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Endodontics

EFFECT OF DIODE LASER DISINFECTION AND THE APICAL BARRIER TECHNIQUE IN AN ENDODONTIC RETREATMENT CASE WITH OPEN APEX: A CASE REPORTS

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ABSTRACT The primary reason for an endodontic treatment failure is the persistence or regrowth of different species of bacteria within the root canal system. The root development and closure of its apex in a permanent tooth occurs till 3 years after the eruption. Treatment of traumatic injury of teeth during the development period of root resulting in open apex poses an endodontic challenge. Various materials are used for induction of apical closure to produce favourable conditions and to confine the root canal filling within the canal space. This paper describes clinical case of retreatment on premolar with improperly treated root canal with open apex. Multiple visit endodontic retreatment of premolar was performed. Disinfection was performed using Intracanal diode laser irrigation activation followed by placing triple antibiotic paste (TAP) as intra-canal dressing. In the second appointment apical plug of Biodentine against a platelet-rich fibrin (matrix) was condensed. The present case showed successful periapical healing and resolution of symptoms with the use of calcium silicate based cement with platelet-rich fibrin as an apical barrier matrix. Procedure is followed carefully using recommended protocols.

KEYWORDS :

INTRODUCTION

The preliminary etiological factors for the occurrence of open apices are traumatic injury of an immature permanent tooth. Subsequently, trauma can lead to the loss of pulp vitality and may also arrest the root development, leading to non-vital teeth with open apices, [1] and often result in pulpal inflammation or necrosis. [1] The immature teeth present wide dentinal tubules that allow the penetration of bacteria and their by-products. Such tooth with open apices presents a number of difficulties for efficient root canal therapy. [2]

Endodontic treatment failures are attributed to inadequacies in shaping, cleaning, obturation and the others like iatrogenic events or reinfection of the root canal system due to failed coronal seal post endodontic treatment. All these factors result in subsequent leakage and bacterial contamination. The disinfection of the reinfected root canal system is critically important in the long-term success of root canal therapy. Laser activation of irrigants proven to be more effective than conventional irrigation technique.[4] As well as, According to Schilder et al, an ideal root canal obturating material has to adapt well to the radicular dentine walls and all of its irregularities. They also suggested, the entire length of the canal has to be densely compacted with a homogeneous mass of root canal filling material. Inadequate obturation, unfilled/under extended root fillings might contain bacteria that can multiply when in contact with nutrients via the periapical region, the lateral or the accessory canals.[5] The treatment option for treating such cases is “apexification”, a method to induce a calcified barrier in a root with an open apex. Traditionally, calcium hydroxide has been used for apexification. Slowly this has been phasing out because of evolution of better and newer biomaterials.[6]

The recent approach is to form an artificial apical barrier by the placement of restorative biomaterials as an apical plug. An apical barrier technique supports the obturating material to confine within the root canal system.[7] The synthetic apical barriers have popularized as alternatives to the traditional methods, like introduction of MTA, Calcium Enriched Mixture (CEM) and a novel material Biodentine, the revolutionary material capable of replacement for dentine.[8] However, while treating cases with wide-open apices the clinical challenge is to confine the restorative material as an apical plug. Hence, the evolution of apical matrix helped to condense or pack restorative material within the root canal system.

Platelet-rich fibrin (PRF) was first described by Choukroun et al.[7] belongs to a new generation of platelet concentrates. It has advantages such as easy preparation, lack of biochemical handling of blood making this preparation strictly autologous, promotion of wound healing, bone growth, bone maturation, and hemostasis.[7] Therefore, present paper highlights the nonsurgical management of symptomatic mandibular right second premolar with improperly treated root canal and open apex using Biodentine in combination with a matrix.

Case Report

Case: A 22 year old female patient reported to the K.V.G Dental College and hospital, Sullia with a chief complaint of pain in the previously endodontically treated lower right back tooth region. Patient had symptoms from few years but in due course developed periodic swelling and now since 3 months had noticed intermittent pus discharge. History revealed that the patient had suffered trauma at the age of 12 years and had visited a private dentist prior for the treatment of the same tooth. The patient's medical history was noncontributory and vital signs were within normal limit.

