Case Report

One-step apexification using platelet rich fibrin matrix and mineral trioxide aggregate apical barrier

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ABSTRACT

The absence of a natural apical constriction in a nonvital young permanent tooth makes endodontic treatment a challenge. There is a need to induce or create an apical barrier against, which the obturating material can be condensed. Traditionally, calcium hydroxide is the material of choice to induce apexification. Due to certain drawbacks such as prolonged treatment duration and unpredictable apical barrier formation, it is being replaced by materials, which have a more predictable outcome like mineral trioxide aggregate (MTA). One-step apexification with MTA reduces the treatment time when compared with traditional calcium hydroxide apexification, which requires an average time of 12–19 months.

In one-step apexification using MTA, the technical problem encountered is controlling the overfill or underfill of MTA. The use of a matrix material helps to overcome this shortcoming. Platelet rich fibrin (PRF) is an immune platelet concentrate, which can be used as a matrix, it also promotes wound healing and repair. This case report presents a case of one step apexification using MTA as an apical barrier and autologous PRF as an internal matrix.

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Pulp necrosis in a young permanent tooth ceases the root development; hence apical closure cannot be achieved. These teeth have thin and fragile root walls with a large open apex. Endodontic treatment of these teeth with open apices is difficult due to inability to completely debride, disinfect and seal the root canal system.[1] In the past, techniques suggested for the management of a nonvital tooth with open apex were restricted to leaving the canal untreated, instrumentation alone, custom fitting the filling material, short fill, paste fill and apical surgery.[2] However, due to the limited success enjoyed with these procedures keen interest was generated in the phenomenon of continued apical development (Apexogenesis), or establishment of apical barrier (Apexification).[3]

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Apexification is a method of inducing apical closure through the formation of mineralized tissue in the apical region of a nonvital tooth with an incompletely formed root (open apex).[2] A wide array of materials have been used for apexification including calcium hydroxide, magnesium oxide, barium hydroxide, zinc oxide, calcium oxide, calcium phosphate collagen gel, tricalcium phosphate and other pastes.[2] Calcium hydroxide is the most commonly advocated material for apexification, with long history of clinical success.[4-6] The disadvantages include prolonged treatment time, need for multiple visits and radiographs, difficulty of the patient's recall management and increase in the risk of root fracture after dressing with calcium hydroxide for extended periods.[7]

An alternative to calcium hydroxide apexification is a one-step apexification technique using mineral trioxide aggregate (MTA) as an artificial barrier. Various studies using MTA for apexification have shown promising results. The advantage of MTA apexification are: (i) Reduction in treatment time (ii) possibility to restore the tooth with a minimal delay (iii) no changes in the mechanical properties of dentine (iv) excellent biocompatibility and (v) stimulation of repair.[8] One technical difficulty associated with the placement of MTA as an apical barrier is the prevention of an overfill and underfill. Lemon (1992) introduced the "internal matrix concept" for treatment of root perforations. He recommended

careful placement of hydroxyapatite through the perforation to form an external barrier and matrix, against which the perforation repair material (amalgam) was condensed.[9] Bargholz (2005) gave the modified internal matrix concept, he recommended the use of collagen as a completely resorbable barrier material and MTA as a perforation repair material.[10] The repair of perforation requires a matrix to control the repair material. The same concept is utilized for the placement of MTA apical barrier in immature teeth.

Platelet rich fibrin (PRF) which is a second generation platelet concentrate can be used as a resorbable matrix material against which MTA apical barrier can be placed. PRF was first described by Choukroun *et al.* in France. It has been shown to have several advantages such as ease of preparation, autologous, promotion of wound healing, bone growth, bone maturation and hemostasis.[11] This case report describes the management of an immature tooth (with open apex) with a one-step apexification procedure with MTA apical barrier and autologous PRF membrane as an internal matrix.

