

# Tooth Root Perforation Repair - A Review

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## Abstract

Tooth root perforation is an artificial communication between the oral environment and the supporting structures in the external root surfaces which may cause serious implications that can even lead to extraction, however if diagnosed early and with appropriate management of the perforation will lead to long term survival of the tooth. A PubMed search was carried out of which 121 results were obtained regarding tooth root perforation repair and this review relates to the factors that lead to prognosis of the perforated tooth and various materials that can be used to seal the perforation sites.

*Key Words: Prognosis, Root resorption, Root caries, Complications, Root canal therapy*

## Introduction

An artificial communication between the oral cavity or, the supporting structures to the external root surface is termed as root perforation [1]. Most of the causes are iatrogenic which occurs during the search of canal orifices and access preparation followed by excessive dentin that is removed during post placement. Root resorption and caries are the common causes for non-iatrogenic perforation [2-4].

In approximately 2–12% of endodontically treated teeth, accidental root perforations may occur, which may have serious implications [4-9]. An infectious process once started at the perforation site either from the root canal or from periodontal tissues impairs the healing and initiates an inflammatory process that exposes the supporting tissues to infection, pain and suppurations. In chronic conditions may lead to abscess and fistulae including bone resorptive processes, thus making prognosis for treatment questionable leading to extraction of the affected tooth [9,10], however if diagnosed early and with appropriate management of the perforation will lead to long term survival of the tooth.

This review relates to the various material used in the treatment of perforation.

Fuss and Trope based on the factors impacting the outcome of treatment classified perforation as:

- Fresh perforation– treated as soon as possible after first observation under aseptic conditions, Good Prognosis.
- Old perforation– previously not treated that is contaminated with bacteria. Questionable Prognosis.
- Small perforation (smaller than #20 endodontic instrument)– trauma to the tissue is small with ease of sealing, Good Prognosis.
- Large perforation– this is usually seen while post preparation, with high amount of trauma to the tissue and there is difficulty in providing an optimum seal, along with contamination from bacteria's, or coronal leakage along temporary restoration, Questionable Prognosis.
- Coronal perforation– this is seen coronal to the level of crestal bone and epithelial attachment with trauma to adjacent tissues are less and easy access possible, Good Prognosis.

- Crestal perforation– at the level of the epithelial attachment into the crestal bone, Questionable Prognosis.
- Apical perforation– apical to the crestal bone and the epithelial attachment, Good Prognosis.

## Factors affecting the prognosis of perforation repair

Successful outcome of perforation treatment depends upon the whether bacterial contamination at the site of perforation can be prevented or eliminated [11]. Various factors that include time from the perforation to detection, size, and shape of the perforation and also its location have a great importance to control infection at the perforation site.

## Time of perforation of tooth root

Lantz and Persson conducted a study by making root perforations in dogs and treatment was initiated as soon as detected or after a small delay and on observation healing response were more clear when perforations were repaired immediately [12-14].

Seltzer et al. also conducted a study [15] on 22 perforations on monkeys at time intervals from immediate observation to 10 months and they noticed that, the periodontium was collapsed in all most all teeth, however increase in tissue damage was in the untreated perforations and in those teeth where the sealing of perforation was delayed. Benenati et al. also [16] noticed that a delay in sealing the perforations with amalgam did not affect the prognosis, with the assurance that the perforation site was kept aseptic.

Healing response is clearer when the perforation repair is done as soon as possible.

## Size of perforation of tooth root

Himel et al. [17] studied the mandibular teeth of the dogs to study the influence three materials that was used for healing the perforations of the pulpal floor and it was noticed that the larger teeth that has smaller perforations had greater incidence of healing. Prognosis is considered to be poor when there is a large perforation that occurs during post placement which leads to increased amount of tissue destruction and higher chances of contamination from the oral cavity.

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Small perforations are easier to seal and thus it has good healing.

### Location of perforation of tooth root

Location along the root surface is the most important parameter in the prognosis of root perforation. A perforation that appears nearer to the crestal bone and to the epithelial attachment is very crucial as there is more chance of contamination from the oral environment through the gingival sulcus [18-21]. Perforations, that are coronal to the crestal bone, are easier to access and repair, and teeth may be restored without periodontal involvement. Sufficient sound tooth structure for an adequate restoration is needed for good prognosis.

Perforations that are apical to the crestal bone and epithelial attachment are observed to have a good prognosis however prognosis depends upon cleaning, shaping and obturation procedures [11]. Seltzer et al. conducted an *in vitro* study and found that furcal areas in molars are more troublesome as there is increased chance of periodontal involvement and tissue destruction [15].

### Various materials used in perforation repair

An ideal materials used in the management of root perforation for root perforation material is still challenging. The repair material that is kept in close contact with hard tissue and the structures of periodontium should be biocompatible as it can cause toxic reaction either by leaching of the material or by material itself. Earlier various material including Amalgam, Gutta-percha, Zinc oxide and glass ionomer cements, Calcium hydroxide, Composites were used. Newer materials like MTA, Biodentine, dentin chips, Bioceramics, Calcium enriched material, with and without the use of barrier could be used to seal the perforation [22].

