Case Report

Mineral trioxide aggregate apical plug and biodynamic intraradicular restoration for rehabilitation of fractured anterior central incisor with open apex: A case report with 1-year follow-up

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ABSTRACT
Restoration of teeth with the extensive loss of coronal structure requires post and core for its rehabilitation. In this context, Biological post prepared from natural tooth offers a feasible and promising treatment option to restore the tooth with a "biologic restoration". Properties of biologic post similar to dentin make it a good alternative in comparison to conventional post systems. Along with post and core if teeth have open apices, it needs a more rationalized approach. It becomes necessary to create an apical barrier for root canal filling. For this purpose, MTA has gained enough popularity thanks to its biomimetic properties and good sealing ability. This case report discusses the successful management of fractured anterior teeth having an open apex. Treatment was done under three phases - Formation of apical barrier with MTA apical plug causing root formation, followed by thermoplasticised obturation and final rehabilitation with the placement of biological dentin post. Freshly extracted maxillary canine was trimmed and shaped to form biological post. This customized biological post was sterilized and cemented. One year of follow up showed successful structural functioning, performance and esthetics of the tooth along with apical root formation.

Keywords: Biological post, mineral trioxide aggregate, thermoplasticized obturation

INTRODUCTION
Restoration of teeth with loss of large amount of coronal structure is still a challenge in dentistry. Most of the times, these teeth require post placement as it helps in the retention and stability of the coronal restoration.1 Although myriad variety of posts are available based on different types, materials, size, and shape,2 none of these posts and core systems have proved to be an ideal restorative option.

Biological post refers to the dentin post fabricated from a natural tooth. This biologic restorative treatment option is basically a biologic replacement of the lost tooth structure which is less stress inducing on the root, biocompatible, favorable esthetics, tarnish and corrosion resistant, economical, physicomechanical properties closer to dentin, adhere both with tooth structure and resin, forms a monobloc and biological core and also serves as an integral extension of the post.3-8 Therefore, biological posts reinforce the natural tooth by the virtue of its biomimetic properties.8

Apart from the loss of substantial amount of tooth structure, if the tooth has an immature apex, it is far more difficult to restore and revive. A conventional method of treating such cases with immature apices was calcium hydroxide apexification. However,
problems associated with calcium hydroxide such as multiple visits treatment, reduced root strength, and incomplete hard-tissue barrier formation “Swiss cheese like” have resulted in unpredictable outcome. Therefore, an improved and reliable version is the use of mineral trioxide aggregate (MTA) to form an apical barrier for the root canal filling.

This case report discusses the management of a fractured anterior tooth with an immature apex by rehabilitation of the apex with MTA apical plug and biological post for strength and stability of the core.

CASE REPORT

A young 19-year-old female patient reported to the clinic with the chief complaint of fractured upper front tooth. A past history revealed an accidental blow to the upper front tooth 8 years ago, followed by discoloration over the years and no history of pain. No systemic disease or any other significant medical history was reported by the patient or her parents. No symptoms of pain or swelling were recorded in the anterior region.

Intraoral examination revealed a fractured anterior tooth with loss of more than half of the tooth structure with respect to the right maxillary central incisor and the remaining tooth structure was discolored. No intraoral draining sinus or swelling was present on the labial or palatal aspect. The fractured tooth was firm with no signs of tenderness on percussion, and mobility was in normal physiological limits. All other maxillary and mandibular anterior teeth were normal with no signs of trauma or fracture. Generalized spacing was present in the anterior region.

Radiographic examination revealed loss of more than half of the coronal tooth structure with respect to 11 and the presence of a single wide canal with an open apex. Root fracture or alveolar bone fracture was not seen in the radiograph. No periradicular pathology could be seen in the radiograph in relation to any anterior teeth. Thermal testing and electric pulp sensibility tests were also performed with respect to all maxillary anterior teeth. Results showed no response with respect to 11 and the normal response was present with respect to 21, 22, and 12.

Treatment plan

The diagnosis was Ellis Class IV fracture with open apex and discoloration. The treatment plan was apexification with MTA apical plug along with thermoplasticized obturation, followed by biological post placement and all-ceramic full-coverage crown.

Treatment procedure

Patient’s consent

The patient and her parents were informed about all the feasible treatment options. Having agreed on the treatment plan involving procedure of the MTA and biological post, all the benefits and associated risks were thoroughly explained, and written consent was obtained from the patient.

Endodontic treatment

The tooth was isolated and all the decayed coronal tooth structure was removed. Using round bur, access cavity preparation was done, followed by working length determination radiographically. After establishing working length, cleaning and shaping was performed with minimum filing without damaging the thin dentin walls and the periradicular area. Irrigation was done with low strength sodium hypochlorite (0.5% of NaOCl) (Dentpro, Chandigarh, India). The canal was dried using sterile paper points, and calcium hydroxide (Prevest Denpro Ltd., India) was placed as an intracanal medicament for 2 weeks.

