Bioceramic sealer in conservative treatment of mandibular molar root perforation

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DOI: https://doi.org/10.14436/2358-2545.11.2.069-075.oar

ABSTRACT

Introduction: Root perforation is a technical-surgical accident that results in communication of the pulp cavity with periodontal tissues. This type of accident may have an unfavorable prognosis because it significantly affects the floor of the coronary chamber or the cervical, middle and apical thirds of the root canal. Factors that interfere with the prognosis of root perforations include location, extension, presence or absence of periodontal pocket, time elapsed between perforation and treatment, and type of obturator material. In this context, bioceramic canal sealers have emerged as an innovative proposal for treatment of perforations previously considered to have an unfavorable prognosis. **Objective:** The aim of this study was to report the treatment of a lower molar root perforation with the EndoSequence BC Sealer bioceramic sealer after a 3-year follow up. **Results:** Radiographic images and patient clinical data showed success in the treatment of perforation with repair of the periradicular lesion. **Conclusion:** EndoSequence BC Sealer bioceramic endodontic sealer associated with the resumption of the original conduit path and its instrumentation favored the repair of periradicular tissues, suggesting promising biological properties of compatibility and bioactivity.

Keywords: Silicate Cement. Root Canal Filling Materials. Root Canal Obturation. Dental Cements.

How to cite: Santiago MC, De-Oliveira LA, Carvalho-Junior JR, Salles LP. Bioceramic sealer in conservative treatment of mandibular molar root perforation. Dental Press Endod. 2021 May-Aug;11(2):69-75.
DOI: https://doi.org/10.14436/2358-2545.11.2.069-075.oar

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» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

Submitted: December 22, 2018. Revised and accepted: November 13, 2019.

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Introduction

Intraosseous root perforations represent one of the most complex accidents in endodontics. They are usually caused by professional inexperience or lack of knowledge about the internal dental anatomy and its variations.[1] The place and accessibility of the perforation is directly linked to the prognosis. The treatment of an intraosseous perforation, regardless the cause, consists of localization, decontamination and hermetic sealing with a biocompatible material, which must be insoluble and tolerant to humidity. Perforations in the apical third are complicated because they are usually located beyond the root curvature and difficult to access for the repair material placing. In addition, the root canal must be remodeled and prepared properly, otherwise the prognosis may become even worse.[2]

The success of the treatment of a root canal perforation depends directly on the properties of the filling material as well. Endodontics has evolved over the years. New materials with improved biocompatibility and bioactivity have been developed. Materials such as amalgam, glass ionomer cement, resin-based cements and zinc-eugenol-based cements are no longer used because they are toxic, and do not promote good sealing in the presence of humidity, which may result in bacterial infiltration.[3]

Initially, in the 90s, the material proposed for the treatment of root canal perforations was the MTA (Mineral Trioxide Aggregate), which can be considered the first bioceramic cement. Over the years, MTA has undergone modifications, mainly to improve the flow. Achieve an improved flow was key to formulate MTA-based root canal filling cements. The new cements that have emerged in endodontics from the improvement of the MTA, defined as Portland cement-free material, consolidated this new class of endodontic cement called bioceramics.[5] MTA is composed of hydrophilic particles of calcium silicates, silicate oxide, calcium sulphate dihydrate, tetracalcium aluminoferrate and small amounts of mineral oxides. MTA has the ability to stimulate the synthesis and repair of bone tissue and is biocompatible with periradicular tissues.[5] However, there are some limitations related to the material handling, flow and staining of the dental structure caused mainly by the bismuth oxide radiopacifier.[8] Another negative factor of the radiopacifier, bismuth oxide, is that its presence in the composition of the MTA, results in a porous surface making the material more soluble when compared to pure Portland cement.[9] The improvement of this material has enabled its use in several types of endodontic treatments, covering complex cases and leading to better prognosis.[9]

