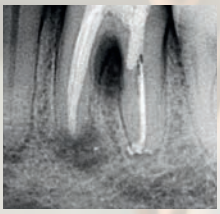
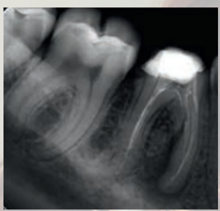
Septodont Case Studies Collection

No. 22 - January 2022

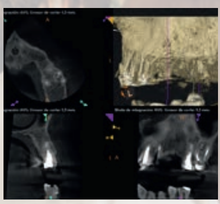
Management of complex root perforations



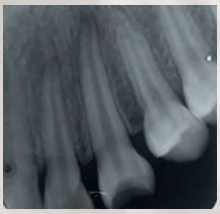
Success of endodontic retreatment



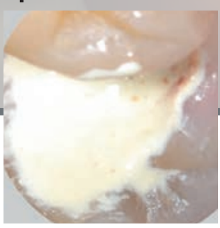
Conservative approach in patient with multiple periapical radiolucent lesions



Apical plugs used in apexification procedures



Full Pulpotomy in Mature Permanent Teeth with Irreversible Pulpitis and Apical Periodontitis



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Editorial

Septodont created the *"Septodont Case Studies Collection"* - a series of case reports - in 2012 to share with you their experience and the benefits of using these innovations in daily practice. Over the past years, authors from more than 15 countries have generously contributed to the success of our magazine that is now distributed on the 5 continents.

Each new issue of the Case Studies Collection is the opportunity to discover new clinical challenges and their treatment solutions. The 22nd issue features **1 case for BioRoot™ RCS and 4 cases for Biodentine™**:

- BioRoot™ RCS is the paradigm for endodontic obturations. Its outstanding sealing properties combined with anti-microbial and bioactive properties allow to get a high seal of the endodontium without having to use complex warm gutta techniques.
- Biodentine™, the first biocompatible and bioactive dentin replacement material. Biodentine™ uniqueness not only lies in its innovative bioactive and "pulp-protective" chemistry, but also in its universal application, both in the crown and in the root.

The cases are written by the practitioners, the products' application in every case is under the responsibility of the author. Septodont reminds that every product has an official indication, available in the product's information notice.

Content

Biodentine™ in the management of complex root perforations

Dr. Clara Eugenia Adrada Cruz
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Introduction

Endodontic therapy seeks to conserve natural teeth. Accidents during this procedure are quite common, which affects the prognosis of root canal therapy.

Iatrogenic perforations occur during the formation of the root canal, but are more common during access and apical shaping, particularly in curved canals (2). Likewise, they can occur when creating the space for the placement of an intraradicular post.

The communication between the root canal system and the supporting tissue reduces the prognosis of endodontic treatment, and often leads to the loss of the tooth. Ingle et al found that the second most common reason for failure associated with endodontic therapy is root perforation (2).

Several clinical findings may be determining factors in the diagnosis of root perforations. Clinical examinations and radiographs are the basis for the diagnosis of these perforations (2,3).

During the preparation of the root canal, the root pulp can be extracted by pulpectomy. After removing the pulp tissue, persistent bleeding during access to the crown or the preparation of the root canal can be a sign of perforation. A paper point with blood can also suggest perforation. Clinically, the diagnosis is challenging (3), but an apex locator can help in the diagnosis of root perforation.

Periapical radiographs are often indicated for endodontic diagnosis, the treatment plan and follow-up (5). Radiolucency associated with communication between the dentinal root canal walls and the periodontal space is a major sign of this accident during the procedure.

The prognosis of perforation depends on the size of the defect, the time, the duration of exposure to contamination, the material used to repair it, the possibility of sealing the perforation, and access to the main canal (4).