In the next appointment, calcium hydroxide was removed, and root canal was dried using sterile paper points. The patient was asymptomatic during the whole treatment procedure, so local anesthesia was avoided in the second visit. MTA (ProRoot MTA, Dentsply/Maillefer, Switzerland) was taken and mixed according to manufacturer’s instructions. Using MTA carrier, MTA was placed at the apical portion, and its apical extent was determined with periapical radiograph. It was placed to a thickness of approximately 4 mm to form an apical plug. A wet cotton pellet was placed in the coronal portion of the canal, and the tooth was sealed with cavit (3M, ESPE, Germany) for 24 h until the patient was called the next day. After confirming the complete setting of MTA, the rest of the canal was filled using thermoplasticized obturation technique using Obtura III Max (Obtura Spartan, USA). The rest of the canal was again refined using K file and H file (Mani Inc., Japan) for the post space preparation. Intracanal impression of the post space was recorded using light body putty material in two stage putty impression technique, and cast model was made.

Biological post fabrication

The extracted maxillary canine was selected after inspecting it for any carious lesion. Then, the tooth was sterilized following the standard protocol (at 121°C for 20 min) and maintaining all biosecurity measures. The sterilized tooth was then sectioned mesiodistally using diamond disk along the long axis. One of the sectioned parts of the tooth was trimmed and shaped to fabricate a biological post. Fabricated dentin
post was checked for fit and adaptation on the dental stone model.

**Biological post placement**
The trimmed biological post was adjusted according to the prepared post space inside the patient’s mouth [Figure 2a]. The adaptation of the post was done radiographically [Figure 2b]. The biological post was again sterilized before cementation. For luting the post, the root canal and the dentin post both were etched with 37% phosphoric acid [Figure 2c]. This was followed by adhesive application and polymerization. Next, the canal and post were coated with dual cure resin cement Rely X U100 (3M, ESPE, Germany) and the post was allowed to set. After complete setting, core buildup was done using dual-cure core buildup (LuxaCore Z), followed by crown preparation [Figure 2d]. A temporary crown was cemented on the same day, followed by metal-free full-coverage crown in the subsequent visits [Figure 2e and f].

**Follow-up**
Six months and One-year follow-up showed satisfactory structural functioning, form, and esthetics of the restored tooth. All the clinical and radiographic findings were found to be normal, and the patient was satisfied too. Complete root formation at the apex is clearly evident at one year follow up radiograph [Figure 2g].

**DISCUSSION**
The present case report addresses an effective management of a fractured central incisor with an open apex. Intraoral periapical radiograph revealed a wide single canal with blunderbuss apex, but fortunately, there was no periapical radiolucency. Therefore, for the retention and stability of the coronal restoration, post and core was performed. The whole treatment plan was divided into three phases:

1. MTA placement for apical plug formation
2. Thermoplastized obturation and post space preparation
3. Placement of biological post and full-coverage crown.

Prefabricated fiber post was ruled out as a treatment option due to adaptation issues, and metal posts were excluded due to esthetics and biomechanics. Customized biological post and core was the best treatment option in this case as it preserves the integrity of the patient’s natural dentition. Rationale of using biological post was also based on the facts such as biocompatibility and biomimetic properties; it is the most biocompatible option available among various posts as it is fabricated from the tooth structure itself.\[^{13}\]

Physicomechanical properties such as fracture resistance and fracture toughness are more than metal or fiber post as it is...
created from natural tooth. Viscoelastic behavior is similar to radicular dentin; compressive strength and thermal expansion are very close to radicular dentin.\textsuperscript{[14-16]}

Biological post’s modulus of elasticity being similar to radicular dentin, adhesion to the cement and the tooth structure, helps it to form a monobloc which further increases post retention and reinforces the remaining tooth structure.\textsuperscript{[13,17]}

Customized post design – dentin posts can always be customized according to the case which improves its adaptation and retention. Esthetics – excellent esthetic results can be achieved when we restore the tooth biological post and core.\textsuperscript{[18]} Therefore, in this case, biologic post and core helped in acing the goal of reincarnating the fractured anterior teeth. Maxillary canine was selected for biological post fabrication as it was freshly extracted from a healthy donor whose thorough medical examination was performed priorly.\textsuperscript{[19]} The tooth was sterilized twice, once after the extraction and second after creating the biological post out of it before cementation.\textsuperscript{[19]}

Next area of focus was the open or blunderbuss apex of the fractured tooth. Revascularization procedure in this case was not advisable due to the gross loss of coronal tooth structure.\textsuperscript{[20]} A wide canal with open apex necessitates the need to achieve an apical plug at the apex as it creates a barrier for stopping the root canal filling material. For this purpose, MTA was the first material of choice (as supported by the literature also).\textsuperscript{[12,21-23]} MTA is composed of tricalcium and dicalcium silicate along with bismuth oxide, forms colloidal gel. MTA being a bioactive material has the ability to promote hard-tissue formation, good sealing, less leakage, high marginal adaptation, single-visit procedure, nontoxic, and nonmutagenic.\textsuperscript{[12,23]} Moreover, its setting in approximately 3 h in moisturous condition makes it an ideal choice for the formation of the apical plug. Calcium hydroxide was also used in this case as an intracanal medicament for 2 weeks for disinfection of the root canal. After achieving an apical seal with MTA, thermoplasticized obturation was done for void-free three-dimensional filling of the remaining canal.\textsuperscript{[22]}

Restoration of an endodontically treated teeth with compromised coronal structure and cases of open apex have always been a challenge in dentistry. However, biological post proves to be a good alternative in such scenarios. Many authors have reported successful cases of tooth rehabilitation with biological post.\textsuperscript{[3,4,8,22,24]} Therefore, biological restoration can now be considered a feasible option that provides excellent results.

