



Case Report

Non-surgical repair of endodontic perforations with bioceramics: Clinical outcomes from a case report

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Abstract

Root perforations are communications between the root canal and the surrounding periodontal tissues, which may be pathological or iatrogenic. It is one of the most frequently occurring iatrogenic error during endodontic treatment and may occur during endodontic access cavity preparation, in an attempt to locate calcified canals or during post space preparation. Several factors predispose to root perforation such as pulp chamber obliteration, root canal calcification, extensive caries and internal resorption. Successful repair of root perforation depends on timely diagnosis, size and location of the perforation, as well as the materials used for repair. A contemporary approach to treatment involves the repair of the iatrogenic perforation utilizing modern imaging techniques and materials.

Keywords: Biodentine, Cone beam computed tomography, Iatrogenic perforation, MTA, Procedural errors.

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1. Introduction

Iatrogenic errors are unintentional complications or injuries that can occur during dental procedures, a common example being root perforation which most frequently occurs iatrogenically during root canal therapy or occasionally as a result of caries. Root canal perforation, as defined by the American Association of Endodontists Glossary of Endodontic Terms, is a mechanical or pathological opening that creates a connection between the root canal system and the external tooth surface.¹ Root perforations are the second most common cause of root canal treatment failures, responsible for 9.62% of all unsuccessful cases.² Kvinnsland *et al*³ reported that 47% of iatrogenic perforations result from routine endodontic procedures where maxilla has reported a higher incidence of complications (74.5%) compared to the mandible (25.5%).

Several factors may predispose to root perforation such as pulp stones, canal calcification, tooth misalignment (including incorrect inclination, tipping or rotation),

extensive caries, internal root resorption, misidentification of the root canal, extra-coronal restorations or intracanal posts which may cause difficulty in root canal access hence increasing the risk of root perforation.⁴

Since the time elapsed between perforation occurrence and its repair significantly impacts the tooth's prognosis, early and precise detection becomes crucial. Several clinical findings play a key role in diagnosing root perforations, with radiographic examinations forming the cornerstone of diagnosis. Periapical radiographs are commonly used for endodontic diagnosis where the radiolucent area indicating a connection between the root canal walls and the periodontal space is a key indicator of this procedural complication.⁵ However due to its 2D view, the integration of cone-beam computed tomography (CBCT), a three-dimensional radiograph, provides advanced imaging capabilities, enhancing the accuracy of diagnosing and assessing extent of perforation.⁶

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This case series will discuss successful management of iatrogenic root perforation with calcium silicate cement utilizing CBCT as a diagnostic tool.

2. Case Report 1

A 36-year-old female reported with a chief complaint of mild pain in her upper right anterior region. On clinical examination, 21 (history of previous RCT) was tender to percussion with a temporary restoration previously placed in the access cavity.

IOPA revealed previously attempted access cavity where the root canal was not located and was partially obliterated. Additionally, on removal of temporary restoration and exploration with DG 16 explorer, hemorrhage was observed leading to suspicion of perforation. For further diagnosis, 3D imaging CBCT (Morita Accuitomo, J. Morita Corporation, Japan) was advised to the patient.

The coronal and axial sections of the CBCT images revealed the location of the main canal (which was partially calcified), which had not been accessed during the original endodontic procedure and appeared to be the cause of perforation, which was located on the labial aspect of the tooth, approximately 5 mm apical to the alveolar crest. Retreatment with location of canal and perforation repair was planned for which consent was taken from the patient. Tooth was anesthetized with 1 ml of 2% lignocaine (1:80,000 adrenaline) via local infiltration. Under rubber dam isolation and 10X magnification of dental operating microscope (MINTRON, Model- MTV-32K9HP, Taiwan), the calcified canal was located with the aid of LN bur (Dentsply Maillefer, Ballaigues, Switzerland). After negotiating the canal with #10 K file (Dentsply Maillefer, Ballaigues, Switzerland), biomechanical preparation was completed using rotary NiTi instruments (ProTaper Gold, Dentsply Maillefer, Ballaigues, Switzerland) upto a master apical size of 25/08. Calcium hydroxide was placed in the canal and at the perforation site. During the second visit, Teflon was placed in the perforation defect and a single cone obturation was performed with F2 ProTaper cone (Dentsply Maillefer, Ballaigues, Switzerland). Thereafter, Teflon was removed and pulp chamber was cleaned with a moist cotton pellet. For perforation repair, a resorbable internalized matrix (AB Gel) was placed at perforation site. Thereafter, Biodentin was mixed and carried to the perforation site with the help of a carrier and packed with an appropriately fitted plugger (Dentmark Pluggers, China) which was followed by post-endo restoration with Universal Restorative Glass Ionomer Cement type 2 (GC Corporation, Japan).