Intraoral examination revealed the presence of porcelain fused to metal three unit Bridge on mandibular right posterior region. The tooth was tender on percussion and palpation. The periodontal status was normal (probing depth <3 mm) with no mobility, ruling out any periodontal pathology. Tracing of the sinus tract with gutta percha confirmed the involvement of the mandibular right second premolar.The preoperative radiograph revealed a root canal filling, which was over extended beyond the apex and showed voids within and between the root canal fillings and root canal walls. Tooth number 45 was associated with apical radiolucency of 2-3mm, thinning of root dentin walls with apical flaring, suggestive of previously root canal treated teeth with symptomatic apical periodontitis [Figure 1a, 1b and 1c]. The basis of clinical and radiographic findings, there were two treatment options available for the right mandibular second premolar, either a surgical removal of the periapical lesion followed by retrograde filling or a nonsurgical endodontic retreatment with apexification. Taking into consideration the current European Academy of Paediatric Dentistry guidelines, a more conservative nonsurgical approach was chosen as the line of treatment. The available treatment options were discussed with the patient. The decision was made to retreat the tooth followed by removal of bridge, apexification of the same tooth by using artificial barrier technique and placing an apical plug of Biodentine™ of 5 mm against a matrix of PRF.

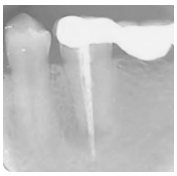
Non-surgical root canal retreatment was initiated after local administration of 2.5ml 2% lidocaine local anesthetic solution containing 1:80000 epinephrine under rubber dam isolation. Access was gained in the premolar with Endo Access Bur #2 with water spray.

Gutta percha removal was carried out with H-file. Working length was estimated by an apex locator (Econnect S, Eighteeth, Changzhou Medical technology co, Ltd), but due to inconsistent reading, an additional intraoral periapical radiograph was also taken for confirmation [Figure 2a]. Minimal instrumentation of the premolar with manual K-files # 80 was carried out with a circumferential filing action to avoid further weakening of the already thin dentinal walls along with passive irrigation with 10 ml of 3% sodium hypochlorite and 2% chlorhexidine solution (MAARC Chloro – Hx, India) alternatively with sterile saline. Irrigation was carried out with side-vent irrigation needles (Neoendo, India) keeping them 1 mm short of the radiographic apex and no attempt was made on shaping the canal. Furthermore, final disinfection of the canal was performed using a diode laser. The root canals were irradiated with a Denlase diode laser using a wavelength of 810 nm at 1.2 W power in continuous wave mode. Laser beam was directed into the canal by the fiber optic cone with a diameter of 200 µm for 10 sec each for 40 sec. The tip of the fiber optic cone was placed in the canal 1mm short of the working length and optic fiber was led in slow, circular, spiral-forming movements from the apical to the coronal part, while the laser was activated [Figure 2b]. Intra-canal dressing used in this present case was TAP containing minocycline, ciprofloxacin, and metronidazole with propylene glycol as the vehicle was packed 1 mm short of the radiographic apex. A sterile cotton roll was placed in the coronal chamber and the access cavity was temporized with glass ionomer cement upon which cavit was placed. After 2 weeks follow-up, the patient was asymptomatic. The tooth was again anesthetized and isolated followed by removal of intracanal dressing with hand instrumentation and copious irrigation. The canal was flushed with 10 ml of 3% NaOCl followed by 10 ml of sterile saline, QMix 3ml of final rinse and dried with absorbent paper points. A master cone was selected which snugly fitted till the apex which had used to pack the PRF membrane at the apex (number 80, 2% butt end).

