



# ORIGINAL RESEARCH PAPER

# Dentistry

## REVISITING EXTERNAL TOOTH RESORPTION

**KEY WORDS:** Resorption, Surface Resorption, Inflammatory Resorption, Cervical Resorption, Ankylosis, Invasive, Reimplantation.

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### ABSTRACT

Tooth resorption is a pathological process caused principally by cells called Odontoclasts. These cells are morphologically similar to osteoclasts but are responsible of resorbing dental hard tissue and may affect the tooth either externally or internally. Thus, in a broader sense, tooth resorption is classified as external and internal tooth resorption. Both the types again have different clinical and radiographic presentations caused by different etiologies. As the etiologies vary, each type of resorption needs to be managed and treated differently. It thus becomes necessary for a clinician to be able to diagnose the type of resorption based on its presenting features and also the different management protocols to be followed based on the latest studies and literature available. This review article focusses on the clinical and radiological aspects and the management protocol to be followed for the different types of External Tooth Resorption.

### INTRODUCTION

The Glossary of the American Association of Endodontists defines tooth resorption as a condition associated with either a physiologic or a pathologic process resulting in loss of dentin, cementum or bone.<sup>[1,2]</sup> Physiologic resorption is seen in primary teeth that results in their exfoliation and allows eruption of their permanent successors.<sup>[3,4]</sup> Traumatic injuries to the teeth and supporting structures, orthodontic treatment, or chronic infections of the pulp or periodontal structures serve as a precursor for pathologic resorption.<sup>[2]</sup> If not intervened, pathologic resorption may result in loss of the affected tooth or teeth.<sup>[5]</sup>

The resorptive process is a network of interactivity between the classic cells of inflammation, resorbing cells and hard tissue structures. The cells mainly carrying out resorption are the osteoblasts and odontoclasts. Tooth resorption in the broader sense is of 2 types - External Resorption and Internal Resorption.<sup>[2]</sup>

### Mechanism Of Tooth Resorption

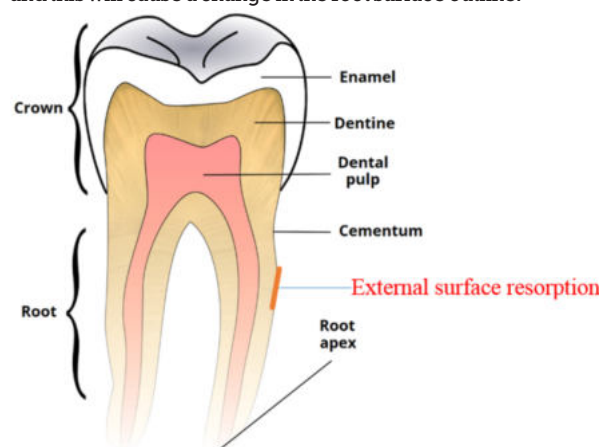
Tooth resorption is carried out by Odontoclast cells that are morphologically similar to osteoclasts but are involved in the action of dental hard tissue resorption.<sup>[26,27]</sup> The stimulation of osteoclasts/odontoclasts is under control of the receptor activator of nuclear factor  $\kappa$ -B ligand (Rank-Rankl) / osteoprotegerin (OPG) system.<sup>[28]</sup>

It serves as a start-shut valve-like system for osteoclastic activity, where activation of the RANK-RANKL system, and down-regulating of the OPG system, may favor differentiation and survival of new osteoclasts.<sup>[29]</sup> RANKL receptors are found on the surface of monocytes and macrophages and its release is thought to stimulate these macrophages and mononuclear cells to fuse and become osteoclasts.<sup>[30]</sup> The osteoprotegrin/osteoclast inhibitory factor (OPG/OCIF) is a glyco-protein and is also a member of the tumour necrosis factor receptor super family.

The osteoblasts and stromal cells itself secrete this factor too that is known to inhibit osteoclastic activity.<sup>[31]</sup> The OPG binds to the RANKL acting as a decoy thus preventing RANK from binding and exerting its action. Thus, it is possible to conclude that, the OPG/RANKL/RANK system is the pathophysiologic process involved during root resorption.