The first reports about the use of bioceramics in endodontics referred the Bioaggregate (Verio Dental), which presented a composition similar to MTA. Except for the substitution of the bismuth oxide as radiopacifier in MTA composition, by the tantalum oxide in the Bioaggregate; and the addition of other components: calcium phosphate and silicon oxide. Bioceramic endodontic materials can be considered as variations of MTA composition. MTA itself is a bioceramic based on calcium silicate associated with different radiopacifying agents. Bioceramic terminology has generated some divergence regarding interpretation because it does not represent a biomaterial but a biocompatible ceramic cement with applications in medicine and dentistry.[4-6] The material biocompatibility and bioactivity have being attributed to its property to induce a process of hydroxyapatite formation similar to the natural biological mineralization and tissue repair.

In addition, the advances in nanotechnology was of great importance to enable the use of bioceramics in dentistry. Bioceramic nanoparticles increased the adhesiveness to nano-irregularities, reduced the setting time and improved other properties such as dimensional stability, insolubility to tissue fluid, chemical bonding to dental tissue and osteoconductivity of the endodontic cements. Bioceramic's composition of tricalcium and dicalcium silicates, calcium phosphates, calcium hydroxide and zirconium oxide as a radiopacifier led to important biological properties, specially, biocompatibility and bioactivity, making it an extremely interesting material for dentistry.[6] Bioaggregates are produced in the laboratory, with chemicals as raw material, not natural minerals.[4] They present tricalcium silicate as the main component in substitution for Portland cement, avoiding the incorporation of heavy metals. The basic hydration process of the bioceramic compound is similar to that of MTA; however, with the substitution of the bismuth oxide radiopacifier, which altered the coloration of the tooth structure. Some additives were incorporated into its composition, causing less radiopacity but with improved hydration.[4] The replacement of the bismuth oxide radiopacifier may be responsible for the decrease in radiopacity, but the bismuth oxide proved to be responsible for changing the color of the tooth structure within time.[4]

Endosequence® BC Sealer® Endodontic cement is a bioceramic based on zirconia oxide as radiopacifier, calcium silicate, monobasic calcium phosphate, calcium hydroxide and thickening agents. It has an initial setting time of approximately 4 hours at room temperature and the ability to harden only when exposed to humidity.[7] These properties made the cement extremely interesting for the treatment of root perforations.[8] The setting time of this material reduces with the presence of humidity. The moisture from the dental tubules is able to hydrate the cement that initiates the setting process, and results in the formation of hydroxyapatite, promoting a chemical bond to the dentin.[8]

Therefore, this study aimed to report an endodontic treatment with the EndoSequence BC Sealer of a perforation in the mesiolingual root canal of a lower molar and the follow-up after 3 years.

Case report

A 38-year-old female patient was referred to the dental clinic for evaluation and planning of a root canal perforation treatment. Clinically, she presented mild edema in the buccal region of tooth #36 and complaints of percussion sensitivity. The periapical radiography showed a radiolucent image associated with the mesial and distal roots. The cone bean computed tomography images confirmed a deviation of the canal light and root perforation were observed in the mesiolingual canal plus a hypodense area in the apical region (Figs 1A and 1B). At the first session of the endodontic treatment, after local anesthesia, a coronary access was performed with 1012 and 2083 diamond spherical drills (KG Sorensen, Barueri, SP, Brazil), under rubber dam absolute isolation and irrigation with 2.5% Sodium Hypochlorite (ASFER, Indústria Química Ltda. São Caetano do Sul, SP, Brazil). Manual endodontic Kerr files, K-file # 10 (Dentsply Maleifer, Ballaigues-Switzerland), were used for the glide path, localization of the deviation of the canal light and perforation in the mesiolingual root (Fig 2A). A pre-curved manual file K-file # 10 (Dentsply Maleifer, Ballaigues-Switzerland) was helpful to gain access to the original path and achieve the root canal patency (Fig 2B). The mesiovestibular and distal canals were explored along their entire length, reaching patency as well. After the biomechanical initial preparation, the root canals were irrigated with sterile saline solution to neutralize the sodium hypochlorite. Thereafter, the session was ended with an intracanal medication of 2% aqueous chlorhexidine solution (Maquira, Maringá, PR, Brazil). Since the root canals had not been completely instrumented, a provisory restoration with Vidrion R glass ionomer cement (SS White, São Paulo, SP, Brazil) was made to seal the dental cavity.

