Case Report

BioRoot Inlay: An Innovative Technique in Teeth with Wide Open Apex

Abstract
This article reports an innovative technique in the treatment of a central incisor with a wide open apex and parallel dentinal walls. Root canal treatment was initiated, and calcium hydroxide intracanal medicament was placed in the canal for a month. The intracanal medicament was removed by instrumentation and irrigation with 3% sodium hypochlorite and 17% ethylenediaminetetraacetic acid. A light body impression of the root canal space was made and replicated the three-dimensional root canal space in a putty impression. Mineral trioxide aggregate (MTA) was condensed into the impression and allowed to set for 24 h in the presence of moisture to obtain a BioRoot inlay. This BioRoot inlay was cemented into the canal. Follow-up of every 6 months for 4 years revealed clinically asymptomatic and satisfactory healing of periapical lesion.

Keywords: BioRoot inlay, mineral trioxide aggregate, open apex

Introduction
Traumatic dental injuries are very common in children and adolescents which can result in pulpal necrosis. The most frequent teeth being maxillary incisors with prevalence of 13%. Dentoalveolar trauma during the maturation process of permanent teeth may result in incomplete root formation and root resorption. Resorption (external or internal) occurs in 5%–15% of injuries, usually within the 1st year and often within the first 2–5 months. The major challenges associated with endodontic treatment of teeth with open apices include achieving complete debridement, canal disinfection, to create an apical barrier, and three-dimensional adaptation of obturating material. Various techniques for management of the open apex in nonvital teeth were confined to custom fitting the filling material and apical surgery. However, the ideal goal is to create an apical barrier with a hard calcified tissue by apexification. Calcium hydroxide, being the most common material for apexification, has some disadvantages that include variability of treatment time (3–21 months), the unpredictability of apical closure, difficulty in patient follow-up, delayed treatment, and difficulty in retrieval. The calcified barrier formed is actually porous and even had a small amount of soft tissue. In addition, the root canal walls become fragile and weak that leads to the inability to withstand the normal forces of mastication, becoming more prone to fracture. Mineral trioxide aggregate (MTA) has emerged as a reliable bioactive material with extended applications in endodontics that include the apexification and obturation of the root canal space. MTA is biocompatible and bacteriostatic and has been recommended for creating an artificial barrier in the apical area of teeth with open apices. Orthograde delivery of MTA is more technique-sensitive and requires multiple radiographs for verification as well as retrograde placement of MTA requires surgical intervention. To use the advantages of MTA and to overcome the disadvantages of placement techniques, an innovative technique was done to obturate the tooth with open apex and apical resorption using a custom-fit prefabricated BioRoot inlay as an alternative to gutta-percha obturation.

Case Report
A 23-year-old female patient presented to our Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences of Sri Ramachandra University, Chennai, with a chief complaint of discolored upper front tooth for the past 6 months. The patient provided a history of trauma 5 years back. Intraoral examination revealed a discolored left upper central incisor. The tooth did not withstand the normal forces of mastication, becoming more prone to fracture.

How to cite this article: Rosaline H, Rajan M, Deivanayagam K, Reddy SY. BioRoot inlay: An innovative technique in teeth with wide open apex. Indian J Dent Res 2018;29:521-4.

Hannah Rosaline, Mathan Rajan, Kandaswamy Deivanayagam, Shravya Y Reddy
Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Sri Ramachandra University, Chennai, Tamil Nadu, India

Address for correspondence:
Dr. Hannah Rosaline, Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Sri Ramachandra University, Porur, Chennai - 600 116, Tamil Nadu, India.
E-mail: hrosaline@yahoo.com