### External Surface Resorption

External surface resorption can be seen as small areas of resorption on the cemental surface and rarely extending into dentin. It is considered as a self-limiting process lasting for 2-3 weeks followed by root surface/cemental healing and reattachment of the PDL ligament to the previously denuded area. In the absence of any further stimulation such as bacterial infiltration, such cavities caused by resorption will heal without any further complication. If the resorptive cavity is only in cementum, the tooth will recover completely but if the cavity has extended into dentin, new cementum will be formed in the cavities involving dentinal tissue additionally, and this will cause a change in the root surface outline.<sup>[6,7]</sup>



### Clinical Features

External surface resorption will not present itself clinically as there will be no symptoms or clinical signs. Clinically, diagnosis is possible based on recent history of trauma.<sup>[7]</sup>

### Radiographic Features

Radiographically, the condition is difficult to diagnose as the cavity formed by resorption is shallow in nature.<sup>[8]</sup>

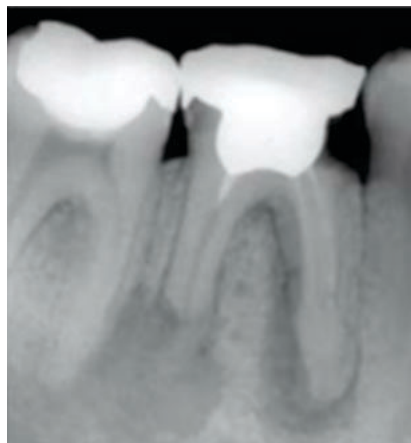
### Management

This type of resorption is usually a self-resolving process. So it does not require any specific management. In cases where the root canal system is infected or necrotic, the resorption may

progress to become external inflammatory resorption. This condition then requires proper diagnosis and a management regime.<sup>[6,7]</sup>

### External Inflammatory Resorption (EIR)

External inflammatory resorption begins with injury or some kind of insult to the root cementum and/or PDL during a traumatic injury such as luxation or avulsion. Also there has to be presence of an infected root canal system, or there must be a pathway of communication between the root canal system and the peri-radicular tissues (such as, the apical foramen or lateral canal foramen). The bacteria and/or their endotoxins make their way into the peri-radicular tissues through these channels and induce an inflammatory reaction, or exacerbate an inflammation that is already present following the injury. If the infected root canal system is left untreated, continued inflammation will be present leading to activation of odontoclasts that will resorb the tooth.



EIR following trauma may occur anywhere starting from cervical to apical parts of the root – lateral being more common, though it may occur apically. EIR usually occurs apically when there has been a persistent infection within the root canals but again at times may occur laterally if associated with an infected lateral canal and its foramen.

An additional cause of EIR can be a traumatic injury such as luxation or avulsion of a tooth where the pulp's blood supply is severed and does not recover following repositioning of the tooth. Additionally, there needs to be presence of bacteria in the root canals which have infected the canal space either during the injury or subsequently leading to the resorption.<sup>[7,9]</sup>

### Clinical Features

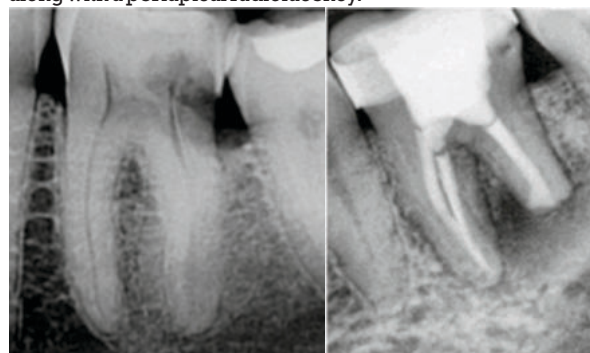
Clinically, EIR may present differently depending on the aetiology. The patient will present with a history of injury to the offending tooth in case of trauma. There might be no direct symptoms associated with this type of resorption and the patient may only present with symptoms associated with the injury depending on the timing of examination since the occurrence of the injury.<sup>[7,10]</sup>

In case of a chronic infected root canal system causing external inflammatory resorption, the patient may present with no, or only occasional mild, symptoms if there is chronic apical periodontitis. Pain on biting or on percussion will be present if it is a case of acute apical periodontitis. If there is an acute apical abscess, there may be presence of swelling. Draining sinus will manifest in cases of chronic apical abscess. Caries, tooth fracture, or fractured restorations may be evident. The tooth may have a necrotic and infected pulp, or a root-filled infected root canal system, if there has been previous root canal treatment and the root canal system has become infected again.<sup>[9,10]</sup>

