Biodentine as a Perforative Repair Material- A Review

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Abstract

Perforations are anomalous communications between the root canal system and the external dental surface that connects the pulp cavity to the periodontal tissue. Current advances in biomaterials has made the recovery of tooth structure and function possible even in the most complicated cases. Ideally, perforations should be immediately repaired with a biocompatible material to seal the communication between the perforation site and the gingival sulcus in order to achieve a more favorable prognosis. This review article is focussed on Biodentine as perforative repair material, and has found to provide good biocompatibility, bioactivity, high compressive strength and a short setting time.

Keywords : *Biodentin, perforation, repair, biocompatible*

Introduction

Perforation can be defined as mechanical or pathological communication between the tooth surface and root canal systems.[1]They may be iatrogenic in cause or pathologic communications between the root canal system and the attachment apparatus. Perforation of the pulpal floor of the molar is one of the most difficult situation to handle in clinical situations. If a perforation occurs, the clinician is faced with the dilemma of repair, surgery or extraction. Prevalence of accidental root perforations ranges 2-12%.[2]As the perforation creates a portal of exit in the root canal system it has to be sealed as quickly as possible, since periodontal involvement arising from the perforation can become irreversible with time.[3] Many techniques have been described for the repair of the furcation perforations; they can be broadly classified into surgical and non surgical methods. The most preferable method is the non surgical method since, surgical method can lead to pathological pocket formation.[4]

The non surgical method involves the placement of the sealing material in to perforation through the access cavity and produces a good seal to avoid fluid movement, which will lead to failure of the treatment. Many materials have been used to seal the furcation perforation from zinc oxide based materials, zinc oxide eugenol cement, super ethoxy benzoicacid , calcium phosphate, glassionomer, Resin modified glass ionomers, Composites, Mineral Trioxide Aggregate.[5-7]

Biodentine is a calcium-silicate bio active material. It has superior mechanical, physical and handling properties comparable to most commonly used restorative materials. It is used as a temporary enamel restoration and permanent dentine restoration. It is used during root perforations, apexification, resorptions, retrograde fillings, pulp capping procedures, and dentine replacement. It is a powder liquid system, powder composed of Tri-calcium silicate, Di-calcium silicate, Calcium carbonate and oxide, Iron oxide, Zirconium oxide. Liquid consist of Calcium chloride, Hydro soluble polymer.[8]

CLINICAL APPLICATIONS OF BIODENTINE:

Biodentine has a wide range of applications including endodontic repair (root perforations, apexification, resorptive lesions, and retrograde filling material in endodontic surgery) and pulp capping and can be used as a dentine replacement material in restorative dentistry. The material is actually formulated using the MTA-

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based cement technology and the improvement of some properties of these types of cements, such as physical qualities and handling makes up Biodentine. [9]

It is easy to handle owing to its ease of manipulation and a short setting time approximately 12 minutes, has high alkaline pH and is a biocompatible material makes it a favourable material for perforation repair. In a study by Guneser et al., Biodentine showed considerable performance as a perforation repair material even after being exposed to various endodontic irrigants as compared to MTA. Biodentine was compared with white MTA (ProRoot) and glass ionomer cement (FujiIX) using human fibroblasts, both white MTA and Biodentine were found to be less toxic compared to glass ionomer during the 1- and 7-day observation period.[10] [11]

PHYSIO-CHEMICAL PROPERTIES OF BIODENTINE :

Working time of Biodentine is up to 6 minutes with a final set at around 10-12 minutes. The density of Biodentine is 2.26g/cm and porosity of 6.8%. There is an increase of the electrical resistance along with the porosity reduction. Therefore, even after the initial setting of Biodentine, the material continues to improve in terms of internal structure towards a more dense material, with a decrease in porosity. The setting of Biodentine is illustrated by a sharp increase in the compressive strength reaching more than 100 MPa in the first hour. The mechanical strength continues to improve to reach more than 200 MPa at 24h. After 2 hours, the hardness of Biodentine was 51 HVN and reached 69 HVN after 1 month. The reported micro hardness values for natural dentine are in the range of 60-90 HVN. Biodentine has surface hardness in the same range as natural dentine. Biodentine contains zirconium oxide allowing identification on radiographs. According to the ISO standard 6876, Biodentine displays a radiopacity equivalent to 3.5 mm of aluminum. This value is over the minimum requirement of the ISO standard (3 mm aluminum). This makes Biodentine particularly suitable in the endodontic indications of canal repair. [11][12]

BIOCOMPATIBILITY OF BIODENTINE :

