CASE REPORT/**CASO CLINICO**

Treatment of a root canal perforation using a calcium-silicate based sealer: a case report with a 4 year follow-up

KEYWORDS
Bioceramic, EndoSequence, Root repair material, Root canal sealer, Root canal retreatment.

PAROLE CHIAVE
Endosequence, Materiali Bioceramici, Perforazioni radicolari, Otturazione canalare.

Raffaella Castagnola*[1], Irene Minciacchi[1], Luca Marigo[1], Massimo Cordaro[2], Nicola Maria Grande[1].

[1]*Department of Operative Dentistry and Endodontics, School of Dentistry, Università Cattolica del Sacro Cuore, Fondazione Policlinico Universitario IRCCS Agostino Gemelli, Largo A. Gemelli 8, 00168, Rome, Italy.*

[2]*Department of Pediatric Dentistry, School of Dentistry, Università Cattolica del Sacro Cuore, Fondazione Policlinico Universitario IRCCS Agostino Gemelli, Largo A. Gemelli 8, 00168, Rome, Italy.*

Received 2018, October 1

Accepted 2019, January 28

Trattamento di una perforazione radicolare con un cemento a base di silicati di calcio: un case report con un follow-up a 4 anni.

Abstract

Aim: *This case report presents a root canal retreatment distinguished by a canal perforation successfully treated with a calcium-silicate based sealer (EndoSequence BC sealer, Brasseler USA, Savannah, GA, USA) with a 4 year follow-up.*

Summary: *Root canal retreatment of a lower left second molar was performed in 80 years old patient because of a periapical chronic periodontitis with buccal fistula. The scouting of the mesio-lingual and distal canal was obtained with a k-file #10, while the mesio-buccal was not negotiable because of a perforation in the middle third of the root. Instrumentation of patent root canal was performed and the distal canal was filled with AH Plus (Dentsply DeTrey GmbH, Konstanz, Germany) and Thermafil Obturator (Dentsply Maillefer, Ballaigues, Switzerland) whereas the mesial canals and the perforation were sealed using EndoSequence BC Sealer and dedicated EndoSequence BC Points in order to perform a successive apical surgery. The improvement of clinical conditions and, successively, the gradual bone healing, confirmed with analogical radiographs, led to avoid the complicated endodontic surgery on this lower second molar, having already an acceptable clinical success.*

Key Learning Points: *This case report confirmed the favorable physical and biological properties of calcium-silicate based sealers and, most of all, the handling properties of the EndoSequence BC sealer. In selected cases these type of sealers might lead to resolve complex treatments without using specialistic equipments like microscope and help general clinicians to approach complicated endodontic cases in an easier way.*

Obiettivi: *Questo case report presenta un ritrattamento endodontico di un secondo molare mandibolare, trattato con successo utilizzando un cemento canalare a base di silicati di calcio (EndoSequence BC sealer, Brasseler USA, Savannah, GA, USA) con un follow-up a 4 anni.*

Riassunto: *Un paziente di sesso maschile di 80 anni è stato sottoposto ad un ritrattamento canalare su un secondo molare inferiore a causa di una periodontite apicale cronica con ascesso in atto e tragitto fistoloso. Lo scouting dei canali mesio-linguale e distale è stato effettuato con un K-file #10, mentre il canale mesio-buccale non è risultato percorribile a causa di una perforazione nel terzo medio del canale. I canali sondabili sono stati strumentati ed il canale distale è stato chiuso con cemento AH Plus (Dentsply DeTrey GmbH, Konstanz, Germany) e Thermafil Obturator (Dentsply Maillefer, Ballaigues, Switzerland). I canali mesiali e la perforazione sono stati chiusi con il cemento EndoSequence BC Sealer ed i suoi coni di guttaperca dedicati, con lo scopo di eseguire successivamente una revisione chirurgica. Il miglioramento delle condizioni cliniche e la graduale guarigione ossea, confermata dai controlli radiografici, hanno permesso di evitare la chirurgia endodontica che in questo sito sarebbe stata sicuramente complessa.*

Punti chiave: *Questo case report conferma le favorevoli caratteristiche fisiche e biologiche dei cementi a base di silicati di calcio e, in particolare, la facilità di utilizzo dell'EndoSequence BC sealer. In casi selezionati questi cementi possono permettere di risolvere casi complessi senza l'utilizzo del microscopio, rendendo questi trattamenti più accessibili al dentista generico.*