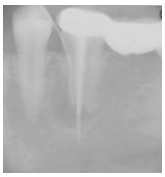
Platelet rich fibrin preparation was done by the protocol developed by Choukroun et al.[7] Patient's 10 ml of venous blood was collected in sterile vacutainer tubes without anticoagulant and centrifuged in centrifugation machine at 3000 rpm for 10 min. This led to the formation of three layers: Upper-straw-colored acellular, red-colored lower fraction containing red blood cells, and the middle fraction containing the fibrin clot. The upper layer was removed, and the middle fraction was collected 2 mm below to the lower dividing line, which was PRF. The PRF clot was retrieved, and fluids were squeezed out to obtain a PRF membrane as described by Kobayashi et al.[9] using two spoons. PRF membrane was then placed in the coronal cavity and gently compacted using the preselected master cone to produce a barrier at the level of the apex.

Biodentine™ (Septodont) was manipulated according to manufacturer's recommendation and placed in the apical one-third of the root canal with the help of Buchanan plugger (SybronEndo USA). It was condensed into the canal with plugger to create an apical plug of 5 mm and was left undisturbed for 15 minute. After placing an apical plug of Biodentine™ of 5 mm against a matrix of PRF, obturation was performed using continuous wave warm vertical condensation technique by using both down pack and backfill handpieces (Eighteeth, Changzhou Medical technology co, Ltd) and AH Plus sealer[Figure 3a]. The access cavity was sealed using composite resin (Filtek Z350 XT, 3MEspe). A radiograph confirmed the completion of the endodontic therapy. Follow up clinical examination after 3 weeks showed complete healing of the sinus tract and absence of any clinical symptoms. The bridge was cemented as provisional prosthesis. The patient was kept on follow up and recalls visit for 3 months, 6 months and 9 months. On every appointment periapical radiograph was advised, which showed progressive resolution of periapical radiolucency and healing at the apex. The 9 months radiographic follow-up presented a completely healed periapical lesion [Figure 3b, 3c, 3d], a symptomless tooth and with a calcific barrier at the apex.

Fig. 1 a. Preoperative image,

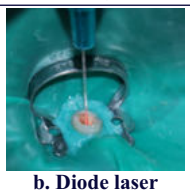


b. Preoperative IOPAR,



c. Sinus tracing IOPAR

Fig. 2 a.Working length determination radiograph



b. Diode laser disinfection

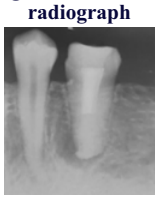


Fig.3 a. Post-operative radiograph

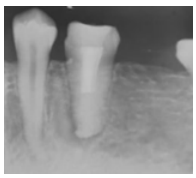
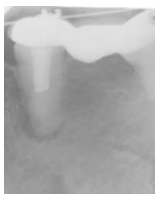


Fig. 3 b. Follow up (3 month)



3 c. Follow up (6 month)

3 d. Healing evident in Follow up (9 months)

DISCUSSION

The present case showed successful management of a failed endodontically treated immature permanent tooth with periapical lesion. Revascularization was not attempted in these present cases as it was already root canal-treated tooth and present literature regarding regenerative therapy in secondary endodontic cases is scarce. Furthermore, previous endodontic procedure could have damaged SCAP (stem cells from apical papilla) or vital mature pulp cells, which play a critical role in regeneration by acting as a source of odontoblast and are responsible for the root maturation.[10]

Most important concern, while treating a previously endodontically treated tooth and associated secondary infection, is disinfection of the root canal and preventing the reoccurrence of a periapical lesion. Complete disinfection of the root canal is mandatory before final obturation.

In the present case report, disinfection of the canals was done using 3% NaOCl, 2% chlorhexidine solution and alternatively with sterile saline. The final rinse of QMix is also used. In addition irrigation activation was perfomed with the diode laser activation to enhance the disinfection. The most important aspect in the clinical application of lasers is the intense heat produced by its irradiation and also the effect on sound periapical tissues. The diode laser has been reported to result in the least amount of heat among other types of hard and soft tissue lasers tested. Diode laser irradiation has ability to eliminate bacteria without leaving any cytotoxic effects on non-intact periapical tissues.[4]

Intracanal medication was given for the purpose of periapical healing and eliminating the necrotic tissue remnants and bacterial byproducts after cleaning and shaping. The present case presented was associated with secondary infection; hence TAP was chosen as an intra-canal medicament. Nevertheless, such retreatment cases present with highly resistant bacteria such as Enterococcus faecalis and Candida species wherein calcium hydroxide is ineffective.[11] Madhubala et al., reported a reduction of upto 98.4% colony forming units with TAP in comparison with 59.4% with calcium hydroxide in E. faecalis-infected root canals,[12] hence TAP was used in the present case.