To minimize contamination in the area of the perforation, it is important to apply suitable sealing immediately (2). The success of the repair always depends on an effective seal between the root canal and the periodontal ligament. This can be achieved using suitable material, which should stop microfiltration and the communication between the tooth and the periodontal ligament. The ideal material for use in root perforations should be biocompatible, capable of a good seal, not resorbable, radiopaque, induce bone formation and healing, induce mineralization and the formation of cementum, and facilitate ease of placement (11).

Case report

Sixty-year-old male patient referred to the endodontist for a periodontal abscess in the vestibular mucosa of the lower left first molar.

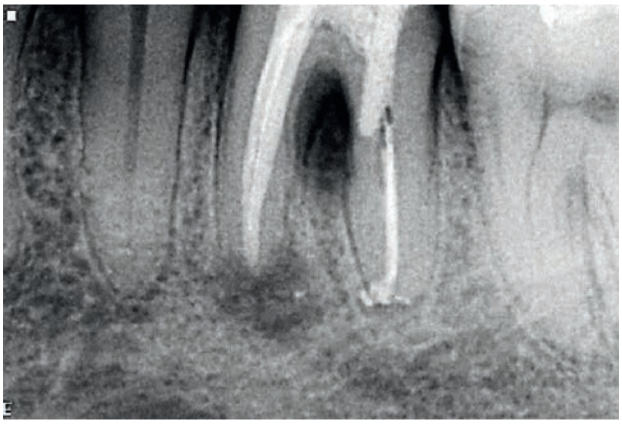
Radiographically, the patient presents a radiolucent zone at the level of the furcation, and a tooth skewed towards the internal wall of the distal root, apparently producing a perforation in the cervical third of the distal root towards the zone of the interradicular furcation.

Local anesthesia is injected into the lower dental nerve and the mental nerve. Removal of provisional crown. Removal of titanium post with No. 3 Start-X Denstply ultrasonic tips.

Once the provisional crown is removed, it is observed under the microscope that purulent material spontaneously seeps out of the perforation site.

We are faced with a perforation of poor prognosis, due to its size comparable with the diameter of the tip of the post, with a width of 2 mm and a long period of contamination equivalent to 3 years, the time since the cementation of the tooth.

The presence of a bone defect adjacent to the site of the perforation and leakage of purulent material indicates a chronic infection with a poor prognosis. The perforation is located in the cervical third of the root, where it can only be observed under magnification. Irrigation is



done with 2% hypochlorite, initially only introducing the needle into the entrance of the canal to avoid accidents. The real entrance of the canal was located under microscope, to eliminate guttapercha, xylol was used.

Thanks to help of the microscope, we place the rotary file in the distal canal, taking care not to touch the perforation site. Instrumentation was done with Protaper Next Dentsply files. Disinfection was done with 2% hypochlorite using an Endoactivator. The calcium hydroxide matrix was placed in the perforation site. In a second visit, we sealed the perforation with Biodentine™ using micro condensers of Marthe's instrumental, while we leave some taperized guttapercha cones No. 25 cut into canals to prevent the entry of Biodentine™ into the canals. Perforations caused by wear and tear are characterized by the need to place the sealing material directly on the periodontal tissue and extend the obturation 1 to 2 mm from the edges of the perforation on the dentin. When a clinical microscope cannot provide sufficient visibility there is a risk of not applying the material correctly (8).

The initial setting time is 6 minutes and the final time between 10 and 12 minutes, followed by 2% hypochlorite as an irrigant and sealing the canals by lateral condensation *(Fig. 1)*.

The patient is then referred to the rehabilitation specialist for the placement of the core and provisional crown, and a period of 3 months is established to evaluate the evolution and be able to recommend the placement of a porcelain crown.

In the follow-up radiograph at 3 months, 80% bone formation is found at the site of the lesion at the furcation, and in the apical zone of the two roots *(Fig. 2)*.

The patient is absent for a period of 5 years. when he returns for his dental control, radiographically he presents a complete healing of the bone defects caused by the perforation and the apical lesions *(Fig. 3)*.