Corresponding author
Raffaella Castagnola, DDS Catholic University of the Sacred Heart School of Dentistry
Largo A. Gemelli, 8 | 00168 Rome, Italy | Tel: +39 06 305W1159 Fax: +39 063051159 | e-mail: castagnolaraffaella@gmail.com

Peer review under responsibility of Società Italiana di Endodonzia
10.32067/GIE.2019.33.01.04

Introduction

Perforation is an artificial communication between the root canal system and supporting tissues of the teeth (1) that can lead to periodontal defects and tooth lost (2).
It might occur because of caries evolution, internal resorption into periradicular tissues or iatrogenic factors such as preparation of access cavities, insertion of manual or rotary instruments or root canal retreatment in which intraradicular posts need to be removed (3, 4). The frequency of accidental root perforations has been reported to range from 2% to as high as 12% (5, 6).
If the iatrogenic damage is not properly treated, the perforation acts as an open portal of exit encouraging bacterial proliferation and that can prevent healing and elicit inflammatory response leading to tender teeth, abscesses, fistulae and bone resorptive process (7). However, the prognosis differs according to different factors. Large perforations present worst prognosis than smaller ones. Large-sized perforations usually occur during operating procedures such as the opening of the pulp chamber with aggressive burs or post preparation causing more traumatic injuries to the surrounding tissues. Small perforations are easier to repair and they provide a better seal of the defect than the larger ones, avoiding continuous bacterial presence in the damaged area (8, 9). Fuss & Trope (1996) defined coronal, crestal and apical perforations basing this classification on the location of the defect and the related prognosis (10).
The timing of treatment influences as well the prognosis, the best time to repair root perforations is immediately after occurrence. The delay in repair of perforations decreases the prognosis for healing (11, 12, 13). The use of the operating microscope may improve the quality of the sealing of perforations (14).
The ideal root repair material should be biocompatible with the host, non-toxic, non-cariogenic, bacteriostatic and radiopaque. It should also induce osteogenesis and cementogenesis and it should provide adequate seal. It should be easy obtainable, relatively inexpensive and it should not cause the patient or the dentist any unnecessary inconvenience (1, 8, 15, 16). No material offers all of these properties. Nowadays Mineral Trioxide Aggregate (MTA) is the most common root repair material.
More recently, bioceramic-based root canal sealers have been introduced in endodontic practice and they have also been reported as root repair materials. Bioceramics have been classified into "bioinert" or "bioactive" materials depending on the interaction with the living tissues: bioinert materials, such as alumina and zirconia, do not induce any biological or physiological effects on the surrounding tissues. Bioactive materials, such as glass and calcium phosphate, stimulate the growth of hard tissues (17). Bioceramic-based root canal sealers can be classified according to their major constituents into calcium silicate-based sealers, MTA-based sealers and calcium phosphate-based sealers (18).
EndoSequence BC Sealer (BC Sealer, Brasseler USA, Savannah, GA, USA) is a premixed calcium silicate-based sealer that is composed of calcium silicates, monobasic calcium phosphate, calcium hydroxide, zirconium oxide, filler and thickening agents (19). The physical and biological properties of this sealer have been largely studied showing good sealing ability, an high pH and a moderate cytotoxicity (20, 21, 22). The setting reaction of EndoSequence BC Sealer is divided in two phases: in the initial setting time the reaction between calcium hydroxide and calcium phosphate in presence of water produces hydroxyapatite and water. In the final setting time the calcium silicate particles react with the water produced in the previous phase to form a calcium silicate hydrogel (22).
This case report showed a root canal retreatment distinguished by a canal