3. Case Report 2

A 65 year-old male patient with a diagnosis of symptomatic irreversible pulpitis was referred for endodontic treatment of 42.

After obtaining informed consent, local anesthesia (2% lidocaine with 1:100,000 epinephrine) was administered. Access was made using an Endo Access Bur (#2 Dentsply Sirona, UK), aligned with the tooth's long axis. After drop of bur, K file was difficult to introduce in the orifice in which excessive haemorrhage was also observed leading to the suspicion of perforation which was confirmed radiographically (Figure 1).

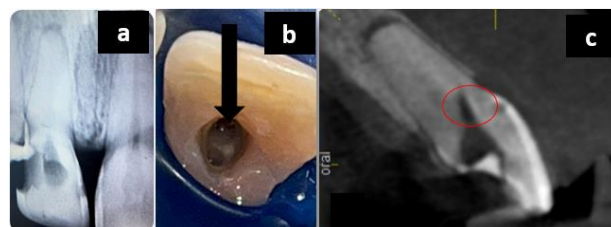


Figure 1: a: Diagnostic IOPAR of 21; b: Clinical intraoperative photographs arrow depicting perforation; c: CBCT scan (axial view showing labial perforation)

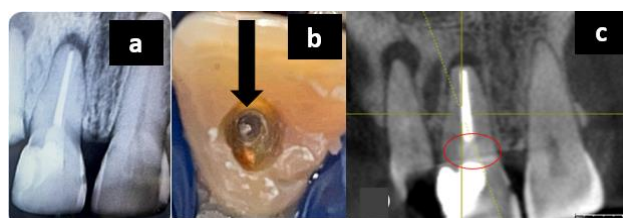


Figure 2: a: Post-operative IOPA; b: Clinical intraoperative photographs arrow depicting perforation; c: CBCT scan

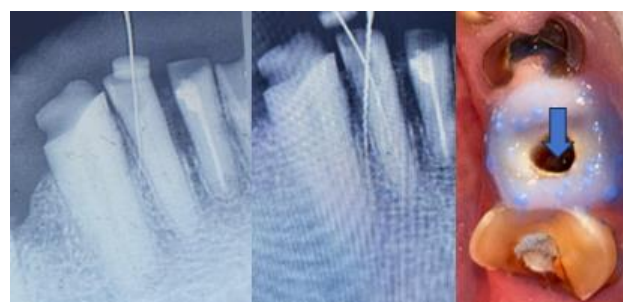


Figure 3: Preoperative images showing perforation in 42

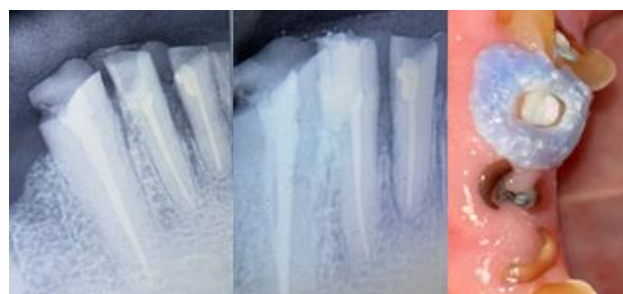


Figure 4: Post-operative images showing perforation repair in 42 using MTA

Haemorrhage from the perforation site was controlled with firm pressure by moistened cotton pellet. The access cavity was extended, revealing the canal orifice in a mesiolingual direction (deviating from its usual location) (Figure 2). Working length was determined and shaping was completed with ProTaper Universal (Dentsply Maillefer,

Ballaigues, Switzerland) in a crown down approach till F₂ size. It was planned to obturate and repair the perforation in the same visit. After thorough irrigation and drying, the canal was obturated with F₂ ProTaper GP cone (Gapadent, Hamburg, Germany) (Figure 3).

A resorbable internal matrix (AB Gel) was placed at the perforation site, followed by placement of Mineral Trioxide Aggregate (MTA, Angelus) using an MTA carrier and appropriately sized plugger. A moist cotton pellet was applied for 20 minutes to facilitate initial setting followed by placement of post-endodontic restoration. The patient remained asymptomatic at the 1-week follow-up.(Figure 4)

4. Discussion

Root canal perforation is a communication between root canal and periodontal structures. Perforations may be induced iatrogenically or may occur pathologically due to resorption or caries. Iatrogenic perforation may occur while trying to locate canal orifice in a severely calcified teeth (first case) or canal orifice at an unusual location (second case) during instrumentation for a post. Resorption can be internal or external, caused by inflammation of the pulp and trauma to the tooth, respectively; eventually leading to perforation. Clinical indicators of perforation maybe sudden bleeding into the canal, or pain during instrumentation. It can be detected by electronic apex locator and confirmed radiographically by placing a file into suspected perforation site. Caries invading the floor of the pulp chamber, extending to furcation can also lead to perforation.