**CONCLUSION**

Restoring the lost tooth structure with natural tissues has now become possible with biological restorations such as biological post and core and biological crowns. Although these restorations do not have any contraindication, these procedures may have some limitations such as the availability of required extracted teeth and shade matching in case of biological crown. However, if these biomimetic restorations are done with complete treatment planning, assessing all the pros and cons, these can prove to be a boon in maintaining the integrity of the patient’s natural dentition.

**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.

REFERENCES

1. Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: A literature review. J Endod 2004;30:289-301.
2. Shetty N. Types of post and core systems. J Int Oral Health 2016;8:1136.
3. Jain J, Shukla S, Singh K. Biological post: A reconstructive approach to achieve aesthetics. J Adv Med Med Res 2015;???:1-5.
4. Batista A, Lopes C. Performed dentin post reinforcing teeth with immature apexes. Rev Bras Prot Clin Lab 1999;3:199-21.
5. Bhatnagar A, Jindal MK, Khan SY. Biological post and core: An innovative approach. Int J Oral Health Med Res 2016;3:75-8.
6. Craig RG, Peyton FA. Elastic and mechanical properties of human dentin. J Dent Res 1958;37:710-8.
7. Ambica K, Mahendran K, Talwar S, Verma M, Padmini G, Periasamy R. Comparative evaluation of fracture resistance under static and fatigue loading of endodontically treated teeth restored with carbon fiber posts, glass fiber posts, and an experimental dentin post system: An in vitro study. J Endod 2013;39:96-100.
8. Swarupa CH, Sajjan GS, Bhupatipathiraju VL, Anwarullahwarullah A, Shashikanth YV. Biological dentin post for intra radicular rehabilitation of a fractured anterior tooth. J Clin Diagn Res 2014;8:242-3.
9. Kumar R, Patil S, Hoshing U, Medha A, Mahaparale R. MTA apical plug and clinical application of anatomic post and core for coronal restoration: A case report. Iran Endod J 2011;6:90-4.
10. Frank AL. Therapy for the divergent pulpless tooth by continued apical formation. J Am Dent Assoc 1966;72:87-93.
11. Holden DT, Schwartz SA, Kirkpatrick TC, Schindler WG. Clinical outcomes of artificial root-end barriers with mineral trioxide aggregate in teeth with immature apices. J Endod 2008;34:812-7.
12. Torabinejad M, Hong CU, McDonald F, Pitt Ford TR. Physical and chemical properties of a new root-end filling material. J Endod 1995;21:349-53.
13. Kinney JH, Marshall SJ, Marshall GW. The mechanical properties of human dentin: A critical review and re-evaluation of the dental literature. Crit Rev Oral Biol Med 2003;14:13-29.
14. Jantarat J, Palamara JE, Lindner C, Messer HH. Time-dependent properties of human root dentin. Dent Mater 2002;18:486-93.
15. Kishen A, Asundi A. Investigations of thermal property gradients in the human dentine. J Biomed Mater Res 2001;55:121-30.
16. El Mowafy OM, Watts DC. Fracture toughness of human dentin. J Dent Res 1986;65:677-81.
17. Tay FR, Pashley DH. Monoblocks in root canals: A hypothetical or a tangible goal. J Endod 2007;33:391-8.
18. Thakur DA, Patil S, Mohkar S, Gade V. Dentin post: A new method for reinforcing the tooth. J Int Clin Dent Res Organ 2016;8:67.
19. Lolyeckar NV, Bhat SV, Bhat SS. Disinfection methods of extracted human teeth. J Oral Health Comm Dent 2007;27:27-9.
20. Gutmann J. Grossman’s endodontic practice-13th edition. J Conserv Dent 2016;19:494.
21. Giuliani V, Baccetti T, Pace R, Pagavino G. The use of MTA in teeth with necrotic pulps and open apices. Dent Traumatol 2002;18:217-21.
22. Mente J, Leo M, Panagidis D, Ohle M, Schneider S, Lorenzo Bermejo J, et al. Treatment outcome of mineral trioxide aggregate in open apex teeth. J Endod 2013;39:20-6.
23. Megeri N, Chole D, Kundoor S, Bakale S, Devagirkar A. Management of fractured anterior teeth with open apex with MTA (Mineral Trioxide Aggregate) as apical plug and biological dentin post for intra radicular rehabilitation: A case report. J Med Dent Sci Res 2013;2:6-11.
24. Kathuria A, Kavitha M, Khetarpal S. Ex vivo fracture resistance of endodontically treated maxillary central incisors restored with fiber-reinforced composite posts and experimental dentin posts. J Conserv Dent 2011;14:401-5.