At the second session, after an interval of 7 days, under local anesthesia, absolute rubber dam isolation, a coronary opening and abundant irrigation with saline solution to completely remove the 2% chlorhexidine medication followed by irrigation with 2.5% Sodium Hypochlorite (ASFER , Indústria Química Ltd. São Caetano do Sul, São Paulo, Brazil) was performed. For the instrumentation of the mesiolingual canal, a K#10 file was inserted in the canal 1 mm beyond the apical foramen and, with the aid of the oscillatory motor, the canal walls were instrumented until the path was clean. Then, a K#15 file was gently inserted 1 mm beyond the apical foramen to guarantee the complete cleaning of the root canal apical third. Thereafter, all the root canals were prepared using the Prodesign M® manual system (Easy, Belo Horizonte, MG, Brazil). With the pre-curved file #.25/06, the middle and cervical thirds were pre-enlarged with rotational movement. Then, with file #.25/01, also pre-curved, a rotational movement continued along the entire path of the canals. Subsequently, with the file #.15/05 in a rotational motion as well, the patency was reached and the preparation with a file # .25/06 was completed (Figs 3A and 3B). The mesiovestibular and distal canal followed the same protocol. However, the distal root canal was refined with a 35.05 Logic® file (Easy, Belo Horizonte, MG, Brazil). After the proper cleaning and shaping step, the final irrigation was performed with EDTA 17% (Biodynamics, Ibiporã, Paraná, Brazil), followed by activation with the Easy Clean® (Easy, Belo Horizonte, MG, Brazil) and dry of the root canals with sterile paper cones.

A calcium hydroxide PA plus sterile saline intracanal medication was prepared and inserted in the root canals with the aid of a Lentulo spiral and the tooth was provisionally restored with a glass ionomer cement. At the third session, after 30 days, the removal of the

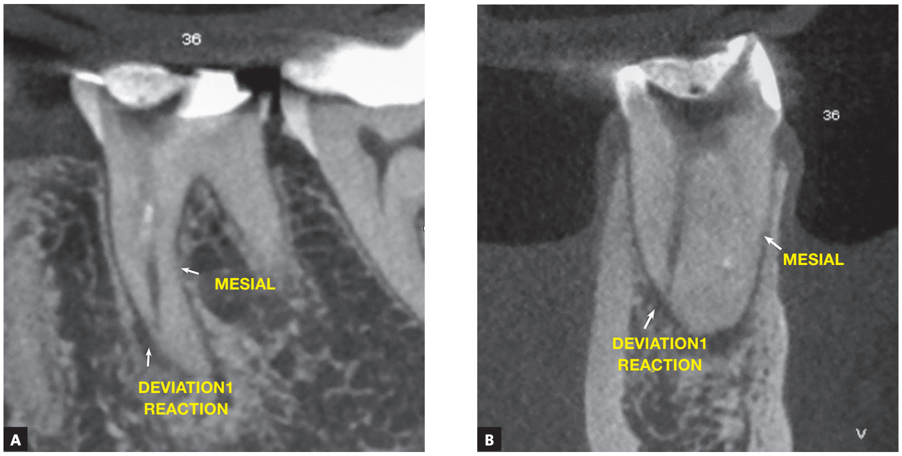

Figure 1. A) Computed tomography showing root canal deviation and perforation. **B**) Perforation of the mesiolingual canal