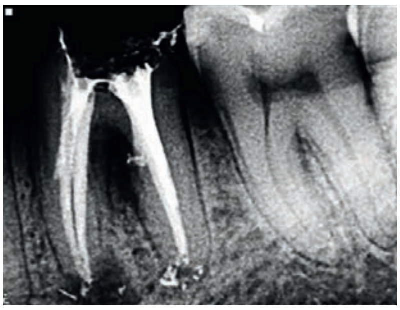


Fig. 1

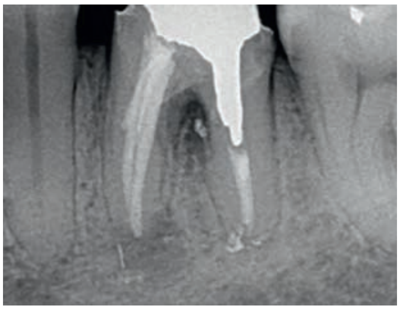


Fig. 2

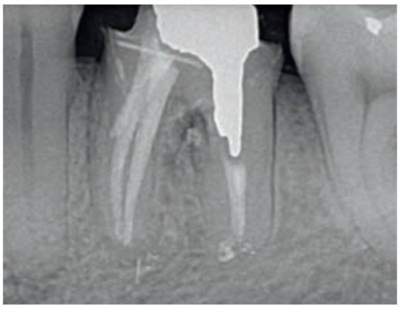


Fig. 3

Discussion

A microscope is essential to try and treat procedural errors in the best possible manner. We need to see what we are going to seal (9).

A range of materials such as composite resin, 4-ethoxybenzoic acid, resin-reinforced glass ionomer cement, calcium hydroxide, gutta-percha, MTA and Biodentine™ are the most commonly used repair materials(1).

When the use of MTA was introduced as an alternative for perforation repair it offered very favourable properties compared with previous materials. Its ability to induce the formation of cement to regenerate periodontal tissue was also a step forward (2).

Advances in bioceramic technology have improved the science of endodontic materials. Biodentine™ is used in dentistry as an alternative to MTA to try and offset the latter's deficiencies. Biodentine™ is a bioactive material that can be used for different purposes, and represents an improvement on the characteristics of MTA in terms of compatibility, manipulation and hardening (11, 12). It also offers better bone regeneration properties than MTA, as it releases more calcium ions(12). This material creates a bond with root dentin that is significantly stronger than that achieved with MTA (14).

At sites that are difficult to access we need to compensate by using easy-to-handle material with good osteo-inductive properties, to be able to apply it at the perforation site.

Specifically at the perforation site, where contamination with tissue fluids is present, Biodentine™ is a good choice because the blood contamination that can occur when placing it in the site does not affect its adhesive strength, whereas MTA is affected by blood contamination (13).

Furthermore, in this type of perforation, located in roots that will receive a core, the material used for sealing should be of high compressive strength. Biodentine™ has greater compressive strength than other materials as a result of the low level of water used in it. It also performs well as a perforation repair material, even after exposure to different irrigants used in endodontics.

Conclusion

- The use of magnification in endodontic therapy has proved very useful for an operator to develop his/her skills to the maximum and offer higher quality and greater precision in treatments. If we add the use of bioceramics such as Biodentine™ in the sealing of perforations, the operator can turn a poor prognosis into a good one.

- Bioceramics have osteo-inductive properties (10) that older materials did not offer, and Biodentine™ has better physical and biological properties in comparison with MTA, which makes it more useful in handling root perforations than other cements. As well as having very good biological properties, placement at the perforation site is very simple, which reduces operative time.

- An old and large perforation, with the associated destruction of bone and purulent infection -variables that produce a poor prognosis- can be solved by using a material that performs well in the presence of blood contamination, has good compressive strength and resistance to leakage, is osteo-inductive and offers good adhesion to the dentin in a single cement: Biodentine™.

- Thanks to advances in contemporary endodontics, we can now save teeth that previously had poor prognosis and could not be saved.