Access this article online
Website: www.ijdr.in
DOI: 10.4103/ijdr.IJDR_559_16

Quick Response Code:
respond to thermal (Pulper Dental Coolant, GC, Tokyo, Japan) and electric pulp testing (Pulp Tester; AT Analytic Technology, Redmond, WA, USA). Intraoral periapical radiograph of 11 revealed a wide open apex with apical resorption and periapical radiolucency measuring about 1 cm × 2 cm in size [Figure 1]. Access cavity was initiated under rubber dam and working length was determined as 19 mm with 140-size file by digital radiography. Minimal circumferential filing was carried out with 3% sodium hypochlorite (NaOCl) (Prime, Mumbai). The canal was dried and calcium hydroxide intracanal medicament was placed in the canal. The patient was reviewed after a month and was asymptomatic. The intracanal medicament was removed by instrumentation and irrigation with 3% NaOCl and 17% ethylenediaminetetraacetic acid (RC Help, Prime Dental Products). The canal was dried. Light body impression of the root canal space [Figure 2] was made with the smart Wetting™ impression material (Aquasil LV, Dentsply Caulk, Germany). The light body impression of the root canal space was placed in a putty impression (Aquasil, Dentsply Caulk, Germany) material. Putty impression was split into two halves to aid in retrieving MTA as a single plug. The apical end of the putty impression was cut to expose the apical part of root inlay for maintaining a moist environment for initial set of the plug. This split putty was stabilized. A thick mix of MTA (White ProRoot MTA; Dentsply) was prepared and carried with a carrier into the putty canal impression. MTA was compacted with a plugger, and a root canal instrument was placed at the coronal end for trial and placement. Moist cotton was placed at both the ends of the putty impression. The root inlay was allowed to set for 24 h [Figure 3]. After 24 h, BioRoot inlay was removed and tried in and was confirmed by digital radiograph. BioRoot inlay along with ProRoot MTA as sealer was used to obturate the root canal and was confirmed by a postoperative radiograph. Resolution of large periapical lesion was observed 6 months [Figure 4] after the treatment and was followed for 4 years [Figure 5]. The periapical areas revealed satisfactory radiographic evidence of bone healing.

Discussion

Three-dimensional obturation of the root-canal system is fundamental for successful endodontic therapy.[21] Inadequate apical seal is a major cause of failure in nonsurgical endodontic treatment.[22] In pulpless teeth with open apices, the divergent apex architecture makes both complete debridement and control of obturation uncertain.[23] Treatment options for open apex cases are calcium hydroxide apexification and gutta-percha obturation,[24] orthograde MTA apical plug,[25] retrograde MTA apical plug,[26] MTA obturation,[27] and revascularization.[28]

The orthograde placement of obturation materials is the most common and preferred technique for managing wide open apex. Lack of definite apical stop and difficulty in achieving three-dimensional adaptation of custom-fitted gutta-percha and orthograde MTA leads to marginal gaps at the dentinal interface.[29] The disadvantages of surgical intervention in the young pulpless tooth are intense crack formation during retrocavity preparation or condensation of the filling material.[16]

An innovative approach, a BioRoot inlay was done to overcome the disadvantages of various management options.
of open apex with parallel dentinal walls. BioRoot inlay is an intraradicular custom-made prefabricated restoration which provides three-dimensional seal of the root canal space and promotes an apical barrier formation in a wide open apex. This BioRoot inlay, placed passively in the canal, had a good seal laterally and apically along with the MTA as sealer forming a monoblock. This sealer helps in sealing milder discrepancies between the plug and the root providing three-dimensional seal which had resulted in good healing of periradicular bone. The porosity in set MTA is a potential drawback for the material allowing the penetration of bacteria or their by-products; however, studies[30,31] have shown that after MTA placement, a layer of hyaluronic acid which is known as biologic apatite forms over the material that fills the voids and surface defects and it develops a chemical bond between MTA and the dentinal walls showing the material’s bioactivity.[32,33]

Thus, in our study, MTA compaction is done extracoronally to minimize the voids and avoid multiple radiographs for verification during orthograde placement. This BioRoot inlay uses the biologic apatite for its bioactivity and chemical bond using ProRoot MTA as a sealer. Proroot MTA was used as sealer because MTA based sealer (fillapex) has 50% of composition 13.2% MTA and 50%contains salicylate resin (1,3 butilene glycol di salicylate resin) we did not want any resin during the healing of the lesion. We wanted to evaluate the healing property of proroot MTA. These advantages have resulted in good healing of periradicular region.

High pH and calcium and phosphorus ion release are required for a material to stimulate mineralization in the process of hard tissue healing.[34] MTA has been found to release high calcium ion even after the initial set of 24 h and was also able to sustain the high releases even after 28 days. This advantage has been utilized by the BioRoot inlay which was placed in the canal after an initial set of 24 h.

Moreover, MTA prevents destruction of collagen by inducing tissue inhibitor of metalloproteinase-2 of dentin matrix and suppresses the degenerative activities of matrix metalloproteinase-2 and -14, which prevents further weakening of the tooth.[35]

**Conclusion**

BioRoot inlay will serve as a good alternative for nonsurgical and surgical approach simultaneously accomplishing a three-dimensional seal and promoting root end induction in cases with wide open apex and parallel walls.

**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.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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