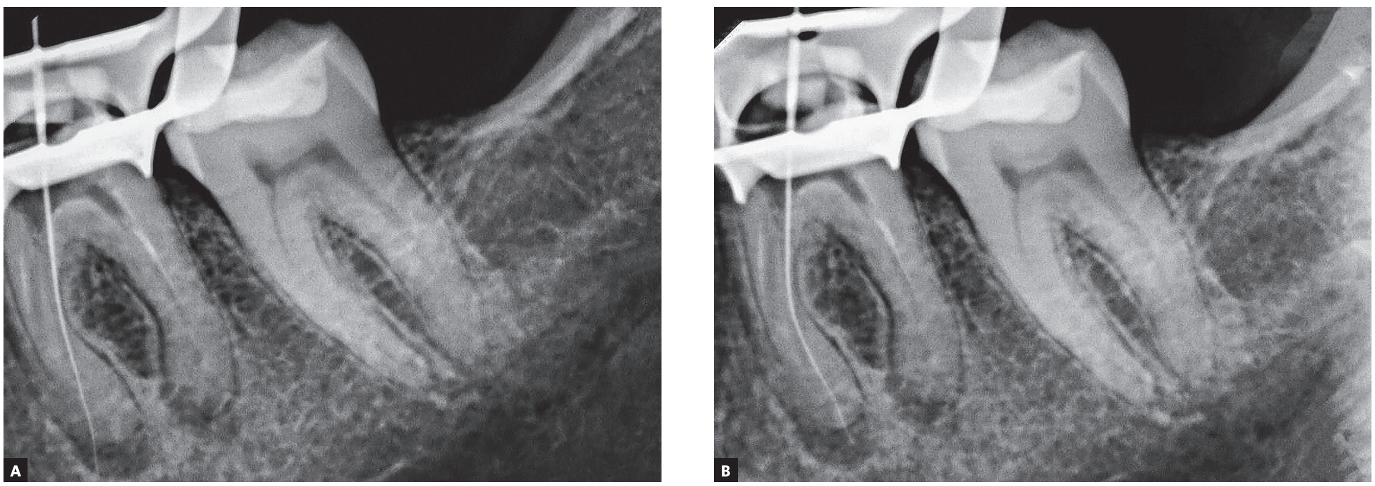

Figure 2. A) Location of the point of deviation of the root canal and the perforation of the mesiolingual root. **B**) Pre-curved hand file resuming the original root canal path.

