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Enhancing Structural Integrity: A Case report on Customized Fiber Post for restoration of maxillary central incisor

Sumaya Changaranchola, Shoba K, Sheena P, Chandrababu K, Shibu Aman, Anupama Ramachandran

Postgraduate student, Department of Conservative Dentistry and Endodontics, Government Dental College, Kottayam

Professor and Head of the Department, Conservative Dentistry and Endodontics, Government Dental College, Kottayam.

Additional Professor, Conservative Dentistry and Endodontics, Government Dental College, Kottayam.

Assistant Professor, Conservative Dentistry and Endodontics, Government Dental College, Kottayam.

Associate Professor, Conservative Dentistry and Endodontics, Government Dental College, Kottayam.

Associate Professor, Conservative Dentistry and Endodontics, Government Dental College, Kottayam.

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ABSTRACT

When developing anterior teeth experience traumatic dental injuries (TDIs), their root development may be interrupted, leading to compromised structural integrity. Managing immature necrotic permanent teeth poses a significant challenge, as traditional endodontic therapy is often inadequate for effective treatment. This case illustrates the use of Mineral Trioxide Aggregate (MTA) apexification to address an anterior necrotic tooth with an open apex. Following thorough cleaning with antimicrobial irrigants, a calcium hydroxide dressing was applied for two weeks. An apical plug of 4-5 mm MTA was then placed, and the tooth was restored with a customized fiber post and composite core. This approach enhanced mechanical strength and minimized the risk of root fracture, providing a reliable method for restoring flared root canals with thin radicular dentin.

I. BACKGROUND

When anterior teeth are subjected to traumatic dental injuries (TDIs), root development is disrupted, which can affect the structural integrity of the tooth and reduce oral health-related quality of life.[1] Although the oral cavity comprises a single percent of the body, it is responsible for more than 4 % of all injuries to the body.[2]Globally, dental trauma affects more than 1000 million individuals.[3] Before the age of 18, around half of children suffer dental injuries worldwide. Those aged 7 to 12 have the highest chance of developing TDI in their permanent teeth.[4]Maxillary anterior teeth are the most common teeth to undergo trauma for various reasons like accidental falls, impact trauma, sports, etc.[5]When the tooth erupts, almost two-thirds of the root is formed.After the eruption, permanent teeth take around $1^{1/2}$ to $3^{1/2}$ years for root completion.[6]Traumatic injuries adversely affect tooth development, especially when roots are immature, which may result in incomplete root formation and weakened tooth structure.[7]Immature apices increase the risk of fracture and make it more difficult to undertake traditional endodontic treatments, such as root canal therapy, making this issue clinically relevant. The most appropriate treatment option in these situations is apexification.[8]Apexification in endodontics involves establishing an apical barrier in teeth with an open apex. The objective is to form a calcified barrier at the root end, which will isolate the root canal system from the surrounding tissue.[9]Through the provision of a firm surface against which filling materials may be compacted, this barrier facilitates safe obturation by avoiding extrusion into periapical tissues.[8,9]In older times, the preferred material that led to the development of hard tissue at the apex was calcium hydroxide.[10]Apexification using calcium hydroxide has an array of significant drawbacks. The prolonged treatment period for apical barrier development, which can range from six to twenty-four months, is one of the main drawbacks. The root canal system may get recontaminated during these prolonged treatment breaks, which might result in recurring infections.[6] Furthermore, long-term consumption of calcium hydroxide might weaken the dentinal walls, increasing the likelihood of root and cervical fractures.[11] Moreover, the calcium hydroxide-formed apical barrier is frequently mechanically weak and might fail to provide an effective seal. This elevates the possibility of bacterial leakage, undermining the procedure's long-term success.[10,11]Mineral trioxide aggregate (MTA), a biocompatible material, stimulates osteoid-like tissue and cementogenesis, which helps to build the apical barrier.[6,12]This material is preferred for apexification due to its ability to overcome the limitations of calcium hydroxide and facilitate single-visit treatments.[10,11]Additional strengthening is required for the post-endodontic treatment of teeth with weak coronal structure. For anterior teeth, customized fiber posts cemented with an adhesive resin cement provide both aesthetics and strength. The fragile tooth structure is sufficiently strengthened by these adhesive resin systems to guarantee future beneficial functioning of the tooth.[6]

In thiscase report, management of an anterior tooth withan open apex isdiscussed using MTA as an apexification material, followedby reinforcement using customizedfiber post and composite core.

II. CASE PRESENTATION

A 14-year-old male patient presented with a primary complaint of a fractured upper right front tooth. He mentioned the history of trauma in this region five years earlier. Upon clinical examination, it was ascertained that the root canal therapy had been attempted 5 years before but was incomplete. No intraoral anomalies or tenderness on vertical percussion were noticed. An exposed root canal system with an open apex was visible on an intraoral periapical radiograph (IOPAR). Tests for pulp vitality, such as electric pulp testing (Waldent, Inc.) and thermal (cold) testing, were negative. Consequently, a diagnosis of pulp necrosis was established for tooth 11. On examination with magnification loupes, the carious dentin was evident along the walls of the root canal system.