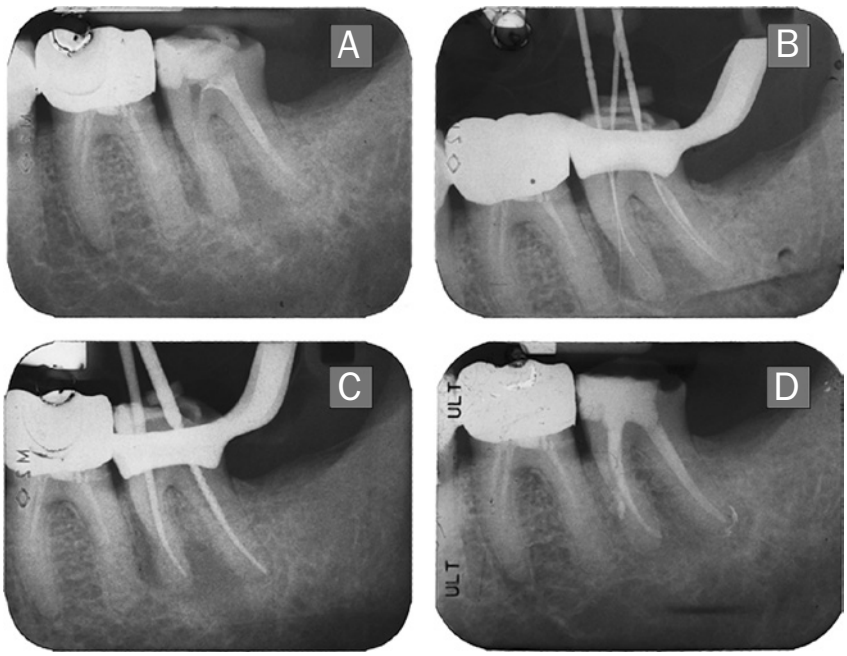

Figure 1
Endodontic retreatment of mandibular second molar with perforation.
(A) *Initial radiographic aspect,*
(B) *detection of perforation and confirmation of working lenght,*
(C) *working length control with Thermafil Verifier in the distal canal and BC Point in the mesio-lingual canal and*
(D) *final obturation.*

perforation treated with the EndoSequence BC Sealer with a follow-up of 4 years.

Report

A 80-years-old male patient was exposed to root canal treatment of mandibular left second molar because of irreversible pulpitis diagnosed in October 2012. The patient was referred to the department of Operative Dentistry and Endodontics, Fondazione Policlinico Universitario IRCCS Agostino Gemelli, Rome, Italy, in May 2013 complaining pain on biting on tooth 37. At a physical examination, the tooth was tender to percussion, presented a buccal fistula in concurrence with a physiological periodontal probing depth. The periapical radiograph (Figure 1A) showed a radiolucency in the mesial root. The analogical radiographs were taken using X-ray holders Rinn. Based on this finding the tooth was scheduled for a root canal retreatment. The anamnesis was not relevant in this treatment. Regarding his dental history, the patient was a bruxist. The local anesthesia was always obtained with 3% Mepivacaine. During first visit, the removal of the composite filling and a new access cavity with a cylindrical diamond bur and Endo Z bur were performed under rubber dam using prismatic loupes at 4X magnification (Orascoptic, Middleton, Wisconsin). Two mesial canals and one distal canal were located. The scouting was obtained with a K-file #10 (Dentsply Maillefer, Ballaigues, Switzerland) in the distal and in the mesio-lingual canal despite of the presence of gutta-percha whereas the apex was not reached in the mesio-buccal canal. A perforation in the middle part of the canal was detected. The perforation and the working lengths were assessed using an electronic apex locator (Dentaport ZX, J. Morita corporation, Tokyo, Japan) and a radiograph (Figure 1B). The glide-path in mesio-lingual and distal canal was obtained using PathFile (Dentsply Maillefer, Ballaigues, Switzerland) #13, 16 and 19, then they were shaped with Protaper Universal using the whole sequence up to F4 and F3. Unfortunately, the mesio-buccal canal was not negotiable. During instrumentation, 5.25% sodium hypochlorite needle irrigation was performed. After root canal irrigation with saline solution, the canals were dried with steril paper points and the access cavity was temporized with a provisional material (Coltosol F, Coltène/Whaledent AG, Switzerland).
A decision was made to try and save the tooth by filling the mesio-lingual canal with EndoSequence BC Sealer and dedicated EndoSequence BC Points (Brasseler USA, Savannah, GA, USA) and by filling the mesio-buccal canal only with EndoSequence BC Sealer in order to seal the apical third and to prepare the mesial root complex for apical surgery.
One week after the first visit, the tooth was asymptomatic but the fistula persisted. The rubber dam was placed and the temporary filling material was removed with a cylindrical diamond bur. The apical preparation was performed with Verifier Files 0.4 #35 (Dentsply Maillefer, Ballaigues, Switzerland) in