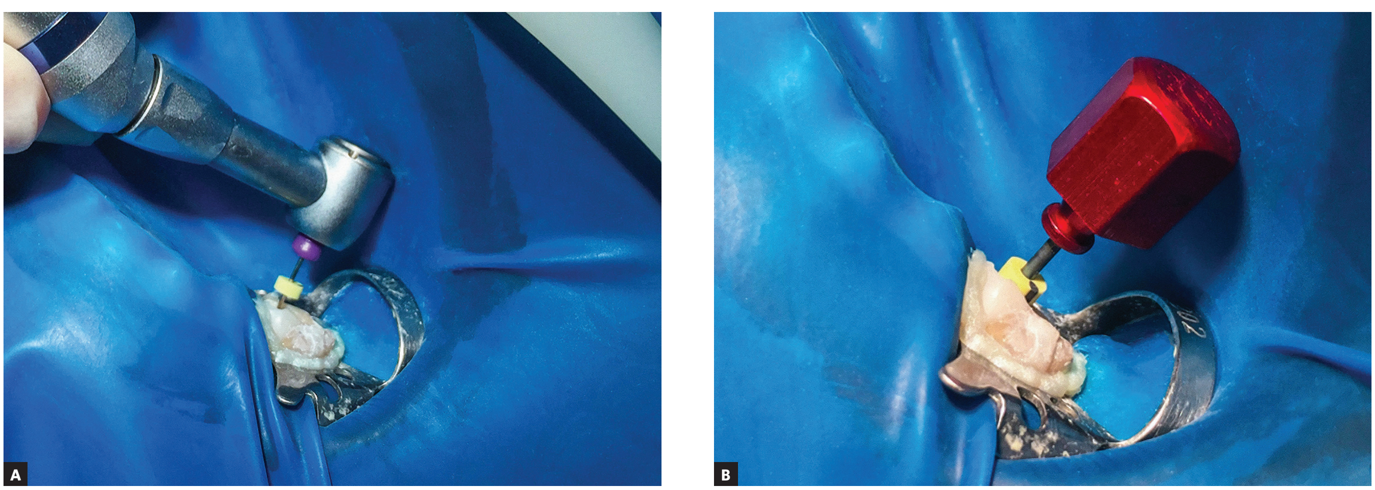

Figure 3. A) Type K #10 file inserted 1 mm beyond the foramen and coupled to the oscillatory motor. **B**) Instrument #.25/06 ProDesign M system (Easy, Belo Horizonte, MG) inserted in the canal to finish the root preparation.

intracanal medication followed similar steps as already described: Anesthesia, absolute isolation, coronary opening, abundant irrigation with 2.5% Sodium Hypochlorite and final irrigation with EDTA activated with the Easy Clean® device. Thereafter, the root canals were dried with sterile paper cones. The endodontic cement EndoSequence BC Sealer (Brasseler USA, Dental Instrumentation, USA) was inserted into the root canals with the aid of a Lentulo spiral in order to ensure good flow and hermetic sealing of the perforation. Thereafter, a 25.06 gutta percha cone (ENDOTANARI, Manaus, Amazonas, Brazil) was introduced into the mesial canals and a 35.05 cone (ENDOTANARI, Manaus, Amazonas, Brazil) in the distal canal surrounded by endodontic cement. As the cement is ready for use, no previous handling was necessary, and its application followed the manufacturer's recommendation for the single cone technique. The cavity was sealed with the Opus Bulk Fill Flow resin (FGM, Joinvile, Santa Catarina, Brazil) and the patient was referred for prosthetic rehabilitation (Fig 4A). The patient returned for clinical and radiographic evaluation at 12 and 36 months after the treatment (Figs 4B and 4C). The success of the root canal of tooth #36, the chemical-mechanical preparation and obturation with an endodontic cement based on calcium silicate allowed the periradicular repair after 3 years of follow-up.

Discussion

The treatment of root canal perforations is a challenge for the endodontists because its approach and success depend on several factors: the region of the perforation, accessibility, sealing with biocompatible materials and mainly the risk of contamination with microorganisms. In the present study, an apical surgery was the first treatment proposed. However, in accordance to the difficulty of access to the region of the perforation and doubtful prognosis, we opted for the conventional treatment via the root canal with the use of a bioceramic cement. The filling with a bioceramic material could represent increased chance for a favorable prognosis. Despite the scarce literature on the bioceramic cement Endosequence BC Sealer, in vitro and in vivo studies with animal models indicated an interesting bioactive potential of this cement to induce mineralized tissue repair.