The goal of apexification treatment is to induce the formation of an apical barrier to prevent the passage of toxins and bacteria into periapical tissues from the root canal.[13] In conventional treatment modality, intracanal dressing of calcium hydroxide paste was used to induce a calcified barrier followed by root canal procedure.[6] Technically, this apical barrier technique is necessary to allow compaction of root canal filling material. Despite higher success rate of apical barrier formation using calcium hydroxide, it has shown inherent disadvantages such as variability in treatment time,

unpredictability of apical closure, difficulty in patient follow-up, failure in controlling infection, recurrence of infection, cervical fracture, and increased risk of root fracture.[6]

Evolution of suitable biocompatible material reduces leakage in the sealing material and allows favourable response of the periodontal tissues for periapical healing and apexification. Recently Biodentine, is being used to form apical barrier due to the disadvantage of MTA such as extended setting time.[14] Since the basic composition similar to MTA and has an accelerators calcium chloride in its liquid component accelerates the setting time. As the setting time is less, Biodentine™ does not require a two-step obturation, resulting in the completion of treatment on the same day and become requires significantly less time. Biodentine has superior biocompatibility and sealing ability and is less cytotoxic than other currently used materials in pulpal therapy.[14] Kokate and Pawar conducted a study that compared the microleakage of glass ionomer cement, MTA, and Biodentine™ when used as a retrograde filling material and concluded that Biodentine™ exhibited the least microleakage when compared to other materials used.[15] Biodentine™ has shown to have an alkaline pH and ability to release calcium ions similar to that of MTA.[16] Hard tissue healing is closely affected by alkaline pH and calcium ion release from root end filling material.

Formation of matrix at the periapex in teeth with open apices avoids the extrusion of the material as it can be condensed against the matrix. This also aids in the reduction of microleakage in the sealing material and allows a favourable response of the periodontal tissues.[17] In this present case, a contemporary concept of using PRF as an apical matrix membrane was performed taking into consideration the merits of PRF over the other materials. PRF is a matrix of autologous fibrin, which gets embedded by a large quantity of platelet and leukocyte cytokines during centrifugation.[18] These cytokines present are released progressively over time (7–11 days), as the fibrin disintegrates.[19] The PRF membrane that is applied in such cases, results in rapid angiogenesis and a resultant easier remodeling of fibrin.[20] PRF also results in stimulation of the osteoblasts, gingival fibroblasts, and periodontal ligament cells proliferation as a mitogen and also releases various growth factors such as platelet-derived growth factors and transforming growth factors with resultant optimal healing of lesion.[19] Most importantntly, PRF being totally autologous and most biocompatible than any other material that may be used as matrix for apexification procedures presenting wide-open apices. The modern techniques of obturation such as thermoplasticized obturation are important for long-term success in the present cases, especially when we are dealing with irregular and large canals. A longer follow up of these cases is, necessary to ensure success of the treatment. This innovative procedure is predictable and less time consuming with a high overall success rate and good patient compliance.

CONCLUSION

This case report emphasizes the novel approach of using laser disinfection method and apical barrier technique to achieve apexification of the cases with an open apex and large periapical lesion. A combination of proper case selection, stringent disinfection protocol, precise and controlled placement of apical barrier at the apex can lead to better periapical healing with a nonsurgical apexification procedure. Diode laser irradiation of canal and Biodentine as apical barrier showed complete healing for a period of 9 month. However, further long-term controlled clinical trials are necessary to investigate the predictability of the outcome of the technique and Biodentine as an effective alternative for MTA. Although the efficacy of barrier technique using Biodentine and PRF as a dentin substitute is yet to be clinically proven for its therapeutic indications, it may be a promising material for apexification.

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