Management of root canal stenosis and external inflammatory resorption by surgical root reconstruction using biodentine

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Abstract

Root canal stenosis and external inflammatory root resorption are potential consequence of trauma that can occur depending on the severity of the injury. Luxation injuries induce reduced blood supply to the pulp, which leads to calcification/narrowing of root canals leading to root canal stenosis. External inflammatory cervical resorption occurs when there has been the loss of cementum due to damage to the external surface of tooth root during trauma, plus root canal system becoming infected with bacteria. External inflammatory resorption can ultimately lead to loss of tooth if it is not managed in a timely manner. The treatment should aim toward the complete suppression of all tissues undergoing resorption and the reconstruction of the resorptive defect by the placement of a suitable bioactive material. This case report presents the management of root canal stenosis in the maxillary left central incisor in 35-year-old female and management of Class IV external invasive cervical and apical inflammatory resorption in maxillary right central incisor, both of which were diagnosed with the help of cone-beam computed tomography scan. The treatment of external inflammatory resorption included surgical excision of granulation tissue and root reconstruction with Biodentine. Twelve months follow-up showed successful outcomes for both the teeth treated for root canal stenosis and external invasive inflammatory resorption leading retention of the traumatized teeth with otherwise poor prognosis.

Keywords: Biodentine; dental trauma; external inflammatory resorption; root canal stenosis

INTRODUCTION

Dental trauma to teeth is very common occurrence leading to an urgent situation that includes physical and psychological issues. Approximately one-third of children and a quarter of adolescents and adults experience some type of dental trauma throughout their lives, being proven by epidemiological studies. Luxation and avulsion injuries during dental trauma affect teeth and also damage the supporting periodontal structures, depending on the severity of the injury. Traumatic sequelae mostly lead to fracture, pulp necrosis, pulp canal obliteration, and root and bone resorption. These complications may occur in weeks, months, or even years after trauma.

Luxation injuries induce reduced blood supply to the pulp, which leads to calcification/narrowing of root canals. With time and further calcification, the radiographic image gives the impression of complete pulp canal obliteration characterized by radiographic loss of pulp space and yellowish discoloration of clinical crown due to dentin deposition. However, Heithersay noted that in most instances, a fine residual canal containing fibrotic pulp tissue remains and suggested that “root canal stenosis” could be considered as alternative terminology to pulp canal obliteration. The American Association of Endodontists included teeth with radiographically indiscernible root canals requiring treatment in high difficulty criteria. In pulp canal obliteration cases, root perforation and canal

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deviation are the most common complications encountered. Even the most experienced clinicians encounter difficulties in achieving the goals of endodontic treatment in calcified canals.

Traumatic injuries are also prone to cause damage to the cemental protection of root surfaces. The exposed dentinal tubules become pathways for bacterial toxins to trigger osteoclastic activity externally. This leads to external inflammatory root resorption, which may occur anywhere along the length of the tooth roots. External inflammatory root resorption typically occurs laterally following trauma, and because of its cervical involvement and invasive property, it is commonly termed as invasive cervical resorption (ICR). Furthermore, when the resorption occurs as a result of a long-standing infected root canal system, it occurs apically too. On examination of intraoral periapical (IOPA) radiograph, ICR may represent as a well-delineated radiolucencies with irregular borders within teeth, and also, the radiolucency may involve the adjacent periodontal ligament and bone. Cessation of the resorptive process and restoration of the lost tooth structure will lead to successful outcomes of such cases.

Till date, various materials have been promoted to seal the resorptive defect such as mineral trioxide aggregate (MTA), glass-ionomer cement, calcium-enriched mixture, etc. A relatively recent bioactive cement, Biodentine (Septodont, St. Maur-des-Fossés, France), can be a useful option since its properties like compressive strength, elasticity modulus and microhardness are comparable with that of natural dentine, and it acts as a substitute for dentin. The material is stable, less soluble, nonresorbable, and easy to prepare and place and needs much less time for setting.

Newer technologies such as cone beam computed tomography (CBCT) enables the diagnosis and treatment of such cases of calcification and resorption more precisely. This article presents the management of root canal stenosis of 21 and management of external cervical and apical inflammatory resorption of the 11 surgically using Biodentine.

**CASE REPORT**

A 35-year-old female patient presented to the Department of Conservative Dentistry and Endodontics (Manubhai Patel Dental College and hospital, Vadodara, India) with a chief complaint of intermittent pain in the past 1 month and discoloration of the upper right and left central incisor (11 and 21). The patient gave a history of trauma approximately 20 years ago when she met with an accident; thereafter, she noticed a gradual change in the color of crown of both central incisors, which became dark yellowish. The medical history of the patient was noncontributory. Intraoral examination revealed discoloration of tooth 11 and 21 with tenderness to vertical percussion. Tooth 11 and 21 also showed a slight fracture of the incisal edges with slight rotation of teeth and anterior open bite indicative of the luxation injuries suffered due to trauma [Figure 1a and b]. Thermal and electric pulp response was negative with tooth 11 and 21, whereas adjacent teeth showed normal response. Both teeth 11 and 21 did not show any signs of mobility.

