compromised. Patients' cooperation in not missing appointments or breaking appliances is important. Oral hygiene must be monitored and appropriate steps taken **(Sameshima, 2001).**

1.7.5 Extractions and Implants:

Extraction cases generally take longer, but with proper mechanics and minimizing movement of at-risk teeth, extractions is important to resolve the moderate and severe crowding. Not achieving ideal or desired out comes even such as correcting overjet and overbite completely must be an acceptable compromise, and the patient must be so informed. The first surgery of the lower jaw was an interesting solution on a 14-years-old patient who had idiopathic root resorption by **(Carlier *et al.*,2019).**

1.7.6 Endodontic Therapy:

Clinical experience and the orthodontic (and endodontic) literature tend to the support finding that endodontically treated teeth. Bender *et al.*, reported this in 1997 with a case series review (43 patients). In their comprehensive study of over 1000 patients found no EARR in teeth that had had a root canal **(Sameshima and Sinclair, 2001).**

A systematic review was inconclusive due to a lack of randomized clinical trials. Resorption of the root apex was found in endodontically treated maxillary incisors after orthodontic tooth movement in a split mouth study, but there was no significant difference **(Walker 2010; Liamas-Carreras *et al*., 2012).**

1.8 Prevention of root resorption:

During orthodontic treatment, progress radiographs should be obtained after 6- 12 months to detect the early occurrence of OIIRR. If detected, active treatment should be halted for 2-3months. So that, a treatment pause of 2-3 months with passive arch wires led to a decrease in the prevalence and severity of root resorption **(Levander, 1994).**

If severe resorption is identified the treatment plan should be re-assessed with the patient. Alternative options might include prosthetic solutions to close spaces, releasing teeth from active arch wires if possible, stripping instead of extractions, and early fixation of resorbed teeth **(Brezniak, 2002b).**

If severe external apical root resorption is observed the treatment on the final radiographs, follow-up radiographic examinations are recommended until the resorption has stopped. After appliance removal, stabilization of active external apical root resorption usually occurs. If resorption does not stop, sequential root canal therapy with calcium hydroxide may be considered **(Pizzo , 2007).**

Chapter Two : Discussion

Orthodontically induced inflammatory root resorption (OIIRR) is considered to be a particularly important sequelae associated with orthodontic treatment. Root resorption associated with orthodontic treatment is undesirable pathologic consequence of orthodontic tooth movement that can jeopardize the prognosis and the success of orthodontic treatment **(Bader, 2001).**

The etiology of root resorption accompanied with orthodontic treatment is complex. Several factors, alone or in combination, could contribute to root resorption.

Monitoring for resorption in every case should be done, but even more for of high risk cases during both the active phase of treatment and after the end treatment. When there is history of trauma or after root canal treatment Also, there are other factors that can contribute to root resorption such as blunted root, long treatment time and using heavy force for teeth movement **(Bader, 2001).**

The screening should involve both the apical and the cervical zones of the teeth subject to orthodontic forces. A mid-treatment radiographic evaluation with IOPAR can reveal teeth at risk, if there is suspicion of resorption, the cone beam is a very precise diagnostic tool. It makes it to possible determine the anatomical context, as well as the extent and severity of the resorption **(Levander, 1994).**

Chapter Three: Conclusion and suggestion

1) Increased incidence and severity of OIIRR is found in patients undergoing comprehensive orthodontic therapy.

2) Heavy force application produced significantly more OIIRR than light force application or control.

3) Patient's age would appear to be an influencing factor in root resorption. Older patients tend to have significant root resorption after orthodontic treatment and an element of upper root resorption before treatment.

4) Treatment duration has a statistically significant correlation with post-treatment root resorption the longer the duration, the more severe the root resorption.

suggestion

For further studies, we suggest making survey among finished orthodontic cases, estimating the degree of root resorption, as well as the most affected teeth with different types and techniques of orthodontic appliance.

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