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Endodontic Management of Root Canal Perforation Using Bioceramic Technology: Original Research

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Abstract

One of the advances in the field of Endodontics in recent years is the introduction of Bioceramic Technology. There are many advantages of Bioceramics in Endodontics and these are principally a result of their physical properties. Bioceramics are exceedingly biocompatible and non toxic. They are chemically stable within the biological environment. The aim of this article is to explore the potential applications of Bioceramics in Endodontics.

Keywords: Bioactive Glass, Biocompatible Ceramics, Biocompatible Glass Ceramics, Calcium Silicates.

Introduction

Maintaining the integrity of the natural dentition is essential for function and esthetics. Endodontic therapy can play a vital role in achieving this goal. Occasionally technical problems do occur during endodontic treatment i.e. perforating a wall or floor of the pulp chamber or root canal during caries removal, during access cavity preparation, locating of canals and mechanical debridement. This can significantly impair the long-term prognosis of a tooth.[1]

Perforations are unfortunate complications that occur in the course of endodontic treatment that can be defined as mechanical or pathological communication between the root canal/pulp space and the supporting apparatus of the tooth, which leads to a compromise on the health of the peri-radicular tissue.[2,3] Perforation can be of two types, one that results from a resorptive process and the other, that is iatrogenically produced, which can occur during the bio mechanical preparation of the root canal or during a post endodontic procedure. Fuss and Trope[4] developed a classification of perforations as a predictor of prognosis. They described perforations that are small, within bone, and repaired immediately as having the best prognosis. Prognosis for a perforated tooth depends on the location of the perforation, the time in which the perforation allows entry of contamination, the possibility of sealing it and the accessibility of the main canal.[5,6,7,8,9]

Different materials have been used for endodontic perforation repair and the search for an ideal perforation repair material is a challenge. A repair material has to be placed in intimate contact with hard tissues of the tooth and soft tissues of the periodontium. These materials may pose a threat to endodontic treatment outcome by causing local or systemic adverse effects, either through direct contact with or leaching of chemical components into the periodontal tissues and alveolar bone.[1,7,9]

Bioceramic a new repair material is, in fact, the EndoSequenceRoot Repair material, which comes either premixed in a syringe (just like BC Sealer) or as a premixed putty. [10, 11] This is a tremendous help not just in terms of assuring a proper mix but also in terms of ease of use. We now have a root repair material with an easy and efficient delivery system.[10,12]

Materials and Methods

This randomised clinical study was done in the Department of Conservative Dentistry and Endodontics at DJ College of Dental Sciences and Research, Modinagar over a period of two years.

The patients visiting the outpatient department of dental College; patients with pain in the right lower back tooth region which demonstrated carious lesion on the mesial aspect of the tooth on clinical examination and presented with radiolucency in the furcation area on intraoral periapical radiographs. The sample size of the study was calculated using the following formula with 85% power of test and 5% error:

Necessary sample size = Z score * standard deviation * (1-standard deviation) / Margin of error

Twenty cases were selected in which bioceramic materials were used for retreatment, perforation repair, and periapical surgery. Recalls up to 2 years are presented. After taking institutional ethical clearance and informed written consent, the demographic data of the subjects was recorded in the Performa and endodontic management of tooth was started.

The root canals were negotiated, biomechanical preparation completed, calcium hydroxide saline paste was used as the intra canal medicament in between appointments and the root canal obturated using AH plus sealer (DentsplyDeTrey GmbH) and Guttapercha cones (DentsplyMaillefer), using a monocone technique.[Fig. 1 A,B,C, D]. The site was cleansed with physiological solution.

Results

This pilot study included twenty subjects (twelve males and eight females) with a mean age of 39 years. The subjects were divided as per Fuss & Trope classification and the present sample consisted of 30% fresh perforation, 70% old perforation, 55% smaller perforation(<#20 instrumentation), 45% large perforation, 10% coronal, 65% crestal and 25% apical perforations.

The root canals were negotiated and the perforation site was subsequently sealed using bioceramic and finally, radiographic evidence was collected to ensure the perforations sealing .[Fig. 1 E]. After one month, a control X-ray was taken.[Fig.2 A]. After three months the tooth was restored, with proper bone regeneration in the furcation zone.[Fig. 2 B]. After six months, radiographically, the repair of the defect was almost complete [Fig. 2C].

The present study showed that the bioceramic material sealed the perforation well and was resistant to dislodgement forces. No flare up or recurrences were noticed in 2-year follow up period.

Discussion

The term “Bioceramics” refers to biocompatible ceramic materials, applicable for biomedical or dental use.[1] “Bioceramics” include Alumina and Zirconia, bioactive glass, glass ceramics, calcium silicates, coatings and

composites, hydroxyapatite and resorbable calcium phosphates, and radiotherapy glasses.[2] Bioceramics are widely used for Orthopedic applications such as joint or tissue replacements and for coatings to improve the biocompatibility of metal implants.[3] Additionally, porous ceramics such as calcium phosphate based materials have been used for filling bone defects.[2] Even some basic calcium silicates such as ProRoot MTA (Dentsply) have been used in dentistry as root repair materials and for apical retrofills.[2]

The Importance of Physical properties of Bioceramics in dental applications:

Bioceramics are exceedingly biocompatible and nontoxic. They are chemically stable within the biological environment. They do not shrink. In fact, upon completion of the setting process, they expand slightly. Another important factor is that if overfill occurs during the obturation process or in a root repair, Bioceramics will produce little, if any, inflammatory response. Furthermore, the material has the ability (during the setting process) to form hydroxyapatite and form a chemical bond between dentin and the appropriate filling materials.