the mesio-lingual canal and #45 in the distal canal. The mesio-buccal canal was prepared with F2 Protaper universal until perforation. Sonic activation with EndoActivator System (Dentsply, Tulsa Dental Specialities, Tulsa, Ok) was performed using 5.25% sodium hypochlorite through the whole canal length. After sodium hypochlorite last flush the canals were flooded with EDTA 17% for 1 minute. The final rinse was obtained by sterile saline solution, and all canals were dried with sterile paper points.
The distal canal was filled with AH Plus (Dentsply DeTrey GmbH, Konstanz, Germany) and Thermafil Obturator #45 (Dentsply Maillefer, Ballaigues, Switzerland) and the mesio-lingual with EndoSequence BC Sealer and EndoSequence BC Point #35. The tip of the EndoSequence BC sealer was inserted until perforation in the mesio-buccal canal and then a "back-filling" of the canal was performed using a light pressure. A Radiograph of the filling was taken (Figure 1D) and a temporary material (Coltosol, Coltène-Whaledent, Langenau, Germany) was used to seal the access cavity. Seven days after the root canal filling the fistula disappeared, the tooth was asymptomatic and it was restored with a direct resin composite. The immediate improvement of clinical conditions led us to prolong the post-operative observational period, in the hope to possibly avoid the apical surgery, if not necessary. Radiographs at 3, 6, 12 months were taken to check the tooth healing (Figure 2A, 2B, 2C). At 48 months the presence of a lamina dura around the tooth and the absence of radiolucency suggested an healthy periodontal ligament (Figure 2D).

Discussion

Root canal perforations represented one of the most difficult situations to deal with in endodontics. Tsesis et al. (2010) reported that root canal perforations more frequently occur in mandibular molar teeth (54.31%) than in other sites (23). The authors ascribe this result to the degree and configurations of mesial canal curvature in the mandibular molar that might impose technical difficulties during instrumentation. As stated above, the ideal material to repair perforations should have several properties such us cytocompatibility, antimicrobial activity and osteogenic potential. Endo Sequence BC Sealer seems to possess all of these features: Zoufan et al. reported that Endo Sequence, both freshly mixed or set, showed lower cytotoxicity than AH Plus (Dentsply De Trey GmbH, Germany) and Tubli-seal (Kerr-Sybron Dental, Orange, CA) sealers; Candeiro et al. found Endo Sequence BC sealer less cytotoxic on human gingival fibroblasts than AH Plus but similar antibacterial effect against Enterococcus faecalis of these two sealers (24,25). Willershausen et al. showed that AH Plus and Pulp Canal sealer (Sybron Dental, Orange, CA) had an higher cytotoxicity than EndoSequence which possessed a superior antibacterial effect (26). Contrarily Loushine et al. described EndoSequence BC sealer more toxic to mouse fibroblast up to the fifth week than AH Plus .
According to the authors these results might be related to the different protocols applied (22). Lastly, EndoSequence BC sealer in vitro seemed to promote more osteoblast differentiation than MTA having potentially in vivo greater osteogenic power (27).
Cytocompatibility and osteogenic potential are important features of an endodontic sealer since the extrusion of the material over the apical foramen is common during the filling of the root canal. During this canal treatment, the extrusion of EndoSequence BC sealer over the perforation and even in the fistulous tract, as well showed in Figure 1D, did not represent a hindrance to the bone healing process.
On the one hand the extrusion of the sealer was a direct consequence of the EndoSequence flow rate that is considered acceptable and higher than AH

Figure 2
Radiographic follow-up after ***(A)*** *3,* ***(B)*** *6,* ***(C)*** *12 and* ***(D)*** *48 months, evidencing the healing of the area.*