The preoperative IOPA radiographic examination [Figure 1c] revealed an irregular, large radiolucent area in the cervical and middle third of the external root surface at the mesial aspect of 11 suggestive of ICR. Furthermore, 11 shows resorption in the apical third on the distal aspect of the root. Preoperative IOPA radiograph [Figure 1c] also showed pulp canal stenosis in 21. CBCT was performed to determine the extent and depth of the lesion in the three spatial levels. Based on the CBCT images and three-dimensional (3D) reconstructions [Figure 1d], a diagnosis of cervical external resorption of Heithersay Class IV and apical resorption in 11 was determined. Completely obliterated pulp canal with only pinpoint trace of canal and diagnosis of root canal stenosis was made in 21.

The treatment plan included endodontic treatment and surgical intervention for removal of the inflamed granulation tissue that occupied the lesion cavity and repair of the resorption defect with Biodentine in 11 and nonsurgical endodontic treatment for 21. Before planning for the surgical procedure, patient’s platelet count (4 lakh/mm$^3$), hemoglobin (14 g/dl), bleeding time (3 min), and clotting time (5.5 min) were assessed and found to be within the normal limits.

After rubber dam isolation of tooth 21, access opening was done with the help of long neck taper fissure bur via palatal approach. Scouting of the root canal orifice was done using a DG 16 explorer and visualized under surgical operating microscope (Labomed Dental Microscope, Prima DNT, USA). A catch was identified in the center of the tooth and Size 8 K file (Mani, Tochigi, Japan) was introduced into the root canal. Copious amount of 17% EDTA (Glyde, Dentsply-Maillefer, Ballaigues, Switzerland) was introduced into the pulp chamber and size 8C + file (Dentsply, Tulsa, OK, USA) was used in watch-winding motion with minimal vertical pressure to reach till the apex. C + files have stronger buckling resistance compared with K files and provide easy negotiation and access to the apical third of the root. During instrumentation, frequent inspection of the file was done to identify any sign of fatigue, irregularity of the flutes or any other defects. Once size 8C + file became loose, size 10 k file (Mani, Tochigi, Japan) was introduced to gain apical patency and working length was measured using an electronic apex locator (Root ZX II, J Morita, Kyoto, Japan) and confirmed radiographically [Figure 1e].
The root canal was prepared by the crown down approach using ProTaper Next rotary files to size X2 (Dentsply Maillefer, Ballaigues, Switzerland) with copious amount of 5.25% sodium hypochlorite (Chloraxid 5.25%, Cerkamed, Poland) as irrigant during instrumentation. Obturation was completed using ProTaper Next X2 gutta-percha (Dentsply Maillefer, Ballaigues, Switzerland) and AH Plus (Dentsply Maillefer Ballaigues, Switzerland) as endodontic sealer [Figure 1f].

In the next appointment, isolation of 11 was done with rubber dam and access cavity was prepared and the working length was checked on the radiograph [Figure 2a]. There was profuse bleeding from the canal in 11 at this stage, so the surgical exposure and enucleation of the granulation tissue was initiated. After infiltration of local anesthesia buccally and palatally to the surgical site using Articaine (Septanest 1:100,000), a rectangular full-thickness flap was raised buccally. This revealed that part of the buccal bone plate was missing and exposed a small amount of inflammatory granulation tissue and the resorptive root surface [Figure 2b and c]. Curettage of the resorptive lesion and the surrounding inflamed tissue both on the mesial aspect and apical third was performed together with curette and surgical round bur [Figure 2d].

Due to the palatal extension of the resorptive defect, after giving sulcular incision, palatal flap was reflected, and complete curettage of the granulation tissue was done till a sound dentin base was revealed [Figure 2e]. A small cotton pellet was then dipped in 90% trichloroacetic acid, and the excess was removed by dabbing it on a piece of gauze. The cotton pellet was then applied over the resorptive defect area with gentle pressure for about 1 min [Figure 2f].

The irregular borders of the defect were smoothed with a small round bur. Biodentine (Septodont, St. Maures Fossés, France) was mixed according to the manufacturer’s instructions and was firmly condensed in the resorptive defect and root canal. Biodentine was contoured laterally and apically as per the external root anatomy [Figure 2g and h]. Biodentine was left for 15 min to achieve the initial setting and relative hardness. After the setting of Biodentine was confirmed, the tissue flap was then repositioned and sutured with 3-0 black silk suture material, and the patient was instructed to report after a week for suture removal. Postoperative IOPA radiograph was taken [Figure 2i].

