

"Root Resorption: Internal Or External? – A Review"

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Abstract

Tooth resorption is a common outcome following injuries or irritation to the periodontal ligament and/or tooth pulp. The process of tooth resorption involves complex interactions among inflammatory cells, resorbing cells, and hard tissue structures. It is a pathological process involving the destruction of dental root structures, often due to trauma, orthodontic treatment, or inflammatory conditions. It can manifest in various forms, including external, internal, and replacement resorption, each with distinct etiologies and clinical implications. Early detection through radiographic imaging and clinical examination is crucial for effective management. Treatment strategies may involve addressing underlying causes, utilizing endodontic therapies, or, in severe cases, extracting the affected tooth. Research continues to explore the molecular mechanisms and preventive measures for root resorption.

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I. Introduction

Dental resorptions pose a significant challenge to dentistry because of the complex organic processes they trigger. Interest and concern regarding this issue have existed for a very long period.¹ The term "root resorption" describes the clastic activity-induced loss of dental hard tissues. It can happen either as a physiological or pathological process. Unless it occurs too soon, root resorption in primary teeth is a typical physiological process. The exact processes causing proper root resorption in primary teeth are not fully understood, however it appears to be regulated by cytokines and transcription factors similar to those involved in bone remodeling. Permanent teeth do not normally experience root resorption, unlike bone, which changes physiologically continuously throughout life. When it does occur, it is invariably inflammatory and considered pathological, potentially leading to the premature loss of the affected teeth.² The hard tissues of permanent teeth, such as dentin, cementum, and enamel, usually do not undergo resorption. Clinically recognized resorption of permanent teeth is typically caused by trauma, long-term infection of the periodontal or pulp tissues, or both. It may also be brought on by tumors, tooth eruption, or forced pressure in the periodontal ligament related to orthodontic tooth movement.³ General dentists often face the challenge of treating patients with moderate to severe root resorption, which raises questions about root resorption causes, prognosis, restoration options, root canal therapy, splinting, implant replacement, and the impact on restoration placement. Incorrect diagnosis can lead to inappropriate treatment, making these questions crucial for dentists.⁴

II. External Resorption

External Surface Resorption⁵

External surface resorption is a temporary, varying degree process where the root surface experiences both spontaneous degradation and repair, likely a normal physiological response in all teeth.

Etiology: it occurs as a response to indirect physical injury to periodontal ligament or cementum on the root surface, because the root surface and the alveolar bone proper are in close mechanical contact, and is part of tissue repair.

Features: it is a self-inhibiting, temporary procedure that occurs within 2-3 weeks, is a normal physiologic response to function in all teeth, and is associated with normal cementum turnover.

Clinical Evaluation: The tooth exhibits a normal pulpal response to vitality testing and the supragingival region of the tooth shows no discernible symptoms of external surface resorption.

Radiographic evaluation: Radiographs often overlook this type of resorption due to its little size, but when it is seen, it resembles tiny periodontal and lamina dura excavations on the root surface.

Histologic evaluation: The process of external surface resorption manifests as minute, superficial lacunae in the cementum and outermost layer of dentin, which are concurrently restored with fresh cementum. It may show up in regions with damaged cementoblasts and localized necrosis.⁶

Treatment: No treatment is indicated.

Transient Apical Breakdown^{5,7}

It is a temporary resorption of the tooth's apex is a radiographic phenomenon, followed by surface resorption or pulp canal obliteration, and typically returns to normal after a year of trauma repair.

Etiology: The cause of this condition is moderate pulp injuries, subluxation, extrusion, lateral luxation, combined periodontal ligament and pulp damage in mature teeth, and other causes include infections, orthodontic treatment, and occlusal insult to the periodontium.

Features: The degradation process is linked to injury type and root development stage, and occurs in teeth that have completely developed roots or closed or half-closed apices.

Radiographic evaluation: A temporary localized change with increased apical periodontal ligament space and semicircular radiolucency, blunt apex due to surface resorption, and possible pulp canal obliteration.

Treatment: No treatment is indicated.

