**Management of perforation repair**

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**ABSTRACT**

Despite the development of endodontic therapy, adverse complications can arise during treatment, resulting in a questionable prognosis; root perforation is one such complication. Root perforations located along different thirds of the root canal are associated with practitioner error during the operative stages of endodontic treatment, particularly with failure to observe the anatomic singularities of different tooth types. Various materials have been suggested and used to repair root canal perforations, including calcium hydroxide, silver amalgam, mineral trioxide aggregate, hydroxyapatite, and glass ionomer cement. Root perforation causes communication of tooth to the surrounding tissues which may act as the source of infection if left untreated. Treatment of perforation at the right time reduces the risk of teeth from being severely infected. One should know how to manage perforation to minimize the infective factor damaging the tooth. Successful treatment of root perforation with proper diagnosis and treatment reduces the risk of infection.

**KEY WORDS:** Biodentine, Iatrogenic perforation, Intentional replantation, Mineral trioxide aggregate, Perforation repair material

**INTRODUCTION**

Perforation is an artificial opening between the root canal system and the surrounding tissues of teeth, which are either created by clinician during entry into the root canal system, during cavity preparation, or by a biological event such as resorption or caries resulting in communication between root canal and periodontal tissues.

Perforation can be defined as the pathologic or iatrogenic communications between the root canal space and the attachment apparatus.\(^1\)

Root perforation is one of the most common mishaps of endodontic treatment that a clinician or even an endodontist will encounter on a regular basis. It occurs in approximately 2–12% of endodontically treated teeth.\(^2\) Such perforations might be compromise the outcome of treatment. Perforation might occur during preparation of access cavities and post space or may occur as a result of extension of internal resorption into periradicular tissues.\(^3\) This acts as a pathway for the ingress of microorganisms either from the oral cavity or periodontal tissues, thus contaminating the perforation site and preventing its healing process. If left untreated or unnoticed, it leads to secondary periodontal involvement, suppuration, and fistula formation, and prognosis of such tooth becomes questionable and extraction becomes the most likely treatment option. Hence, this review discusses about the management of perforation repair.

**Etiology**

The causes of perforation can be of iatrogenic and non-iatrogenic.\(^4\) Iatrogenic perforation occurs due to the lack of knowledge about internal anatomy of tooth structure and in failure of analyzing the possible variations in the root canal system. Iatrogenic perforation can occur in any level of endodontic treatment.

During access cavity preparation, without having the proper angulation from burs to the tooth and also attempts to search for extra canal orifices. It occurs mostly at the coronal level of the tooth. During negotiating of calcified and curved canals, lateral extension of the canal preparation called strip perforation, and during post space preparation. Over instrumentation of rotary instruments cause apical or
crestal perforations of root canal wall, which is also called as strip perforation. During cleaning and shaping procedure, perforation may occur in coronal, middle, or apical third of the root.

Non-iatrogenic perforation occurs due to internal or external resorption trauma, and caries mostly involving the furcal area.

According to Fuss and Trope, perforation can be classified based on time, size, and location.

Based on time
a. Fresh perforation – Perforations that occurs at the same appointment, characterized by fresh blood at the perforation site. These if treated immediately or shortly after occurrence under aseptic conditions have good prognosis.
b. Old perforation – Previously not treated or unnoticed with likely bacterial infection; these have questionable prognosis.

Based on the size
a. Small perforation – These are smaller than size 20 endodontic instruments, because the mechanical damage to tissue is minimum, and due to the ease of sealing, they have good prognosis.
b. Large perforation – Occurs mainly during post preparation with significant tissue damage and obvious difficulty in providing adequate seal; there is obvious salivary contamination or coronal leakage, and these have questionable prognosis.

Based on the location
a. Coronal perforation – Perforations that occur coronal to the level of crestal bone and epithelial attachment; they cause minimal damage to the supporting tissues and are easy to access and seal, good prognosis.
b. Crestal perforation – Perforations at the level of the epithelial attachment into the crestal bone, questionable prognosis.
c. Apical perforation – Perforations apical to the crestal bone and the epithelial attachment, minimal risk of salivary contamination, hence good prognosis.

Ideal Requirements of Perforation Repair Material
- It should provide adequate seal.
- It should be biocompatible.
- It should have an ability to produce cementogenesis and osteogenesis.
- It should have bacteriostatic, bactericidal, and radiopaque.
- It should be relatively inexpensive.
- It should be non-toxic, non-cariogenic, and easy to place.

Various Materials used for Perforation Repair Include
1. Indium foil
2. Amalgam
3. Plaster of Paris
4. Zinc oxide eugenol
5. Super Ethoxy benzoic acid (EBA)
6. Intermediate restorative material
7. Gutta-percha
8. Cavit
9. Glass ionomer cement
10. Metal-modified glass ionomer cement
11. Composite
12. Dentin chips
13. Freeze decalcified freeze dried bone graft
14. Calcium phosphate cement
15. Tricalcium phosphate cement
16. Hydroxyapatite
17. Calcium hydroxide
18. Portland cement
19. Mineral trioxide aggregate (MTA)
20. Biodentine
21. Endosequence
22. Bioaggregate
23. New endodontic cement.

Diagnosis
Accurate diagnosis of root perforation can be tricky. Sudden bleeding and pain during instrumentation are warning signs of a potential root perforation. Continuous and profuse bleeding will occur in case of perforation, and the patient will complain of severe pain. Location and presence of perforation can be determined by:

1. Radiographs
   - X-ray
   - Digital radiography
   - CBCT.
2. Electronic apex locator.
3. Appearance of blood on paper points.
4. Dental operating microscope.