Plus flow rate (21), on the other hand the good flow of this material makes the sealer injectable, more attractive for clinical use and leads a good sealing of the apical foramen, dentinal tubules and accessory canals (22).
In the clinical case here described the extrusion of EndoSequence was not resorbable, after four years of observation almost the same amount of sealer is visible over the apex. Many authors affirmed that the placement of MTA, similar for composition to EndoSequence, should be confined within the root canal system because the extrusion might reduce the possibility of success of the endodontic treatment (28) but, if not, case reports showed a slight reabsorption of the extrusion MTA and a favorable healing around this material (29, 30).
Concerning EndoSequence setting time, the values appear controversial. EndoSequence showed lower values of setting time (2.7 hours) than MTA Fillapex and two epoxy resin-based sealers (AH Plus and Thermaseal) (21). On the contrary Loushine et al., in absence of water, reported an initial setting time of 72 hours and a final set of 240 hours (22). The manufacturer states a prolonged setting time in case of overly dry canals but many authors point out overly water can affect the micro-hardness of the material. Moreover Charland et al. noticed EndoSequence not completely set by 48 hours in presence of blood (31). In this treatment, a week after the root canal filling, the sealer of mesio-buccal and mesio-lingual canals was completely set in the coronal visible part despite the perfect drying of the canals. Unfortunately the clinical setting was not equipped with a microscope hence the decision to use, in the mesial root and for the perforation, a silicate-calcium based sealer to get a fill for the prior to apical surgery. In this case the operator used prismatic loupes at 4X magnification, that couldn't give an ideal visualization of the perforation, during sealing procedures. The healing of the bone was reasonably due to a good sealing of the perforation and to a possible confluence of the mesial canals.

Conclusions

Although many studies demonstrated the importance of using the microscope for root canal treatments (32), this case report confirmed the handling properties of these new calcium silicate based sealers, in particular of the EndoSequence BC sealer, which allow to repair some types of perforations without the use of microscope making these complex cases more accessible to general dentists.

Clinical Relevance

This simple cold root canal filling technique with EndoSequence BC sealer and his dedicate gutta-percha cones could be a valid alternative to warm root canal filling techniques. Further clinical studies are necessary to assess efficacy of this calcium-silicate based sealer.

Conflict of Interest

All authors declare no conflict of interest.