Biocompatibility of a dental material is a major factor that should be taken into consideration specifically when it is used in pulp capping, perforation repair or as a retrograde filling. During the aforementioned procedures, the material is in direct contact with the connective tissue and has the potential to affect the viability of periradicular and pulpal cells. Therefore, it is essential that toxic materials are avoided and materials promoting repair or that are biologically neutral are preferred during procedures in which the material is directly in contact with the surrounding tissue. Dentine element uptake is prominent for Biodentine. There is presence of high release of calcium for Biodentine. [13] [14]

Biodentine consistency is better suited to the clinical use than MTA's. Biodentine presentation ensures a better handling and safety than MTA. Biodentine does not require a two step obturation as in the case of MTA. As the setting is faster, there is a lower risk of bacterial contamination than with MTA. Adding to its ability to be used as dentine substitute, Biodentine could safely be used for each indication where dentine is damaged. Therefore, it is an advantage for the clinician and the patient. [15]

Fig 2: Occlusal view

BIODENTINE AS PERFORATIVE REPAIR MATERIAL :

Biodentine is fast setting, so if perforations are communicated to the oral cavity, use is recommended. Another factor to consider the Biodentine is their coloration, similar to the dental tissues and produces no staining of these. The Biodentine cement is selected as perforation filing material due to its satisfactory bond strength to dentin compared with the MTA, as in repair furcation perforations situations. It is easy to handle owing to its ease of manipulation and a short setting time approximately 12 minutes, has high alkaline pH and is a biocompatible material makes it a favourable material for perforation repair.[16,17] In a study by Guneser et al., Biodentine showed considerable performance as a perforation repair material even after being exposed to various endodontic irrigants as compared to MTA. [18]The satisfactory tissue response and cytotoxicity compared with other cements based on calcium silicate were decisive factors for the choice of Biodentine cement as filling material for root perforation.[19]

Biodentine was found to significantly increase TGF-B1 secretion from pulp cells.[20]TGF is a growth factor whose role in angiogenesis, recruitment of progenitor cells, cell differentiation, and mineralization has been highlighted in recent studies.Biodentine can induce the synthesis of a dentin- like matrix by human odontoblast-like cells in the form of mineralization nodules that have the molecular characteristics of dentin. Additionally, the FTIR analysis has previously shown that this mineralized material was a specific deposition, which had the same mineral and organic composition of dentin.[21]This can also stimulate cell growth and induce Hydroxyapatite (HA) formation on the surface of the material when exposed to the simulated body fluid. HA have been shown to induce bone formation, growth and maintenance at the bone-material interface in vivo and this can be reproduced and demonstrated in vitro by soaking HA in simulated body fluids .This is of prime importance during the process of healing as Silica can induce the mineralisation function of cells by affecting cell proliferation and gene expression.

Zanini et al. [22] also evaluated the biological effect of Biodentine on murine pulp cells by analysing the expression of several biomolecular markers after culturing OD-21 cells with or without Biodentine. Their results, consistent with other studies, were in favor of Biodentine, which was found to be bioactive due to its ability to increase OD-21 cell proliferation and biomineralization.

Laurent et al. [19] indicated that though the interactions between pulp capping materials and the injured pulp tissue are yet unclear, there is growing evidence on the role of growth factors, with TGF-□1 being the most important one. These factors' main role is the signalling of reparative dentinogenesis. In a recently published article, they assessed the reparative dentin synthesis capacity of Biodentine as well as the ability to modulate TGF-□1 secretion by pulp cells which has previously shown to be released from dentine by calcium hydroxide.[23,24] Using an entire human tooth culture model, they showed that, upon application on the exposed pulp, Biodentine had the potential to significantly increase TGF-□1 secretion from pulp cells and induce an early form of reparative dentin synthesis.

Biodentine has bioactive properties, encourages hard tissue regeneration, and provoke no signs of moderate or severe pulp inflammation response. The material has the ability to maintain a successful marginal integrity due to the formation of hydroxyapatite crystals at the surface which enhances the sealing ability. Due to its superior sealing potential, there is no risk of microleakage which may cause the pulp to become infected or necrotic and jeopardize the success of vital treatment procedures. The hard tissue formation due to calcium hydroxide is a defense response of the pulp against the irritant nature of the material whereas calcium silicate based materials are compatible with the cell recruitment.[25]

Conclusion

A perforation is an artificial communication between the root canal system and the supporting tissues of the teeth. When not properly managed, root perforation complicates the treatment and deprives the prognosis. A wide range of materials have been proposed in literature to seal the perforations.Biodentine has a wide range of applications in endodontics and has shown remarkable results as a perforation repair material. It is a calcium silicate-based bioactive material.In our review we have found that biodentinehas superior mechanical, physical and handling properties comparable to most commonly used restorative materials and can because of its ease of manipulation, short setting time, high alkaline pH and biocompatibility. Hence it is a favourable material for perforation repair.

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Conflict of Interest – Nil

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