External Inflammatory Root Resorption (EIRR)⁸

This kind of external root resorption is the most prevalent kind. It is best defined as a dentin-piercing, bowl-shaped resorptive deformity.⁹

Etiology: External inflammatory resorption is caused by various factors, including trauma, periodontal infection, or orthodontic treatment. It can happen on any portion of the root, but is often subcategorized by the tooth in which it has happened. Trauma (most prevalent), tissue breakdown products, bacteria, and bacterial byproducts cause the periodontal tissue surrounding them to become inflamed, which triggers aggressive, progressive inflammatory resorption. In addition, pressure is also thought to be a potential etiologic agent,

Clinical Evaluation: It is a major resorption disorder that goes undiagnosed and mostly affects young teeth due to the weakened dentinal walls and large tubules. It is most common in the tooth's cervical region, progressing inward and lateral but leaving the canal intact. It may be transient or progressive, especially after tooth replantation in patients aged 6-10 years.⁵

Radiographic evaluation: External inflammatory root resorption widens periodontal space, causing loss of tooth structure and the surrounding lamina dura, which leaves the mesial and distal margins ill-defined. Radiopacity towards root canal space may increase. A solitary resorption lacuna may be encountered in the cervical aspect in the supra-alveolar region, which is the site of external resorption. Radiolucency that is both persistent and progressive is usually detected at the root apex.¹⁰

Histologic evaluation: External inflammatory root resorption is defined by a necrotic or infected pulp in the root canal, inflammation of the surrounding periodontal tissue, and a bowl-shaped region in the cementum and dentin. The periodontium contains lymphocytes, plasma cells, and leukocytes.¹¹

Treatment: External inflammatory root resorption treatment depends on the etiology. When pulpal injury occurs during repair, baseline tests and electrical pulp tests should be done, followed by restoration of the defect. Cervically located resorption occurs in vital pulp and the treatment is likely to cause pulpal injury. If orthodontic treatment is the only cause, removing the pressure of orthodontic movement can arrest the process. Resorption due to pulp necrosis and periodontal injury can be treated with nonsurgical root canal therapy.¹²

External Apical Root Resorption

It is a pathological condition in which the hard tissues undergo resorption, often triggered by local inflammation and infected necrotic dental pulp.^{(Hammarstrom & Lindskog, 1985)¹³}

Etiology: External inflammatory root resorption can occur due to traumatic injury, periradicular periodontitis, or orthodontic treatment. Periradicular periodontitis causes inflammation at the apex, causing pressure to overcome cemental layer resistance. Traumatic injuries, particularly intrusive luxation, can lead to inflammatory root resorption at the apical foramina due to microbial stimuli from the infected root canal.¹³

Features: This type of root resorption is prevalent in clinical practice. In most cases, the cementum on the root surface remains intact. When infection is the cause, communication primarily occurs by means of the apical foramina and occasionally via accessory canals (Delzangles et al., 1996)¹⁴

Clinical Evaluation: Apical external root resorption is generally asymptomatic. If clinical symptoms are present, they are typically related to apical periodontitis. Teeth with irreversible pulpitis exhibit the least resorption, while those with necrotic pulp are more likely to show apical resorption (Mauleg et al., 1996).¹⁵

Histologic Appearance: (Vier & Figueiredo, 2102)80 Resorption of the root at the cemento-dentinal junction (CDJ) is invariably seen. This resorption at the CEJ can be categorized into three types: (i) Periforaminal resorption (resorption affecting the area surrounding the foramen but not including its outline); (ii) Foraminal

resorption (resorption occurring within the outline or periphery of the foramen); and (iii) A combination of perforaminal and foraminal resorptions.

Radiographic Appearance: Root resorption at the cement-dentinal junction is usually subtle, but extensive resorption can cause apical remodeling, widened periodontal space, and inflammatory resorption, with adjacent bone resorption being a typical symptom. Nearly all teeth with apical periodontitis exhibit apical resorption; with 83.2%-87.3% of roots showing resorption associated with periapical lesions. An advance of external apical root resorption may also show apical internal root resorption in 74.7% of roots. Single radiographs have limitations for clinical diagnosis, as less than 21% of teeth show inflammatory root resorption. Angled radiographs are recommended for detecting apical root resorption.¹⁶

Treatment: Root canal therapy.

External Cervical Root Resorption (Invasive cervical resorption)¹⁷

The term cervical invasive root resorption is most frequently used to describe external root resorption linked to marginal periodontitis without pulpal involvement [because to the defect's marginal position].

(Heithersay 1999)⁵

Etiology: The cause of invasive cervical resorption is unclear, leading to varying terminology. Researchers are unsure if it's purely inflammatory or a benign proliferative disorder. Current interpretations rely on clinical manifestations and histopathological material, but more precise etiology requires molecular biological, enzyme histochemical, or microbiological investigations.¹⁸

Clinical Evaluation: it is usually asymptomatic but symptoms of pulpitis can develop. Pulp tests are crucial, except for intracoronary bleaching. Probing may cause profuse bleeding. Longstanding granulation tissue spreads coronally, causing a pinkish appearance called a pink spot.

Histologic Appearance: (Vier & Figueiredo, 2102)80 The histologic appearance of root resorptive defects is similar to external inflammation, with multinucleated giant cells and granulomatous tissue resorbing the dentinal structure. In extensive defects, healing is indicated by the presence of osseous tissue inside granulomatous tissue.