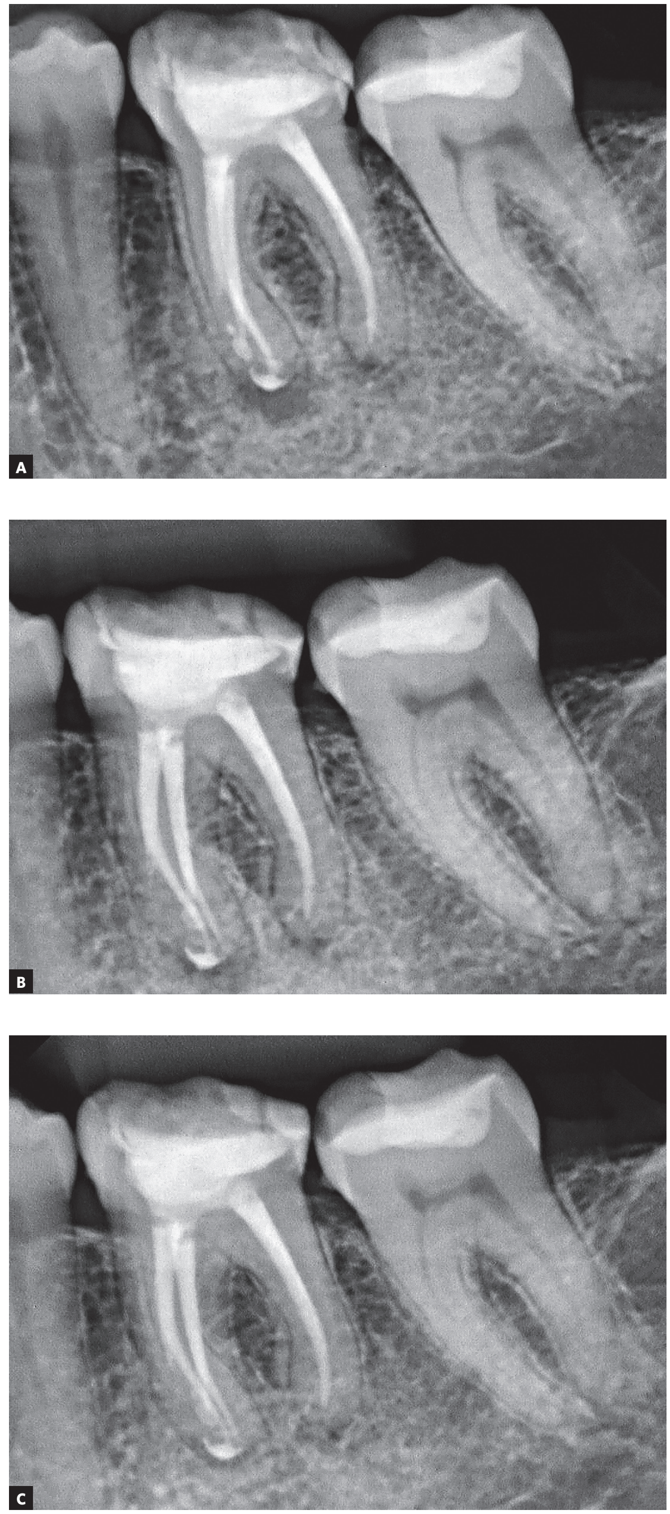

Figure 4. A) Radiography immediately after the endodontic treatment is completed and the perforation is filled with endodontic cement Endosequence® BC Sealer®. **B**) Radiograph 12 months after filling the root canal. **C**) Radiograph after 36 months. Radiographic image suggesting apical repair.

Our result is corroborated by the study carried out by Dhingra et al.,[14] who used the EndoSequence Root Repair to seal a perforation in the floor of the pulp chamber.[14] After a 6-month follow-up, it was possible to observe a radiographic image suggestive of the perforation repair and absence of any symptomatology.[14] However, different from this clinical report, which the root perforation occurred in the apical third and was impossible to visualize even under the operatory microscope; the vast majority of studies about non-surgical treatments of root perforation are in accessible regions such as the pulp chamber floor and cervical and middle thirds where visualization with a microscope is possible. Apical regions usually require surgical intervention, unlike the case presented in this study. In our study, the reported techniques favored the access to the original path of the root canal, the endodontic prepare and decontamination, enabling its filling with a bioceramic cement with ideal flow to seal the perforation site. Properties of the cement such as flow, sealing, biocompatibility, in addition to the instrumentation of the original canal, were essential for the success of the treatment without the need for surgical intervention.[15]

The results obtained in this work demonstrated important properties of the Endosequence as adequate radiopacity on radiographs and satisfactory flow allowing the filling of the perforated region and its visualization. Candeiro et al.[11] performed a comparative study and evaluated some physical-chemical properties of the Endosequence BC Sealer compared to AH PLUS (resin-based cement). The bioceramic radiopacity was lower than AH PLUS, but both were in accordance to the ISO 6876/2001. The release of calcium ions was significantly higher than that of AH PLUS and the fluidity of both did not show significant differences. Such results indicated the Endosequence BC Sealer as an excellent option for the root canal filling. The ability to maintain a high pH in the region adjacent to the cement is a well-recognized property of calcium hydroxide and MTA. This property can directly explain the success in tissue repair achieved in this study. The high pH in the first days of the cement setting may also explain a favorable antibacterial action and an environment conducive to mineralization in our clinical case.[11] Importantly, the tricalcium silicate present in bioceramic cements reacts in the presence of physiological fluids forming hydroxyapatite in a basic pH environment. This formation occurs on the surface of the tricalcium silicate paste, which is biocompatible and capable of inducing differentiation of human pulp cells, similar to what occurs with calcium hydroxide. The replacement of MTA components by tricalcium silicate improved the material physical properties as well.[13]