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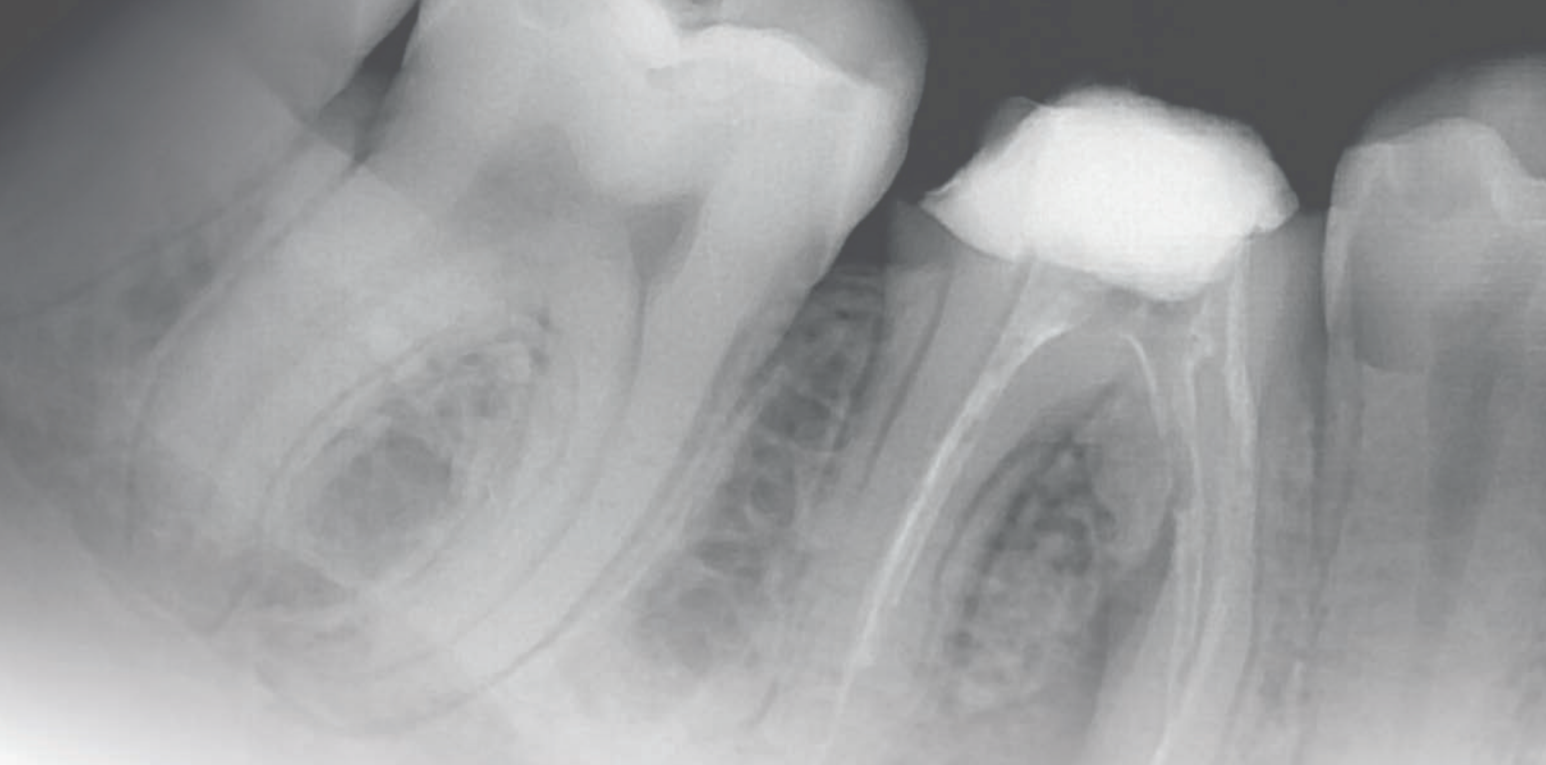
Biodentine™

Biodentine can be used both in the crown and in the root:

In the crown: temporary enamel restoration, permanent dentin restoration, deep or large carious lesions, deep cervical or radicular lesions, pulp capping, pulpotomy (reversible and irreversible pulpitis).