Radiographic Appearance: The resorptive process occurs on the root surface, with small radiolucent openings potentially misdiagnosed as root caries. Radiolucency expands in dentin and reaches the root canal, but usually doesn't perforate. In buccal or palato-lingual cases, diagnosis becomes difficult and requires separating from internal root resorption. To diagnose, look for ragged margins, angled radiographs, and use CARP (Computer-Assisted Rapid Prototyping) to create a starch model.¹⁹

Treatment: The treatment aims to stop resorption, remove granulomatous tissue from the root, severe blood supply to the tissue, and use a foreign substance to cover the exposed root surface. This can be done using 90% trichloroacetic acid and glass ionomer cement. However, root attachment only occurs apical, leaving a periodontal pocket.¹²

External Replacement Resorption⁵

Etiology: Replacement resorption is caused by luxation injuries, where the bone progressively replaces the tooth. This process differs from ankylosis due to inflamed connective tissue. Tooth avulsion damages periodontal ligament, leading to healing from the alveolar side of the socket.

Clinical Evaluation: Replacement resorption, similar to ankylosis, typically follows an asymptomatic course, with a louder reaction to percussion than neighboring teeth.

Radiographic evaluation: The periodontal ligament space will disappear, leading to progressive root resorption and bone replacement, with irregularly shaped defect margins.

Histologic evaluation: There is a connective tissue interface and bone in lieu of the root material. Inflammatory and osteoclastic cells resorb tooth and bone, forming a connective tissue interface, and bone grows in the resorbed region.

Treatment: Despite attempts like calcium hydroxide, advances to the point where the tooth must be extracted because no root remains.⁵

III. Internal Resorption

Internal root resorption is a unique tooth resorption process that typically commences within the tooth, often due to inflammatory pulp hyperplasia.²¹

Introduction²¹

Rarely occurring internal root resorption is sometimes mistaken for external cervical resorption (ECR), which might result in undesirable treatment. It is described as intra-radicular or apical, and gradually deteriorates the dentin and dentinal tubules along the canal walls. It is more common in males and is related to teeth that have received specialized care, such as auto-transplantation. Studies have shown that maxillary

incisors are the teeth that are most often affected. Teeth with periapical disease frequently experience internal resorption apically. Internal apical resorption was found in 75% of teeth linked to periapical lesions in a research, while vital teeth showed significantly lower levels of apical internal resorption than teeth with periapical radiolucencies. A single root from the control group showed mild internal resorption, which was thought to be temporary owing to stress. In contrast, 48% of patients with periapical radiolucencies had severe internal resorption. To determine racial preferences in the presentation of intra-radicular internal resorption, more epidemiologic research is required.

Etiology: The odontoblastic layer and predentin can be lost or reformed due to trauma, caries, iatrogenic procedures, restorations, partial pulp removal, calcium hydroxide procedures, and other procedures. In permanent teeth, it is unusual, and is often misdiagnosed as internal resorption. The highest incidence is in incisors, and it is not associated with any systemic diseases. The condition progresses more slowly than external resorption, and it is not associated with any systemic diseases.

Features: Internal resorption is an unusual occurrence in permanent teeth, with the highest incidence in incisors. It is not associated with systemic diseases and progresses more rapidly in primary teeth. A vital pulp is required for resorption, and it is more frequent near blood vessels and regions of elevated oxygen pressure and electrical activity associated with active hyperemia. Internal inflammatory resorption can be classified as either a transient or progressive type.²²

i) Transient type: Transient root resorption is a common issue in traumatized teeth, orthodontic and periodontal treatment teeth, and other teeth due to wear and tear. It occurs when hard tissue-resorbing cells invade injured root surface regions, but this process requires continuous stimulation. Denuded dentin or cementum surfaces might not be able to withstand the resorptive activity for longer than two to three weeks. This kind of resorption, called surface resorption, happens inside the root canal as well as on the surface of the root. It is often missed on radiographs because of its small size.

ii) Progressive type: Root resorption, triggered by mineralized or denuded areas, can be exacerbated by increased pressure, dentin and root canal infections, mechanical irritation and certain systemic diseases, leading to progressive resorption and root destruction.²²

Clinical Manifestations: Internal root resorption is a condition where the tooth becomes partly vital and might show signs of pulpitis. The tooth may not exhibit any symptoms, but if it continues to advance, it might become vital and exhibit symptoms. Due to highly vascularized connective tissue, resorption may show as a pinkish or reddish tone throughout the crown. If the coronal pulp with untreated internal resorption becomes necrotic, the teeth may turn gray or dark gray.¹²