At 12 months follow-up, the patient was completely asymptomatic on presentation. Clinical and radiographic examinations for treated teeth [Figure 2j] revealed repair of resorption defect was successfully treated with Biodentine. The gingival attachment was still healthy (maximum probing depth of 3 mm), and tooth mobility was normal; the patient remained complaint-free. Further follow-up examinations were planned along with esthetic treatment.

**DISCUSSION**

Root canal stenosis and external inflammatory root resorption are a potential consequence of trauma that can occur depending on the severity of the injury. In this case report, both are evident in adjacent central incisors as a sequela to trauma. Root canal stenosis makes endodontic management of the teeth difficult, while pathological root resorption leads to irreversible loss of tooth structure, and the progression of resorption can cause tooth loss if the process is not stopped.
The diagnosis of root canal stenosis and root resorption depends on careful clinical and radiographic analysis. As conventional intraoral radiograph has shown to reveal limited information on complete/partial obliteration of pulp canal and true extent and nature of the resorptive lesion, CBCT has become an important diagnostic tool in this regard. 3D display of images in axial, sagittal, and coronal planes simultaneously allows the clinician to gain geometrically accurate extent of the lesion without any anatomical noise.14 In our case, CBCT helped to determine a pinpoint presence of canal in 21 and the position and depth of the resorptive defect both mesially and palatally (which was not evident on IOPA) in 11.

Heithersay13 divided the type of external cervical resorption into four classes according to the degree of damage to the mineralized tissues. Class I corresponds to a small, invasive resorptive lesion near cervical area with shallow penetration into the dentin; Class II corresponds to a well-defined resorptive lesion close to coronal pulp chamber with little or no extension into radicular dentin; Class III corresponds to a resorptive defect involving the coronal third of the root; and Class IV corresponds to resorptive defect extending beyond cervical third of the root. In our case, cervical resorption was classified as Class IV after examining CBCT.

Pathophysiology of external inflammatory resorption is that after trauma, the inflammatory response triggers the activation of clastic cells, which are responsible for bone and tooth resorption. Bone marrow stromal cells or mature osteoblasts express receptor activator of nuclear factor kappa B ligand (RANKL). The receptor of RANKL is RANK and is localized on the surface of the progenitor osteoclast. Direct physical contact between the osteoblast or stromal cells and the progenitor osteoclast is essential for a direct interaction of RANKL and RANK for osteoclast formation and activation.15,16

Different treatment modalities have been suggested by several authors for the treatment of cervical external root resorption, but the basic aim is the complete removal of resorptive tissue and restoration of the defect area.12 In our case, being ICR, which has destructed majority of the tooth structure, making it weak, surgical exposure was planned followed by root restoration with Biodentine – a dentine substitute.

The rationale for using trichloroacetic acid to remove or inactivate resorbing tissue lies on the fact that it being a chemical escharotic agent renders the tissue avascular by process of coagulation necrosis. The self-limiting necrosis zone is well demarcated from the adjacent tissue, and therefore an uncomplicated repair of surrounding periodontal tissue can be expected.17

Biodentine was selected as the material for restoration of the resorbed area, as it can be placed in permanent and close

Figure 2: (a) Working length radiograph of 11. (b) Incision. (c) Surgical exposure of resorption. (d) Curettage of the resorptive tissue buccally. (e) Curettage of the resorptive tissue palatally. (f) Application of 90% Tricholoroacetic acid. (g) Reconstruction of root with biodentine buccally. (h) Reconstruction of root with biodentine palatally. (i) Postoperative peri-apical radiograph. (j) 12 months follow-up clinical and radiographic images.
contact with periradicular tissue due to its bioactivity and biocompatibility. Dentin-like mechanical properties advocate its use as a dentin substitute on crowns and roots. Compared with other bioactive materials such as MTA, Biodentine handles easily and needs much less time for setting. Its property to release calcium ion and enhancing alkaline environment makes Biodentine more conducive for osteoblastic activity. Also, calcium and hydroxide ions stimulate the release of pyrophosphatase, alkaline phosphatase, and BMP-2, which favors the regeneration and mineralization process.\(^{[12]}\)

Regeneration of the periodontal tissue remains vital for the success of our case as it has become a combined endodontic-periodontic lesion. Bone graft material and membrane were used in many cases for the guided tissue regeneration of the periodontal tissue. However, in our case, we avoided using the bone graft material and membrane, as a study by Rahimi et al.,\(^{[18]}\) concluded that mineralized bone graft materials negatively affect the surface microhardness of Biodentine. In our case, the microhardness of Biodentine was inevitable to give strength to the root structure. Moreover, Biodentine alone has shown the potential for periodontal tissue repair and regeneration.

In conclusion, treatment of the pulp canal stenosis and extensive cervical and apical resorptive defect restored with Biodentine was considered successful, as evidenced by clinical and radiographic findings after 12 months. The patient was further recalled for the esthetic treatment of teeth.

**Declaration of patient consent**
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**
There are no conflicts of interest.

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