In the root: root and furcation perforations, internal/external resorptions, apexification, retrograde surgical filling.



Success of endodontic retreatment using BioRoot™ RCS and single cone technique: a case report

Prof. Dr. André Luiz da Costa Michelotto

Summary

Introduction: The aim of the present study was to describe a case of endodontic retreatment in a mandibular molar with symptomatic apical periodontitis.

Methods: The treatment was carried out using contemporary techniques and a simple endodontic obturation with BioRoot™ RCS bioceramic endodontic sealer (Saint Maur Des Fosses, France).

Discussion: Bioceramic endodontic sealers have several advantages, including properties such as biocompatibility and bioactivity, stimulating bone formation. In cases of apical periodontitis, it is convenient to use a material with these characteristics. With the development of these sealers, a simple endodontic obturation can be used. Thus, in this case report, the single cone technique associated with a bioceramic sealer was used to perform the obturation of the root canal system.

Conclusion: The obturation with the single cone technique associated with BioRoot™ RCS bioceramic sealer provided success in the case of symptomatic apical periodontitis, with extensive bone loss.

Introduction

The objectives of endodontic treatment are the prevention and treatment of apical periodontitis. Maximum amount of organic, live, or decomposed substrate and microorganisms must be eliminated to achieve the root canal system disinfection. (1) It is essential for the success of endodontic treatment that all steps are performed correctly, and an error in one of them can lead to failure.

The final goal of endodontic therapy is to obtain a endodontic obturation that allows tridimensional sealing of the root canal system, using a nonirritant material to support periapical healing. Currently, endodontic sealers with bioactivity deserve special mention, that is, the ability to stimulate repair and deposition of mineralized tissue. Among these sealers it is possible to highlight BioRoot™ RCS, developed by Septodont (Saint-Maur-des-Fossés, France), based on calcium silicate and which presents zirconium oxide as a radiopacifying agent. Its components exhibit high purity and presentation in powder-liquid form. The development of these new sealers, whose physical-chemical properties improve in the presence of moisture and involve chemical adhesion to dentin (2,3) helped to popularize the single cone technique. This technique, with greater taper gutta-percha cones, made filling the root canals a faster and simpler procedure, while minimizing the forces applied to the root canals walls by the spreaders, without decreasing the quality of the apical sealing. (4) The reported results are similar to the classic techniques of lateral compaction and vertical compaction, either in relation to the percentage of voids volume (5) or to the depth of penetration of sealer into the dentinal tubules. (6) The obturation technique with a single cone basically consists of the insertion of a single cone in the root canal, usually of the same diameter and taper of the last instrument used for the apical preparation and thus adapted to the anatomical configuration of the prepared canal, associated with an endodontic sealer.

Therefore, the aim of this report was to present the diagnosis and endodontic management of a retreatment clinical case of permanent mandibular first molar with apical periodontitis, by using BioRoot™ RCS sealer and a single cone technique for the root canal system obturation.

Case report

The patient, a 32-year-old Caucasian woman was referred for endodontic retreatment of tooth 46. She was undergoing endodontic retreatment, but as the tooth remained sensitive, the dentist preferred refers the patient to another professional. Radiographic examination revealed the presence of remnant of filling material and extensive periapical lesion in the mesial root ***(Fig. 1)***. On clinical examination, the tooth was symptomatic, with spontaneous, moderate, and controlled pain

Fig. 1: Pre-operative radiograph. Note periradicular lesion in the mesial root.