### Radiographic Features

Radiographically, this resorption has a “classic” appearance

having a radiolucent, concave, and at times irregular-bordered cavity within the tooth root, with radiolucency in the alveolar bone adjacent to the resorptive defect. There is complete loss of lamina dura at the site of the resorption. In case of external lateral inflammatory resorption, the radiolucency within the tooth root has been described as a ragged “bowl-shaped” radiolucency. If there is external inflammatory resorption in the apical region, then the loss of tooth structure starting at the root apex and progressing coronally will give a typical “moth-eaten” appearance. Additionally, there will be presence of an open apical foramen along with a periapical radiolucency.<sup>[9,7]</sup>



### Management

Studies done in the past have shown that external inflammatory resorption can be prevented from initiating following trauma as well as stopped from continuing if it has already begun.<sup>[11-14]</sup> In either case, the goals in managing EIR are to prevent the root canal space from being invaded by micro-organisms or, if already invaded, to destroy the microbiota that are present. Thus endodontic treatment along with the use of specific intracanal medicaments must be executed that can eradicate the bacteria and also provide a favourable tissue response in the PDL.<sup>[7,11-13]</sup>

The earlier the resorption is diagnosed and treated, the better will be the prognosis for the affected tooth whereas failure to diagnose and treat the condition may result in tooth loss.<sup>[9]</sup>

In 1986, Hammarström *et al.* reported that systemic antibiotics such as penicillin and streptomycin prevented external inflammatory resorption when administered rather earlier during the resorptive process. Their efficacy was also evaluated by using them as intracanal medicaments. These antibiotics were successful in preventing the initiation of EIR when placed in root canals immediately after replantation. Additionally, in the other group, where these antibiotics were placed in the canals 3 weeks after replantation; they were capable of almost completely eliminating the resorption which might have already initiated.<sup>[7,15]</sup>

Corticosteroids can be used topically on the root surface, systemically, or intradentally as a root canal medicament. These drugs are potent inhibitors of inflammation and they also inhibit clastic cells to have direct anti-resorptive action. Corticosteroids when used as intracanal medicaments during endodontic treatment, can be combined with an antibiotic for added antimicrobial effect. The effects of a commercially available corticosteroid/tetracycline intracanal medicament known as Ledermix paste on inflammatory resorption was investigated by Pierce and Lindskog on extracted monkey incisors. There was no sign of resorption in the tooth or PDL after 8 weeks in the Ledermix group histologically. In marked contrast, the other group (without a medicament) had 89.3% of the root surface undergoing inflammatory resorption and a further 8% of the root surface had inflammation in the PDL. The Ledermix group had 25.1% of the root surfaces with external surface resorption but this had not progressed to inflammatory resorption.<sup>[7,16]</sup>

Calcium hydroxide is a relatively toxic material known to

induce necrosis of cells coming into contact with it. Thus, it can induce necrosis of both resorbing as well as reparative cells and will eventually cause ankylosis and replacement resorption in contrast to healing. To overcome this, they have suggested calcium hydroxide can be used later, after the inflammatory process has ceased following the use of the corticosteroid-antibiotic compound.<sup>[7,17,18]</sup>

### External Replacement Resorption (ERR)

External replacement resorption is the process where resorption of cementum and dentin occurs along with subsequent replacement by bone. ERR occurs after an injury to the root surface (i.e. the cementum) and/or the adjoining PDL. It is also referred to as trauma-induced resorption and ankyloses-related resorption.<sup>[19-21]</sup>

It is commonly seen after severe luxation injuries such as avulsion and intrusion. It can also occur after lateral luxation – especially in the apical part of the root it is due to the resultant crushing of the PDL and comminution of the bone with the cementum.<sup>[7]</sup> Also in cases of avulsed teeth that have been out of the mouth long enough for the cells on the root surface to dry out and die. However, there is a possibility of reversal of the process of ankylosis, if there is less than 20% of involvement of the root surface. If the process is not reversed, the ankylosed teeth get embedded in the alveolar bone and become a part of the normal remodeling process of the bone. This is then followed by their gradual resorption and replacement by bone.<sup>[19]</sup>