### Mineral trioxide aggregate

Mineral trioxide aggregate (MTA) has been considered as an ideal material for perforation repair, apexification retrograde filling, pulp capping etc. MTA is a mineral powder that is made up of hydrophilic particles, whose principal components are dicalcium silicate, tricalcium of silica aluminium and oxide along with other mineral oxides. Main et al. [23] noticed that MTA provides an optimum repair of tooth perforations and enhanced the prognosis of perforated teeth.

Economides et al. [24] conducted an *in vitro* study on dog's teeth and showed that MTA can be used in root end cavities, being a biocompatible material, MTA stimulated reparation of periradicular tissues, showed no inflammation [25]. It also had the ability to induce hard tissue formation [26]. This superior property of MTA like lesser bacterial leakage, biocompatibility and better adaptation to cavity walls [27] makes it a useful material in sealing the root and furcal perforation.

However, the drawback of the MTA is its difficult handling, slow setting, 3-4 hours, with the possibility of solubilized by being in contact with oral fluids as this process occurs [28], of the two commercially available MTA angelus and ProRoot

MTA, MTA Angelus has shorter setting time compared to MTA pro-root according to manufactures [27].

### Calcium silicate based cements (biodentine)

Calcium silicate based cements has a powder liquid system in which powder consist of Tri-calcium silicate, Dicalcium silicate, Calcium carbonate and oxide such as Iron oxide, Zirconium oxide and Liquid consist of Calcium chloride, Hydro soluble polymer.

Biodentine has shorter setting time approximately 12 minutes and it is easy to handle and has high alkaline pH which makes it a biocompatible material and thus making it a favorable material for perforation repair [29,30].

### Bioceramics

This is a bioceramic material which refers to a mixture of calcium silicate and calcium phosphate.

### Endosequence

It is bioceramic material composed of calcium silicates, zirconium oxide, tantalum oxide, calcium phosphate monobasic and filler agents. It has a working time of more than 30 minutes and a setting reaction initiated by moisture with a final set achieved in approximately 4 hours. Bioceramics can be used in two forms either as premixed putty or in a premixed syringe. The syringe eliminates need of hand instruments and also need for mixing. The bioceramic particle size is less than 2  $\mu$  thus can be delivered by a 0.012 capillary tip which allows premixed material to be placed by syringe [31].

Nanosphere particles are produced which enables the material to enter in the dentinal tubules and thereby initiating the setting reaction by interacting with the moisture, this creates a mechanical bond on setting and makes it dimensional stable, The material also shows superior biocompatibility characteristics due to its high pH [32,33]. Jeevani et al. conducted a study on furcation repair with Endosequence, biodentine and MTA and showed that endosequence has better sealing ability compared to others [34].

### Bioaggregate

Bioaggregate is a bioceramic material composed of tricalcium silicate, dicalcium silicate, calcium phosphate monobasic, amorphous silicon dioxide and tantalum pent oxide. It promotes mineralized tissue formation and leads to precipitation of apatite crystals that become larger which increases on immersion time suggesting it to be bioactive [35].

The sealing ability and biocompatibility is compared to that of MTA.

### Calcium enriched mixture

This a bioactive material that is mixture of calcium oxide, calcium phosphate, calcium carbonate, calcium silicate, calcium sulphate, calcium hydroxide, and calcium chloride [36]. It has a setting time of less than 1 hour and sets in

aqueous medium. Calcium enriched mixture is a preferred material for furcation repair as greater amount of calcium and phosphate ions are formed thus producing higher concentration of hydroxyapatite [37].

Asgary et al. conducted a study and observed cementogenesis and periodontal regeneration when CEM was used as perforation repair material [38].

### Glass ionomer cement

Glass ionomer cement is a powder liquid system that has been used for perforation repair Alhadainy and Himel observed that light-cured glass ionomer cement showed a better repair than amalgam or Cavit when used for furcation perforations repair [39].

A subsequent study suggested that light-cured glass ionomer cement has greater sealing ability compared to chemically cured glass ionomer cement [40].

### Dentin chips

It is used as matrix in repair of perforation defects. After adequate debridement of the canal, using an H file the canal are instrumented and the dentin chips that are produced are pushed using the blunt end of an absorbent paper point or a plugger to seal the perforation. Petersson et al. used dentin chips as matrices under AH26 for obturating perforation defects.

They reported periodontal pocket formation apical to the perforation regardless of the technique used [18]. This technique is not commonly used in perforation repair.

### Repair using internal matrix

Lemon et al. introduced the internal matrix concept to seal the perforation site. This concept was introduced with aim to overcome the chances of overfill and extrusion of the sealing material [41].

Mithra et al. observed a positive outcome when conducted a study in teeth with open apices using collagen sponge as a barrier prior to the apexification with MTA [42]. Rafler M et al. also conducted an *in vitro* study on female baboons to compare the healing at the perforation site with and without internal matrix, it was seen that there was a marked extrusion of the material when matrix was not used and also healing was compromised throughout their experiment [42].

### Conclusion

Perforation repair requires proper knowledge regarding the size, site, time and various materials that are used there by to achieve a long term success of the perforated tooth.

The materials used for perforation repair needs to be delivered to the site to obtain a permanent seal between the peridontium and root canal system, however the skill of the operator play a very important role in the success of tooth root perforation repair.

The prognosis of tooth root perforation repair depends on how well the perforation has been sealed and also the

cleaning, shaping and obturation techniques which cleans and seals root canal system three dimensionally.

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