Radiographic evaluation: Internal root resorption is a radiographically easy condition, manifesting as a symmetrical, circular enlargement of the root canal area. But not every resorption progresses in the same way; others have irregular shapes and are oval in form. In teeth with a single root canal and a limited pulp chamber, resorption in the coronal pulp/crown area might be symmetrical, or it can begin in one place and spread into the surrounding dentin in the molars. Diagnosing internal and external cervical resorption requires direct access, cleaning, and surgical examination during endodontic treatment.¹²

Histologic Evaluation: Internal tooth resorption is a process that involves the accumulation of osteoid or cementoid hard tissue after the dentin around the root canal has been reabsorbed. In animal models, this process can take place in both naturally occurring and intentionally produced situations. Research has indicated that primary teeth undergo resorption at a higher rate, but there are no additional distinctions among both dentitions. The pulp tissue next to the resorption exhibits neutrophilic leukocytes, macrophages, and lymphocytes infiltration, as well as hyperemia and inflammation. Numerous odontoclastic cells are seen in resorption lacunae, and neutrophils and macrophages are adhered to the calcified dentin surface. A histological variation of this process has also been suggested, with root canal replacement resorption being a possible cause of this.²¹

Internal Inflammatory Resorption²¹

Any part of the root canal system may experience internal inflammatory resorption, a condition marked by an ovoid expansion inside the pulp chamber. It may be undiagnosed until the lesion has progressed to the point where perforation or signs of either acute or chronic apical periodontitis occur. The tooth may become pink if resorption takes place in the coronal area. A gradual loss of intra-radicular dentin occurs in internal inflammatory resorption when hard tissues next to the resorptive regions are not deposited as an adjunct. On several occasions, it is linked to chronic pulpal inflammation, and if the lesion worsens, microbes may be found in the granulation tissues. In order for the event to begin, other requirements, such as recruiting and activation, must be met concurrently.

Internal Replacement Resorption²¹

It is indicated by an uneven expansion of the pulp chamber and a break in the usual canal space radiographically. Unless the resorptive activity develops in crown or root perforation, it is usually asymptomatic and offended teeth may respond as usual to pulp testing. It is induced by low inflammation of the pulpal tissues, such as partial necrosis or chronic irreversible pulpitis. Instead of dentin, a metaplastic hard tissue resembling bone or cementum is deposited throughout the resorption process.

"Internal tunnelling resorption," a variation of internal replacement resorption that is frequently seen in the coronal root fractures but may also be observed following luxation injuries, has been identified. In some areas, bone-like tissues are simultaneously deposited as a result of the resorption, which burrows into the dentin next to the root canal. The process may then come to an end, and the cancellous bone may completely obliterate the canal space.²¹

Diagnosis: The clinical presentation of internal root resorption varies; based on the kind and place of the lesion within the tooth. Pulpitis symptoms might arise if the pulp is still somewhat vital, but apical periodontitis symptoms can appear if resorption ceases and the pulp becomes completely necrotic. Clinical detection of sinus tracts may reveal a persistent apical abscess or root perforation. Internal resorption may cause a pink discoloration that is apparent through the tooth's crown.

It has proven hard to discern between external cervical resorption (ECR) and internal resorption (IR), particularly when the ECR lesion is radiologically projected across the root canal and cannot be accessed by probing. Guidelines for radiologically distinguishing between the two processes have been created; the lesions of internal resorption being smooth and are often distributed symmetrically throughout the root. While these lesions should stay in the same location with respect to the canal, ECR lesions that are lingually or palatally positioned migrate identically with the movement of the x-ray tube.²²

Treatment: After diagnosing internal root resorption, the clinician must decide on the tooth's prognosis. The best course of action is a root canal therapy if the tooth can be restored and has a good prognosis. This involves removing vital tissue and necrotic pulp to stimulate resorbing cells and disinfecting the root canal system. Endodontists face unique challenges in preparing and obturating affected teeth, as access cavity preparation should be conservative and avoid further weakening. In teeth with active resorption, bleeding may be profuse and impair visibility during debridement.¹²

IV. Summary

Tooth resorption presents a challenging issue for dental professionals. The diagnosis is typically based on educated guesswork, the etiologic reasons are unknown, and the proposed therapies usually do not stop the quick loss of dental tissues that have become calcified.

Although resorption cannot always be anticipated, radiographic imaging can be used to detect it. However, this diagnostic method has its limitations, especially regarding resorption on the buccal and lingual surfaces. The challenge is further heightened by the need to differentiate between internal and external resorption.

The diagnosis, treatment, and prognosis of various resorptive defects vary, so practitioners need to be able to differentiate between internal and external resorption, diagnose resorption using radiography or clinical observation, and take corrective measures to halt the resorptive process.

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