Management of Perforation
Successful perforation management is achieved by sealing the perforation immediately or as early as possible, type of material used, location of perforation, and by adequate sealing the perforation. There are two types of management of perforation, nonsurgical approach or surgical approach.

Nonsurgical Management
Nonsurgical management of perforation includes orthograde approach, management of crestal root perforation, intentional replantation, and iatrogenic perforation.
Orthograde approach

Fresh perforations that occur during endodontic and operative procedures are followed by hemorrhage. Hemorrhage can be controlled first by applying pressure or irrigation and perforation should be sealed adequately.\(^4\)

Bleeding can be controlled using hemostatic agents and materials that arrest bleeding.\(^5\) In order to arrest the bleeding, we can place calcium hydroxide into the canal and allow to remain 4-5 min and then flush with saline, repeat this procedure for two or three times.\(^6\)

Other hemostatic materials used to control bleeding are collagen, calcium sulfate, freeze-dried bone, and MTA.\(^7\,^8\) Calcium hydroxide material is used for perforation management.\(^9\)

Absorbable barrier materials used are collagen and calcium sulfates. Nonabsorbable barrier materials are MTA, Super EBA, resin cement, composite bonded restoratives, and calcium phosphate cement.

Management of Crestal Root Perforation

Sealing should be done with any biocompatible material with short setting time and good sealability properties. For a single-rooted teeth, orthodontic extrusion is recommended to bring the perforation to a coronal position, so that it can be sealed externally without surgical intervention.\(^4\)

Internal matrix technique is suggested for large perforations in the furcal region of molars to avoid extrusion of repair material.\(^9\,^11\) MTA, ProRoot MP, \(^12\) iRoot BP, \(^13\) calcium-enriched mixture cement, \(^14\) ProRoot MTA, \(^15\,^16\) and Biodentine are considered as the best materials for furcation perforation. MTA and calcium-enriched mixture cement induce formation of cementum-like tissue.\(^18\) For crestal root perforations, Biodentine is considered to be the best material.\(^19\) The use of stem cells with treated dentin matrix in the management of perforation enhances bone formation.\(^20\)

Intentional Replantation

It is considered when orthograde and surgical treatment are not possible. It is indicated when perforation is too large for repair and inaccessible without excessive bone removal.\(^4\)

Atraumatic extraction of tooth should be done without damaging the surrounding tissues. Immediately removal of tooth which has to be transported to hank balanced salt solution. Replantation should be done as quick as possible.

Complications are inflammatory root resorption and ankylosis.

Iatrogenic Perforation

The more apical the perforation, prognosis will be more favorable. Perforations occurring in the coronal one-third of the root below the crestal bone have poor prognosis.\(^13\) MTA can be used as a obturating material and perforations located at the level of epithelial attachment and bone in case of strip perforation.\(^21\)

Surgical Management

Surgical approach is done in cases of large perforation, perforation as a result of resorption, and failure of healing after nonsurgical repair. Parameters considered before surgical management are amount of bone remaining, extent of osseous destruction, duration of defect, periodontal disease status, attachment level of soft tissue, oral hygiene, and surgeons expertise in tissue management.\(^4\) Guided tissue regeneration is attempted to manage perforation.

Buccal full thickness flap is raised for visibility of perforation site. Perforation is then sealed with MTA, and then, sutures are placed on the flap. After healing of surgical wound, sutures are removed, and then, post can be cemented.\(^22\)

Multidisciplinary Treatment Approach

In multidisciplinary approach, sequential procedures include conventional endodontic retreatment, an initial orthograde sealing of perforation, guided tissue regeneration, and rescaling of perforation with ketac-endo and intermediate restorative material.\(^22\)

Old to New Materials used in Repair of Perforation

There are various materials used in perforation repair. They are indium foil, amalgam, plaster of Paris, zinc oxide eugenol, Super EBA, intermediate restorative material, gutta-percha, cavity, glass ionomer cement, metal modified glass ionomer cement, composite, dentin chips, decalcified freeze-dried bone, calcium phosphate cement, tricalcium phosphate cement, hydroxyapatite, calcium hydroxide, portland cement, MTA, Biodentine, endosequence, bioaggregate, and new endodontic cement.\(^23\)

Microscope in Management of Perforation

Microscope enhances the visibility of perforation in a magnified field. It helps in locating even smaller perforation site, so that it can be treated earlier preventing from future infection.\(^25\)

It helps mainly in sealing the cervical perforation with Vitremer and iatrogenic cervical perforation during access preparation.\(^26\)

Significant Factors for Prognosis

Time

Early treatment of perforation has a good prognosis. If perforation left untreated, it leads to secondary
inflammation of periodontal attachment and leads to tooth loss.[27]

**Size and shape of perforation**
Smaller the size of perforation better will be the prognosis.[28]

**Location**
Perforation located near gingival sulcus promoting inflammation and loss of epithelial attachment results in pocket formation.[29] Perforation locating away from the gingival sulcus in healthy periodontium has fair prognosis.[30]

**CONCLUSION**

The perforation management should be decided on the above discussed factors. Thus the clinician should have thorough knowledge of the anatomy of tooth in order to prevent the chances of perforation. With the advent of newer materials and techniques for sealing, the clinical management and prognosis have been improved.

**REFERENCES**


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