4.1. Diagnosis

Root perforation must be diagnosed promptly to ensure the appropriate treatment, improve prognosis, and to prevent bacterial colonization, as delaying the diagnosis and treatment can lead to further complications and tooth loss.

Diagnosis of a perforation can be done by various techniques, such as sudden profuse bleeding into the pulp chamber and pain experienced during instrumentation or blood on a paper point,⁷ electronic apex locator⁸ and observing under magnification by using a dental operating microscope (as the location and extent of the perforation can be easily visualized due to its bright operating light and high magnification).⁸

Radiographs play a major role in detecting perforation however two-dimensional IOPAs have their own limitations in their inability to detect labial/lingual perforations. CBCT serves as a valuable tool in diagnosis of such perforation and appropriate treatment planning due to 3-D imaging.

4.2. Perforation repair materials

An important aspect in perforation repair is the selection of perforation repair material, which should have ideal requisites of being radiopaque, biocompatible, osteogenic and cementogenic.⁹ In addition, it should be antimicrobial

and cost effective. Most commonly employed materials for perforation repair are MTA, biodentine, biosilicates, endosequence and BioAggregate.¹⁰

MTA is a hydraulic silicate cement, introduced in endodontics in 1998 and is an osteogenic, biocompatible material, inductive and conductive of hard tissue formation. In addition, it is bactericidal due to its strong alkalinity and stimulates cementum-like hard tissue formation. It has various applications such as direct pulp capping, pulpotomy, root-end filling, apexification and apexogenesis in immature pulpal necrotic teeth, endodontic obturation of the root canal, treatment of horizontal root fracture, repair of resorptive defects and repair of root perforation.¹¹

Biodentine is a calcium silicate-based bioceramic material, introduced in 2009. It has wide range of clinical applications such as repair of root perforations and resorptive defects, apexification, retrograde filling, pulp capping and dentine replacement. Although both MTA and biodentine include tricalcium silicate, biodentine has denser particles and less porous structures; as a result, it has superior mechanical properties, more alkaline pH, it is easier to manipulate, and has a shorter setting time as compared to MTA.^{12,13} Aggarwal *et al*¹⁴ studied the push-out bond strengths of Biodentine, ProRoot MTA, and MTA Plus in furcal perforation repairs. They concluded that the 24hr push-out bond strength of MTA was less than that of Biodentine and blood contamination affected the push-out bond strength of MTA Plus. The setting time of Biodentine is 12 minutes and it exhibits superior bond strength compared to MTA (in the absence of blood contamination), which may be attributed to its smaller particle size.¹⁵

4.3. Prognosis

Various studies have demonstrated that numerous factors^{8,15,16} such as time elapsed after perforation, location and size of the perforation, material utilized for the repair, as well as systemic factors, affect the prognosis of the tooth with perforation.¹⁷

Old perforations when left untreated are prone to bacterial contamination from either periodontium or caries. Immediate perforation repair shows the most favorable outcome due to the possibility of bacterial contamination when left untreated for longer duration.⁸

The small size of perforation facilitates a secure seal of the affected area, resulting in a more favorable prognosis.^{8,17}

Perforations located near the crestal bone and epithelial attachment are at increased risk of contamination from the oral cavity through the gingival sulcus, hence may not have a favorable prognosis. However, in such cases the outcome depends on effectiveness of cleaning, shaping, and obturation techniques.¹²

Choice of repair material plays a major role in governing the prognosis of perforation. The materials should be biocompatible, possess antibacterial properties and osteogenic potential, and offer improved sealing capabilities.¹⁸ The healing process may also be influenced by systemic factors such as age, chronic illnesses, hormone imbalances, which can impact host immune response and in turn the outcome and healing process.¹⁹

5. Conclusion

The present cases highlight potential iatrogenic complication which can significantly affect the success of endodontic procedures. Prognosis of a tooth with root canal perforation is related to various factors such as its location, time of occurrence, size and treatment. It is essential to consider the use of advanced 3D imaging techniques such as CBCT to assess the case difficulty, while planning an endodontic treatment in complexities such as calcifications. With use of modern techniques and materials, it is possible to manage perforations with a high degree of predictability.

6. Source of Funding

None.

7. Conflict of Interest

None.

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