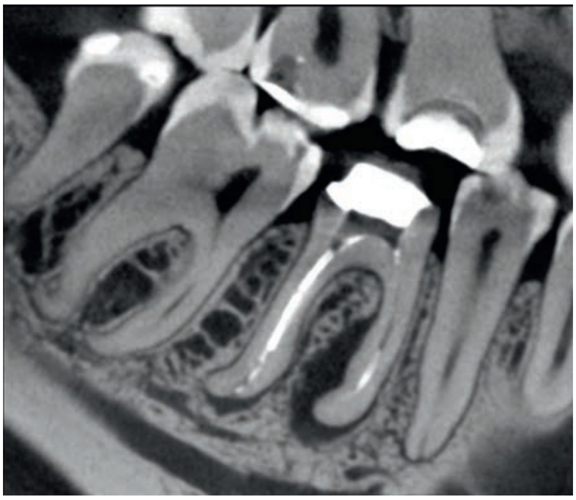


Fig. 2: CBCT sagittal image.

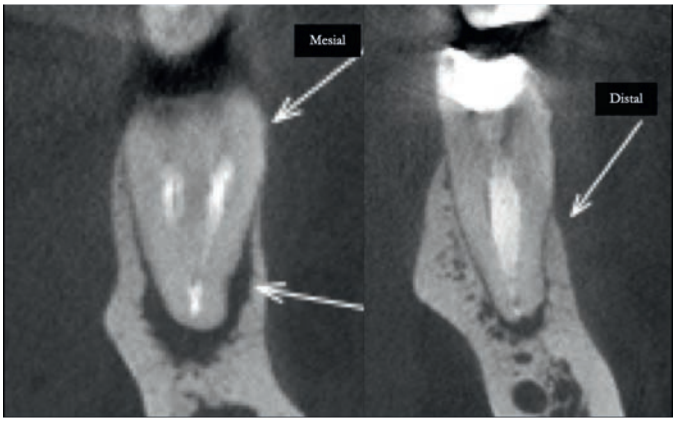


Fig. 3: CBCT coronal images.

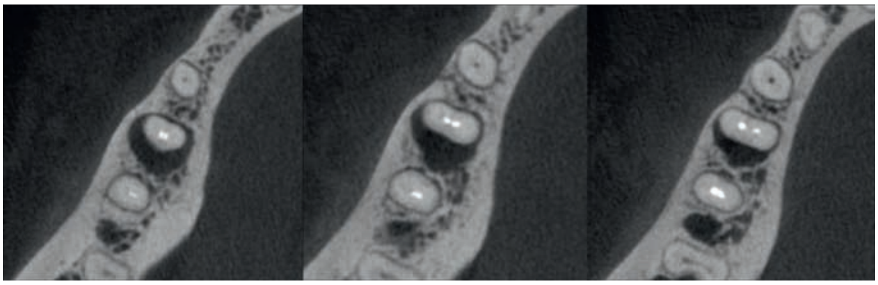


Fig. 4: CBCT axial images.

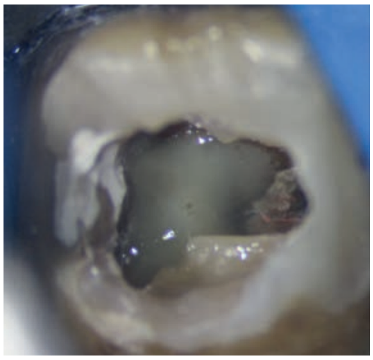


Fig. 5: After temporary filling removal, presence of purulent secretion.

with analgesic medication, characterizing as a diagnosis a symptomatic apical periodontitis. To establish a treatment plan and rule out the presence of crack in the mesial root, which would be suggestive depending on the aspect and extent of the lesion around the root, a CBCT (Prexion Elite, Tokyo, Japan) was requested. The scanning parameters were 90KVp, 5mA, a spatial resolution of 150 µm and a field of view of 50 x 50 mm. The tomographic image showed an extensive lesion in the mesial root and a smaller area of bone rarefaction in the distal root ***(Fig. 2, 3, 4)***. The presence of crack was discarded. From these data, it was proposed for the patient to continue the endodontic retreatment.