References

1. Kakani AK, Veeramachaneni C, Majeti C, Tummala M, Khiyani L. A review on perforation repair materials. J Clin Diagn Res 2015;9(9):9-13.
2. Hashem AA, Hassanien EE. ProRoot MTA, MTA-Angelus and IRM to repair large furcation perforations: sealability study. J Endod 2008;34(1):59-61.
3. Hamad HA, Tordik PA, McClanahan SB. Furcation perforation repair comparing gray and white MTA: a dye extraction study. J Endod 2006;32(4):337-40.
4. Cosme-Silva L, Carnevalli B, Sakai VT, Viola NV, Franco de Carvalho L, Franco de Carvalho EM. Radicular Perforation Repair with Mineral Trioxide Aggregate: A Case Report with 10-Year Follow-up. Open Dent J 2016;10:733-8.
5. Kvinnslan I, Oswald RJ, Halse A, Gronningsaeter AG. A clinical and roentgenological study of 55 cases of root perforation. Int Endod J 1989;22(2):75-84.
6. Farzaneh M, Abitbol S, Friedman S. Treatment of outcome in endodontics: the Toronto study. Phases I and II: Orthograde retreatment. J Endod 2004;30(9):627-33.
7. Tsesis I, Fuss Z. Diagnosis and treatment of accidental root perforations. Endodontic Topics 2006;13(1): 95-107.
8. Himel VT, Brady J, Weir J. Evaluation of repair of mechanical perforations of the pulp chamber floor using biodegradable tricalcium phosphate or calcium hydroxide. J Endod 1985;11(4):161-5.
9. Balla R, LoMonaco CJ, Skribner J, Lin LM. Histological study of furcation perforations treated with tricalcium phosphate, hydroxyapatite, amalgam, and Life. J Endod 1991;17(5):234-8.
10. Fuss Z, Trope M. Root perforations: classification and treatment choices based on prognostic factors. Endod DentTraumatol 1996;12(6):255-64.
11. Seltzer S, Sinai I, August D. Periodontal effects of root perforations before and during endodontic procedures. J Dent Res 1970;49(2):332-9.
12. Bhaskar SN, Rappaport HM. Histologic evaluation of endodontic procedures in dogs. Oral Surg Oral Med Oral Pathol 1971;31(4):526-35.
13. Harris WE. A simplified method of treatment for endodontic perforations. J Endod 1976;2:126-34.
14. Schmidt BS, Zaccara IM, Reis Só MV, Kuga MC, Palma-Dibb RG, Kopper PM. Influence of operating microscope in the sealing of cervical perforations. J Conserv Dent 2016;19(2):152-6.
15. Levin MP, Getter L, Cutright DE, Bhaskar SN. Biodegradable ceramic in periodontal defects. Oral Surg Oral Med Oral Pathol 1974;38(3):344-51.
16. Zarrabi MH, Javidi M, Jafarian AH, Joushan B. Histologic assessment of human pulp response to capping with mineral trioxide aggregate and a novel endodontic cement. J Endod 2010;36(11):1778-81.
17. Hess D, Solomon E, Spears R, He J. Retreatability of a Bioceramic root canal sealing material. J Endod 2011;37(11):1547-9.
18. Al-Haddad A, Che Ab Aziz ZA. Bioceramic-based root canal sealers: a review. Int J Biomater 2016;2016:9753210.
19. Hess D, Solomon E, Spears R, He J. Retreatability of a Bioceramic root canal sealing material. J Endod 2011;37(11):1547-9.
20. Shokouhinejad N, Razmi H, Nekoofar MH, Sajadi S, Dummer PM, Khoshkhounejad M. Push-out bond strength of bioceramic materials in a synthetic tissue fluid. J Dent (Teheran) 2013;10(6):540-7.
21. Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Physical properties of 5 root canal sealers. J Endod. 2013;39(10):1281-6.
22. Loushine BA, Bryan TE, Looney SW et al. Setting properties and cytotoxicity evaluation of e premixed bioceramic root canal sealer. J Endod 2011;37(3): 673-7.
23. Tsesis I, Rosenberg E, Faivishevsky V, Kfir A, Katz M, Rosen E. Prevalence and associated periodontal status of teeth with root perforation: a retrospective study of 2,002 patients' medical records. J Endod 2010;36(5):797-800.
24. Zoufan K, Jianq J, Komabayashi T, Wang YH, Safavi KE, Zhu Q. Cytotoxicity evaluation of Gutta Flow and Endo Sequence BC Sealers. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112(5):657-61.
25. Candeiro GT, Moura-Netto C, D'Almeida-Couto RS et al. Cytotoxicity, genotoxicity and antibacterial effectiveness of a bioceramic endodontic sealer. Int Endod J 2015;49(9):858-64.
26. Willershausen I, Callaway A, Briseño B, Willershausen B. In vitro analysis of the cytotoxicity and the antimicrobial effect of four endodontic sealers. Head Face Med 2011;7(8):5.
27. Ryfaey HS, Villa M, Zhu Q, Wang YH, Safavi K, Chen IP. Comparison of the Osteogenic Potential of Mineral Trioxide Aggregate and EndoSequence Root Repair Material in a 3-dimensional Culture System. J Endod 2016:42(5):760-5.
28. Holland R, Bisco Ferreira L, de Souza V, Otoboni Filho JA, Murata SS, Dezan E Jr. Reaction of lateral periodontium of dogs' teeth to contaminated and noncontaminated perforations filled with mineral trioxide aggregate. J Endod 2007;33(10):1192-7.
29. Chang SW, Oh TS, Lee W, Cheung GS, Kim HC. Long-term observation of the mineral trioxide aggregate extrusion into the periapical lesion: a case series. Int J Oral Sci 2013;5(1):54-7.
30. Negmode PS, Satpute AB, Patel AV Ladhe PL. The Effect of Mineral Trioxide Aggregate on the Periapical tissues after Unintentional Extrusion beyond the Apical Foramen. Case Rep Dent 2016; 206:3590680.
31. Charland T, Hartwell GR, Hirschberg C, Patel R. An evaluation of setting time of mineral trioxide aggregate and EndoSequence root repair material in the presence of human blood and minimal essential media. J Endod 2013;39(8):1071-2.
32. Khalighinejad N, Aminoshariae A, Kulild JC, Wang J, Mickel A. The influence of Periodontal Status on Endodontically Treated Teeth:9-year Survival Analysis. J Endod 2017;43(11):1781-5.