CASE REPORT

An 18-year-old female patient, reported to the Department of conservative dentistry and endodontics, with a chief complaint of pain in the left mandibular second premolar. On further examination it was found that tooth number 35 showed no signs of caries or fracture [Figure 1a], but was sensitive to percussion and palpation. The concerned tooth did not respond to heat test, cold test and electric pulp testing. A radiographic image revealed an open apex and an associated periapical lesion in relation to the lower left second premolar [Figure 1b]. The treatment options given to the patient were (1) endodontic treatment, followed by surgical removal of periapical lesion and retrograde filling, and (2) nonsurgical root canal treatment with single visit apexification procedure using apical plug of MTA. Patient was apprehensive about the surgical option, also considering the age of the patient and the extent of surgical trauma, a nonsurgical treatment was opted.

After administration of local anesthesia, a rubber dam was placed and an access cavity preparation was done. Working length was determined with a no. 15 k file and an apex locator (Root ZX, Morita, Tokyo, Japan), and was confirmed radiographically [Figure 1c]. Root canal preparation was done with a no. 80 k file (DentsplyMaillefer, Ballaigues, Switzerland) using circumferential filing motion. Root canal debridement was done using alternate irrigation with 1% NaOCl and saline and a final irrigation with 2% chlorhexidine. The canal was dried with paper point, and triple antibiotic paste (metronidazole, minocycline, and ciprofloxacine) was placed as an intracanal medicament and the access cavity was sealed with a temporary restoration.

At 1 week and 2 weeks recall appointment, the intracanal medicament was replaced. This was followed by placement of calcium hydroxide mixed with propylene glycol as an intracanal medicament at 3 week recall appointment. At the 6 week recall appointment, the tooth was asymptomatic and nontender on percussion. It was decided to use PRF membrane as an internal matrix against which MTA would be placed as an apical barrier. $Ca(OH)_2$ was removed from the canal using copious irrigation with saline. The canal was debrided further with NaOCl and saline, and final irrigation was done with chlorhexidine. The canal was dried with paper point.

Platelet rich fibrin membrane was prepared using the procedure described by Dohan *et al.*, blood (8.5 ml) was drawn by venipuncture of the anticubital vein. This blood was collected in a 10 ml sterile glass tube without anticoagulant, and was centrifuged immediately at 3000 revolutions/min (rpm) for 10 min. After the centrifugation the resultant in the glass tube consisted of the topmost layer of acellular platelet poor plasma, PRF clot in the middle and red blood cell's at the bottom [Figure 1d]. The PRF clot was squeezed in a piece of sterile gauze to obtain a PRF membrane. The PRF membrane was cut into two halves to reduce the size of the membrane [Figure 1e]. PRF membrane was introduced into the canal and was gently compacted using hand pluggers to form an apical barrier at the level of apex using an operating microscope [Figure 1f]. MTA (Angelus, Londrina, Brazil) was mixed according to the manufacturer's instructions and was placed in the apical portion of canal against the PRF matrix, subsequent increments were condensed with hand pluggers till a thickness of 5 mm [Figure 2a]. A wet cotton pellet was placed into the canal, access cavity was sealed with temporary cement.

After 1 week the patient was asymptomatic, the tooth was isolated with rubber dam, temporary restoration and cotton pellet was removed. A hand plugger was tapped against the MTA barrier to confirm the setting of MTA. The remaining portion of the canal was obturated using AH plus sealer (Dentsply-DeTrey, Maillefer, Switzerland) and injectable thermoplasticized gutta-percha (Obtura, SpartanEndodontics, Fenton, USA) [Figure 2b]. The access cavity was restored with resin composite. The patient was recalled at 3 months and 1 year postoperatively. At 3 months recall, radiograph was taken, which showed a decreased in the size of the radiolucency [Figure 2c]. Follow-up radio graph at 1 year showed complete healing of the lesion [Figure 2d].