The process of resorption in this case is usually progressive, where there will be complete resorption of the root and the tooth will be lost eventually. Though in certain cases, it may be transient depending on the severity of the damage and also if it involves a comparatively smaller portion of the ligament and/or tooth root. When this happens, fibroblasts present in the adjacent PDL will repair the damaged PDL along with the cementum.<sup>[7,20]</sup>

### Clinical Features

As mentioned earlier, a tooth affected with this type of resorption will undergo ankylosis prior to the process of resorption. The normal physiologic mobility will be absent along with the presence of a different percussion sound. It has been described as being “high-pitched”, “metallic” or “woody” but it again varies based on effect of the resorption. The important aspect regarding percussion is, the sound will be dull and very different when compared to the adjacent teeth that do not have ankylosis and replacement resorption. The patient if can recall, will definitely give a history of a trauma to the tooth. Apart from this, there will be absence of any other symptom being reported by the patient. In extremely progressed cases and cases where the resorption commenced at a young age, such as prior to puberty, the tooth may appear submerged and will be in infra-occlusion.<sup>[7]</sup>

### Radiographic features

Radiographically, the cementum and at times the underlying dentin appear to have been resorbed and bone has replaced it. The contour of the existing root appears irregular as the resorption process occurs at a faster pace in some areas compared to the others. Absence of the PDL space and loss of lamina dura in areas of resorption will be seen.<sup>[7,22]</sup>

### Management

Management of external progressive replacement resorption usually consists of monitoring the tooth on a regular basis both clinically and radiographically so as to determine the rate of resorption which will eventually lead to loss of the tooth. In addition, this type of resorption is a slow paced taking years and the patient requires to be prepared both mentally and financially as the lost tooth site will require a subsequent prosthetic replacement, more importantly if it involves tooth/teeth in the anterior region which is not only important

functionally but also aesthetically. Also the patient's age and facial growth stage must be considered, as the eruption of the resorbing tooth will appear to have ceased and thus it will in turn hinder the alveolar downgrowth, resulting in a long-term defect that will be unmanageable. Such cases may be managed by decoronation just below the cemento-enamel junction and “root burial”. This will allow normal development of the alveolar bone as well as maintenance of sufficient bone around the resorbing tooth. The transient variety of ERR does not need any management, though the tooth requires regular examination to confirm that it is not a progressive type.<sup>[7,23]</sup>

### External Invasive Resorption (EIR)

External invasive resorption is an insidious and aggressive type of tooth resorption process. There is still uncertainty regarding its etiology and pathogenesis. It has been historically termed as “cervical resorption” due to the cervical region being more commonly involved. However, in cases where there has been recession of the gingiva, it may not occur exactly at the cervical region and may initiate rather apically. Once the resorption process has set in, it may progress all around the tooth. Thus, using the term “cervical” seems rather inappropriate and the term “invasive” should be more aptly used, as it is more descriptive of the resorptive process.<sup>[7,24]</sup>

Heithersay has provided with a classification for research purposes and also to provide as a clinical guide in the assessment of such type of cases. Heithersay described this type of resorption as having four classes based on the stages and has numbered them as Classes 1, 2, 3 and 4. His classification is based on the radiographic appearance of the resorptive defect on periapical radiographs.<sup>[25]</sup>

An alternative classification, based on CBCT imaging, was proposed by Patel et al. This can be used to plan treatment protocols only if there is availability of such images. However, the classification proposed by Heithersay is more practical to use since it only requires a periapical radiograph in case of resorption being suspected in a tooth.<sup>[7]</sup>

External invasive resorption has yet not been attributed to any specific cause or aetiology. However, various theories have been proposed with the most likely seeming to be a developmental defect at the cemento-enamel junction, where the cementum and enamel do not meet or do not overlap, leaving exposed dentin. Apart from the above mentioned developmental defect, there might be absence of cementum following trauma, for example; after repeated scaling and root planing procedures during periodontal treatment, after restorative dental procedures or even after surgical procedures. Additionally, an initiating factor needs to occur that will stimulate the action of the resorbing cells. However, this theory still requires investigations for confirmation.<sup>[7]</sup>

Several potential predisposing factors have been identified and of these intra-coronal bleaching has been the most widely documented following the first report by Harrington and Natkin in 1979.