Application of Bioceramic technology in Endodontics[9-12]:

1. Bioceramic Sealer: Bioceramics are exceedingly being used as root canal sealers. Some of the Bioceramic sealers introduced are Endosequence BC Sealer (Brasseler USA, Savannah, Georgia), iRoot SP and iRoot BP (IBC, Canada). Some of the specific advantages of a Bioceramic if used as an endodontic sealer are:

- All Bioceramic sealers have enhanced biocompatibility and are insoluble in tissue fluids.
- They do not shrink.
- They do not resorb.
- Achieve extremely good hermetic seal.
- Ease of use. (The particle size is so small that it can be used in a syringe).
- High pH (12.9) during the setting process which is strongly antibacterial.[3] The antibacterial effect might be a combination of high pH, hydrophilicity, and active calcium hydroxide diffusion.[4]
- Following obturation, potential increased strength of the root.

The Bioceramic sealer is Calcium phosphate silicate based cement. It utilizes the water inherent in the dentinal tubules to drive the hydration reaction of the material, thereby shortening the setting time.[3] Dentine is composed of approximately 20% (by volume) water.[5] It is this water which initiates the setting of the material thus forming hydroxyapatite. Furthermore, Kossev and Stefanov in their article note "The use of bioceramic - based sealers with their features-osseoconductivity, hydrophylity, adhesiveness and chemical bonding to root canal dentinal walls-appears to be an effective approach to eliminate on long term, the microspace, otherwise remaining between the root canal walls and the materials filling the root canal. Such microspace is a potential place for possible microbial growth, because of microleakage observed with other kind of sealers."[6]

2. Bioceramic coated Gutta Percha cones: Bioceramic coated Gutta Percha cones (BC gutta percha) are now available. Used along with Bioceramic sealer the bioceramic glass particles create a good bond. That does not mean that retreatment is not possible with bioceramic technology. The key is using bioceramics as a sealer, not a filler.[7] The real asset in retreating Bioceramic cases is to use an ultrasonic with a copious amount of water.[8] On reaching half the canal length add a solvent to the canal. Then hand files can be used followed by rotary file for Gutta Percha removal.

3. As root repair material: New root repair material like EndoSequence Root Repair material comes premixed and thus is easy to use. It is an insoluble, radiopaque and aluminium-free material based on a Calcium Phosphate Silicate composition.[7]

Its advantages are:

- High pH (> 12.5)
- Excellent biocompatibility.
- High resistance to washout.
- It has a compressive strength of 50-70 MPa, which is similar to that of current root canal repair materials, Pro Root MTA (Dentsply) and Bio Aggregate (Diadent).[7] However a significant advantage of this material is that it comes premixed in a syringe and thus is easy to use.

4. As Pulp Capping Material: Bioceramic material is available in the following forms: as a sealer in a premixed syringe, as a root repair material also in a premixed syringe and as pre mixed putty in a glass jar. [9] Direct pulp caps can be done by premixed putty.

Technique for a direct pulp cap with the bioceramic putty is as follows:

- Isolate the tooth under rubber dam.
- Place the bioceramic putty over the exposure site.
- Place a thin layer of GIC over the pulp cap.
- Restore it with composite material (conventional Sandwich technique).

5. In Apexifications: Bioceramic root repair material can be used for performing apexifications. Syringeable root repair material is used to fill the apical portion of the root canal first. Then X ray verification is done followed by complete filling of the canal with the same material.

6. Surgical applications of Bioceramics: As previously mentioned the Bioceramic root repair material is available in two different modes: one is syringeable root repair material and the other is premixed putty. Both can be used for perforation repairs, resorption defects and for apical retrofills. When using the putty, simply remove a small amount from the room temperature jar and knead it for a few seconds with a spatula or in your gloved hands.[8] Then create an oblong shape and place a section of it with a sterile instrument where needed. After placing the putty into the apical preparation (or defect), simply wipe with a moist cotton ball and finish the procedure.[8] The syringeable root repair material is delivered by the syringe.

Conclusion

For a skilled practitioner, focus should be on retaining the natural dentition whenever possible. Saving teeth is now more feasible with the introduction of Bioceramic technology in Endodontics. Moreover the use of Bioceramics in Endodontics significantly helps us perform better quality Endodontics than ever before.

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Figure Citations

Figure 1

1[A]: Preopoerative Radiograph showing carious lesion on the mesial aspect of the tooth and a radiolucency in the furcation area

1[B]: The root canals were negotiated, biomechanical preparation completed; calcium hydroxide saline paste was used as the intra canal medicament in between appointments

1[C]: The root canalobturated using AH plus sealer (DentsplyDeTrey GmbH) and Guttapercha cones (DentsplyMaillefer), using a monocone technique.

1[D]: The perforation site was subsequently sealed using bioceramic showing the perforations' sealing

1[E]: Radiographic view showing the sealing of perforation site with bioceramic.

Figure 2

2 [A]: One month, a control X-ray

2 [B]: Three months X ray with proper bone regeneration in the furcation zone

2 [C]: Six months, radiographically, the repair of the defect is almost complete.