DISCUSSION

Apexification procedure aims at formation of an apical barrier to prevent the passage of toxins and bacteria from the root canal into periapical tissues. Technically this

Figure 1: (a) Preoperative intra oral picture with no carious lesion or fracture wrt 35, (b) Preoperative radiograph, with a welldefined radiolucency at the apex of 35, (c) working length radiograph, (d) preparation of platelet rich fibrin (PRF), (e) PRF retrieved and divided into two halves to reduce the size, (f) placement of PRF into the tooth

barrier is necessary to allow compaction of root filling material and to confine the obturating material into the root canal preventing an overfill.[12,13] Ca $(OH)_2$ is the material of choice for apexification. Previous studies have shown a 100% success rate for this technique, the mean time required for the barrier formation being 12–19 months.[14] Patient compliance is a problem with such long term multiple appointment procedure, moreover prolonged contact with calcium hydroxide alters the intrinsic property of root canal dentine making it more susceptible to fracture.[15] For these reasons, single visit apexification with has been suggested. Various materials proposed for this purpose include tricalcium phosphate,[16] calcium hydroxide,[17] freeze dried bone,[18] freeze dried dentine,[19] collagen calcium phosphate[20] and proplast.[21] MTA has become the material of choice for single visit apexification procedure owing to its excellent biocompatibility, minimal microleakage and promotion of bone and PDL formation.

The major problem information of an artificial barrier at the apex is the need to limit the material to the apex, preventing over extrusion, which may complicate or prevent repair of tissue.[22] Using a matrix will restrict the barrier material at the apex and prevent the extrusion of material into the periodontal tissues. Various materials used as a matrix are calcium hydroxide, hydroxyapatite, resorbable collagen and calcium sulfate.[10,23,24] PRF is an immune platelet concentrate which has been used as a matrix. In the present case, Choukroun's technique for making PRF was used. The advantages of Choukroun's technique and PRF in general are: [25]

- Contains growth factors including transforming growth factor beta, vascular endothelial growth factor, and platelet-derived growth factor

Figure 2: (a) Mineral trioxide aggregate apical plug, (b) immediate postobturation radiograph, (c) 3 month follow-up radiograph, (d) 1 year follow-up radiograph showing complete healing

- Platelet rich fibrin stimulates osteoblasts, gingival fibroblasts and periodontal ligament cells proliferation as a mitogen
- Platelet rich fibrin is an immune platelet concentrate, collecting all the constituents of a blood sample favorable to healing and immunity on a single fibrin membrane
- Does not dissolve quickly after application
- Completely natural, no use of chemicals
- Low cost and greater ease of the procedure
- Ability to produce PRF in large quantities
- Completely autologous and biocompatible.

Platelet rich fibrin membrane has a soft consistency and it inherently contains some amount of moisture, still it serves as a good matrix material for placement of MTA, this is because MTA has a wet sand like consistency and can be placed without pressure application and therefore it does not require a pressure-resistant matrix for application. Moreover, MTA sets in the presence of moisture and does not require a moisture-free environment. Another advantage of using PRF as a matrix is that it promotes wound healing and repair.[25]

In teeth with open apices and thin root canal walls instrumentation cannot be done properly, thus cleaning and disinfection of the root canal system rely on the chemical action of irrigant and intracanal medicament.[26] In the present case canal disinfection was achieved by irrigation with NaOCl and chlorhexidine. NaOCl is known to be toxic, especially in higher concentrations. There is an increased risk of pushing the irrigant beyond the apex in immature teeth with open apices, therefore a lower concentration of 1% NaOCl was used in the present case. Further disinfection was achieved by the use of triple antibiotic paste and Ca $(OH)_2$ as an intracanal medicaments. Since calcium hydroxide was placed for a period of 3 weeks propylene glycol was used as a vehicle, this allows slow release of calcium hydroxide ions and the medicament remains active for longer periods.[27]

CONCLUSION

The combination of PRF as a matrix and MTA as an apical barrier can be considered as a good option for one-step apexification procedure. However, controlled clinical trials need to be conducted to investigate the predictability of the outcome of the technique.

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