Heithersay analyzed a total of 257 teeth in 222 patients that displayed varying degrees of invasive cervical resorption. The teeth were analyzed for potential predisposing factors and according to the results, orthodontics was the most common sole factor being identified in 47 patients (21.2%) while in combination it was seen in 62 teeth (24.1%). The second most frequent sole factor was trauma with 31 patients (14.0%) and in combination with other factors it was seen in 39 teeth (15.1%). The 3<sup>rd</sup> most common factor was identified as intra-coronal bleaching.<sup>[24]</sup>

### Clinical features

Clinically, external invasive resorption usually does not



present with any symptoms. The clinical signs might be present depending on the location and extent of the resorption and any concomitant pulpal pathology present along with the resorption process. A few relatively common symptoms reported by patients is bleeding of the gingiva during brushing or the presence of a 'pink' tooth. In a large number of cases the diagnosis is incidental during a routine dental check-up, during simple restorative or periodontal procedures, or a radiographic examination indicated for a different tooth. The pulp and periapical tissues of the associated tooth appear normal clinically. Probing of the defect is possible and may cause the adjacent tissue to bleed. Ankylosis and reduced mobility can be seen as features in the more advanced Class 4 cases.<sup>[7,22,24]</sup>

### Radiographic Features

Radiographically, this resorption will present distinctly at different stages of the resorptive process—which is determined by the size of the resorptive defect. The defect is usually an irregular radiolucency within the tooth with variations depending on the extent. As the defect increases in size, it appears to encircle the pulp leaving the root canal walls intact. In the more advanced stages of class 3 and 4, the invading tissue spreads throughout the tooth in all directions. There is ectopic bone-like tissue formation in the advanced stages, which may present as diffuse radio-opacities seen within radiolucency. The resorbed tooth structure within the tooth gives it a somewhat "moth-eaten" appearance.<sup>[7,24]</sup>



### Management

External invasive resorption can be managed based on the stage of the resorptive process and the extent of involvement. Heithersay has reported a treatment approach that uses Trichloro-Acetic Acid (TCA) in a concentration of 90%. TCA causes coagulation necrosis of the invading granulation tissue. This avascular tissue must then be curettaged from the resorptive cavity and followed by restoration with glass ionomer cement. This should be followed by a more predictable restoration after it can be confirmed that the resorptive activity has stopped. In his article, Heithersay has given an account of successful outcomes when treating Class 1 and Class 2 invasive resorptive defects with the above mentioned treatment.<sup>[7,24]</sup> An indirect or direct pulp cap using a bioactive endodontic cement such as Biodentine or MTA may be indicated if the pulp is close to being, or is perforated. According to Koubi et al. and Rajasekharan et al. bioactive restorative materials such as Biodentine can be used to completely rehabilitate subgingival EIR cavities with loss of PDL attachment. These bioactive materials are aesthetically acceptable and are also known to favour PDL attachment.<sup>[25]</sup>

The outcomes for Class 3 defects were considered to be reasonably acceptable but these cases may require treatments such as endodontic treatment, periodontal surgery for access or crown lengthening, orthodontic extrusion, crowns, etc.<sup>[7,24]</sup>

Intentional reimplantation can be done in resorptive cases

where EIR is inaccessible to surgery, for example, interproximally or middle/apical-third of roots.<sup>[26]</sup>

The Class 4 cases were reported to being beyond repair or treatable with the above mentioned treatment approaches and hence when faced with such cases, these teeth must be simply kept under follow-up both clinically and radiographically. Also, an important aspect in advanced class 4 cases is that, the pathological process appears to be very sluggish or even completely stagnated and thus the tooth can be left to remain until further complications develop. However, counselling of patients with such defects about the prognosis of the tooth is required. The short/long term outcomes include root fracture, pulp disease, periodontal disease, ankylosis, etc. and when any of these occur, the tooth may require extraction.<sup>[7,24]</sup>

### CONCLUSION

It is important for a clinician to have knowledge about the etiology, pathogenesis and prognosis of each type of resorption so that appropriate intervention can be done at the time of presentation and an attempt can be made to save the tooth or teeth undergoing resorption.

### Conflicts Of Interests

The authors have no financial interests or conflicts of interests.

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