Fig 1: Preoperative intra-oral Image

Fig 2: Access opening done 5years back

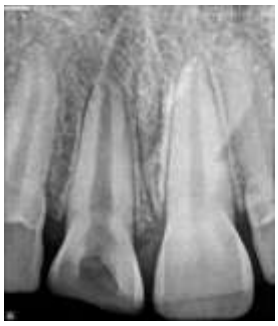

Fig 3: Preoperative Radiograph

Fig 4: Working length determination using radiographic method.

The treatment plan for the involved teeth included apexification and a custom-made fiber post and composite core for 11.The patient was given an explanation and discussion of the treatment plan. Following the patient's informed consent, root canal therapy was started. Rubber dam (Medium sized Nic Tone® rubber dam Professional Latex sheet) isolation was performed. Since the tooth was necrotic, no local anesthesia was administered. Using the #50 K file (Mani, Inc. Japan) and the radiography, the working length was determined.

After determining the working length, a circumferential filing motion was used to clean and shape the root apex up to the #80K file. Up to the #120K file, the step back preparation was completed. An effective irrigation protocol was performed to meticulously disinfect the canal, eliminate debris, and dissolve tissue remnants.Sodium hypochlorite,3% (PRIME DENTAL PRODUCTS PVT LTD) and 17% ethylene diamine tetra-acetic acid (EDTA)were utilized to irrigate the canal. Once the canal was thoroughly cleaned and dried, Calcium hydroxide (Prime dental products, Pvt.Ltd.) dressing was placed as an intracanal medicament for a period of 14 days.

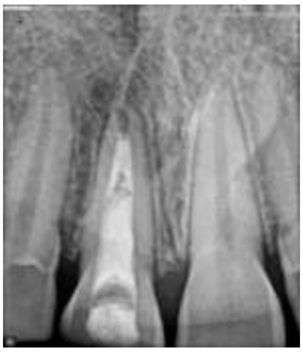

Fig 5: Calcium hydroxide Intracanal medicament for 14days

Fig 6: MTA apical plug

On second visit, the dressing was removed using Hedstrom files (Mani Inc. Japan) and copious irrigation with 3% Sodium hypochlorite was performed. The canal was then dried using absorbent paper points (Dentsply Maillefer, Switzerland). Apexification was subsequently completed with root repair material MTA (SafeEndo BioStructure MTA). To condense the MTA into the canal, the right plugger size was chosen with the support of a radiograph. MTA liquid and powder were combined to the appropriate consistency and inserted into the canal using an MTA carrier (Waldent, Inc.). The apical barrier was formed by packing the MTA in the apical 4-5 mm of the canal using the chosen plugger. After covering the MTA with a moist cotton pellet, Prevest Denpro Orafil Gwas used for as an interim restoration.

In the third visit, the apical plug's development was confirmed using pluggers and hand files. The pericervical dentin thickness was significantly reduced due to the removal of carious dentin from the root canal walls, resulting in a flared root canal. Consequently, it was determined to restore the tooth using a customized fiber post and a composite core to enhance the strength and retention of the final prosthesis. Sectional obturation was performed.

Fig 7: Sectional Obturation

The impression of canal was made using putty and light body (Zhermack EliteHD+ putty & light body) impression technique.

Fig 8: Impression for post

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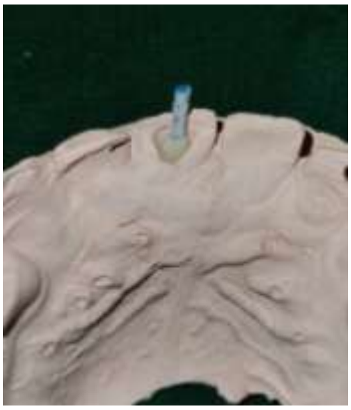

Fig 9: Prepared cast and customized fibre post

After cleaning with alcohol, the prefabricated fiber post (Angelus Reforpost, size 3) was treated with Silane (Ultrdent™ Silane) for 60 seconds and allowed to dry for one minute. A hybrid composite layer was subsequently applied to the prefabricated fiber post, carefully placed into the root canal area within the cast, and partially polymerized for 10 seconds. After carefully removing this anatomic post from the canal space, the re-lining resin was fully polymerized by further 20 seconds of light curing. To make sure it is placed passively and without any interference, the anatomic post was tried once again in the cast.

Fig 10: customized fibre post checked in canal

After preparing the customized fiber post and core, we thoroughly rinsed the canal and the customised fiber post with water and air. A rubber dam isolation was performed, and alcohol was used for disinfecting the post. After 15 seconds of etching with 37% phosphoric acid, the canal was thoroughly rinsed and dried. The canal was coated with a dentin bonding agent. An intracanal mixing tip was used to mix and inject dual cure resin cement (Coltene Paracore) into the root canal space. A small layer of the cement was then applied on the anatomic fiber post, and the post was carefully seated. Excess cement was removed, and light curing was performed for 30 seconds. The remaining part of the post was trimmed, and the composite build-up was created using Prevest Fusion Flo Light Cured Nano Hybrid Flowable Composite A2 shade.