An ideal cement to seal root perforations must be biocompatible and bioactive, since it will come into direct contact with bone tissue and periodontal ligament. Bioceramic cements showed good results of biocompatibility in several studies.[12,16] In particular, Endosequence BC Sealer demonstrated superior biocompatibility when compared to MTA Flllapex in mouse fibroblast culture. MTA Fillapex exhibited significantly less viable cells than Endosequence BC Sealer cement after 1 and 20 hours of incubation. The authors argued that in the first hours, cements are more cytotoxic, but over time they become well tolerated.[18] Benetti et al.[16] evaluated the cytotoxicity and biocompatibility of a bioceramic cement similar to Endosequence BC, Sealer Plus BC (Mk Life), compared to MTA Fillapex (Angelus) and AH Plus (Dentsply). It was observed that the cell viability was directly linked to the dilution of the extracts and the implantation time of the samples in the rat's subcutaneous. At 30 days, the Sealer Plus BC was similar to the control group. MTA Fillapex and AH Plus exhibited greater inflammation than the Sealer Plus BC group. Sealer Plus BC was considered by the authors to be biocompatible when compared to MTA Fillapex and AH Plus. These in vivo results provided interesting evidence for the clinical use of the Endosequence BC. In our study, the patient did not report any postoperative pain after the end of treatment.

The sealing capability and dimensional stability of the cement are essential to prevent marginal infiltration through the perforation and to maintain the environment in condition of repair. Studies such as the one carried out by Lertmalapong et al.[17] showed in vitro that apical plugs made with bioceramic cements in extracted teeth avoided bacterial infiltration. The authors evaluated ProRootMTA, Biodentine, TotalFill BC Sealer, TotalFill BC Putty and RetroMTA in simulated open apexes filled with these materials as apical plugs with thicknesses of 3 mm or 4 mm and exposed to Enterococcus faecalis for 75 days. The Biodentine,TotalFill BC RRM and the ProRootMTA groups of cements in 4 mm plugs showed the best sealing capacity and marginal adaptation. Antimicrobial properties, biocompatibility, in addition to material stability, endorse the therapy proposed in this study. In a 3-year follow-up, there was a clear evidence of apical repair.

Compared to MTA, the bioceramic cement Endosequence BC Sealer was easier to handle and its flow allowed the sealing of the root canal perforation, with consequent repair of the affected adjacent tissues. The repair of periradicular tissues, evident after a period of 3 years, reinforces the biocompatibility and bioactivity of this cement reported in in vitro studies. Perforation treatments in the apical third usually require some surgical intervention. Reports about the use of endodontic cements to fill/seal perforations in the apical third are scarce in the scientific literature. Therefore, this report represents an alternative of a treatment more conservative that was possible because of the excellent properties of the endodontic cement, for instance, flow, sealing, biocompatibility, bioactivity and radiopacity. In addition, long periods of follow-up support the credibility and accredit the material as a suitable alternative for the endodontic therapy of root canal perforations.

Conclusion

Bioceramics root canal sealers are already a reality in endodontics. Their application has been studied and results of several studies indicate excellent properties. The new class of endodontic material are becoming the material of choice for endodontic practice and promises successful results, especially in complex root perforation treatments avoiding the need of apical surgery. Other modalities of endodontic treatment are also benefiting from this new type of material, for instance, regenerative endodontics and apical surgeries.

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