Fig 11: Post-operativeIntra Oral Image

III. DISCUSSION

This case establishes the customized fiber post as a feasible choice for restoring immature teeth with flared roots and narrow radicular dentin. Endodontic treatment for traumatized maxillary anterior teeth aims to preserve the affected teeth, restore functionality, and maintain aesthetics.[13]When immature anterior teeth suffer trauma, especially when the root apex is not fully formed, traditional endodontic treatments can pose challenges.[14]Two revolutionary techniques for managing these cases are apexification and revascularization, which attempt to encourage root development.[15]

The preferred nonsurgical treatment for necrotic immature permanent teeth is apexification. There are currently several kinds of materials available for apexification. Kaiser introduced the gold standard therapy in 1964, which involved using calcium hydroxide and camphorated monochlorophenol to trigger the apical barrier formation at the apex. [16]The prolonged use of calcium hydroxide can weaken the dentin, increasing the risk of root fracture over time.[11]Advanced apexification using Mineral Trioxide Aggregate (MTA), on the other hand, offers a far quicker and more reliable approach.[6]Because MTA produces an apical barrier nearly instantly or within a few days, this method usually allows the treatment to be finished in one to two visits. [6,10]These biocompatible materials reduce the risk of root fractures by encouraging the formation of hard tissue without compromising dentin strength. MTA is the first material that encourages the regeneration of periodontal tissues and permits cementum development.[10,11]

In the systematic review by Izaz Shaik et al., they concluded that Mineral Trioxide Aggregate (MTA) is superior to calcium hydroxide for promoting faster and more reliable formation of an apical barrier and the ability to complete the procedure in a single visit.[16]Omar A.S. et al., found that Mineral Trioxide Aggregate (MTA) demonstrated both clinical and radiographic success as a material used to induce root-end closure in immature teeth.[17]In the study conducted by Mahmoud Torabinejad et al., Mineral Trioxide Aggregate (MTA) was found to exhibit significantly less bacterial leakage compared to other commonly used root-end filling materials.[18]For apexification, MTA was chosen over calcium hydroxide in the current case study. MTA's attraction to water molecules and tendency to be dissolved by water allows it to act effectively in moist conditions, which is particularly beneficial in the apical area, where moisture from periapical tissues is abundant. When exposed to moisture, it expands slightly and aids in the filling of tiny gaps and spaces in the root apex, thereby improving its sealing ability and reducing bacterial penetration.[19] Many studies suggested that MTA might possess an antibacterial effect, particularly against Staphylococcus epidermidis, a common bacterium involved in endodontic infections. [18,20]Mineral Trioxide Aggregate (MTA) also plays a critical role in promoting hard tissue formation by providing a scaffold for the deposition of new mineralized tissue. [21,22]

When a tooth hasundergone endodontic treatment and has lost both its structure and vitality, the standard course of treatment is to place a post-and-core buildup.[6]Prefabricated fiber posts adapt poorly to root canal anatomy, requiring the dentist to use additional resin cement to repair lost structure. Compromised root canals can be restored by anatomically shaping prefabricated fiber posts with composite resin into the canal. This method minimizes resin cement thickness, enhances mechanical and retentive characteristics of restored teeth, and reduces root fracture risk by closely adapting the post to the root canal. The current case was appropriate for the preparation of a customised fiber post as it exhibited a flared root canal with narrow radicular dentin.Research conducted by Lazaro Augusto de Almeida Goncalves et al., evaluated the fracture resilience of compromised roots repaired with transilluminating posts and composite resins, in comparison to conventional cast and prefabricated post systems.[23] The results demonstrated that composite resins significantly strengthened compromised roots, improving their fracture resistance during evaluation.

Recent studies indicate that the utilization of metal posts for the restoration of teeth with large canals may result in a graying and shadowing of the root surface. This occurs because metal posts create discoloration of the gingival margin, a cosmetic concern resulting from reflections through the relatively thin dentin and gingival tissue.[24,25]Furthermore, cast metal posts are rigid and inflexible, potentially inducing a wedging effect within the canal, thereby exerting excessive stress on the already compromised root system. These concentrated stresses from the wedging effect may lead to a vertical root fracture. [25]These hazards make fiber posts more desirable than cast metal ones, especially for teeth with wide canals or inadequate structural integrity. [19]

IV. CONCLUSION

In conclusion, this case demonstrates that a customized fiber post, combined with apexification using Mineral Trioxide Aggregate (MTA), can provide an effective restoration for an anterior necrotic tooth with an open apex and flared root canal.Due to the patient's flared root canal with narrowed dentin, prefabricated posts were inappropriate because of their poor adaptation to the root canal morphology. Cast metal posts, although an option, are inflexible and may induce a wedging effect, applying excessive stress on the damaged root. Consequently, a customized fiber post was fabricated with composite resin to accurately adapt to the canal's structure. This method improved the mechanical strength of the tooth, and diminished the likelihood of root fracture, establishing it as a reliable treatment for rebuilding compromised root canals with narrow radicular dentin.

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