During the first visit, an inferior alveolar nerve block followed by buccal infiltration was performed with epinephrine 1: 100 000 and with 2% mepivacaine (Mepivalem AD, DLA Pharmaceutical, São Paulo, Brazil). The tooth was isolated with a rubber dam and the temporary restoration was removed with a round high-speed diamond bur (1014, KG Sorensen, Cotia, Brazil). After this, a little purulent collection was drained ***(Fig. 5)***. The four root canals were negotiated with C-Pilot # 10 and # 15 (VDW Dental, Munich, Germany) and the instrumentation was performed with NiTi CM Pro-T system (MK Life, Porto Alegre, Brazil) ***(Fig. 6)***. The canals were copiously irrigated with 2.5% sodium hypochlorite (8 mL per root

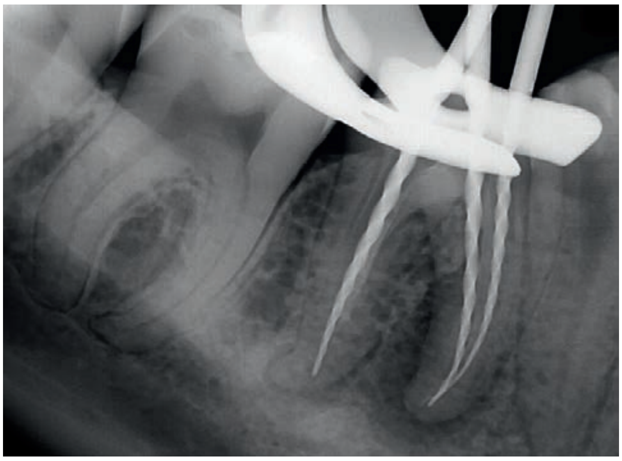


Fig. 6: Rx with Niti CM instruments after root canal preparation. The foraminal exit of the distal root does not coincide with the radiographic apex.

canal) and a final rinse with 17% EDTA for 3 min was performed before drying the canals with matched paper points # 30 (VDW Dental, Munich, Germany). An ultrasonic tip (Irrisonic, Helse, São Paulo, Brazil) was used to agitate the irrigating solution, with 3 cycles of 20 seconds for each solution. An intracanal dressing with calcium hydroxide paste (UltraCal XS, Ultradent) was applied for 30 days. The entire procedure was performed under an operating microscope.

In the second visit the tooth was without symptoms. The root canals were irrigated in the same way as in the first visit. After drying with paper points, the root canals were filled with gutta-percha and BioRoot™ RCS sealer (Septodont, Saint-Maur-des- Fossés, France) by using the single cone technique ***(Fig. 7, 8, 9, 10)***.

The patient considered continuing the prosthetic procedure only after the success of the endodontic treatment was confirmed. A 5-month follow-up CBCT was taken showing total repair in the distal root and in final stage in the mesial root ***(Fig. 11, 12, 13)***. A 7-month follow-up X-ray was taken, showing the presence of a filling core with fiber post, suggesting normal periapical tissues and the patient presents without symptoms ***(Fig. 14)***.

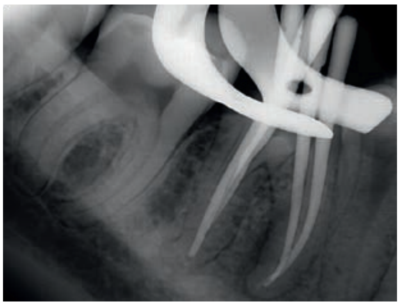


Fig. 7: Gutta-percha master cones fitted to length.

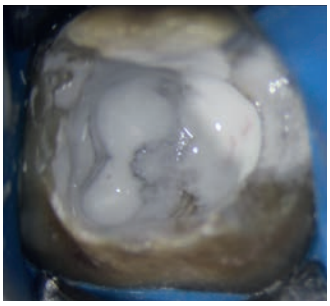


Fig. 8: Image after cutting the gutta-percha cones showing the BioRoot™ sealer.

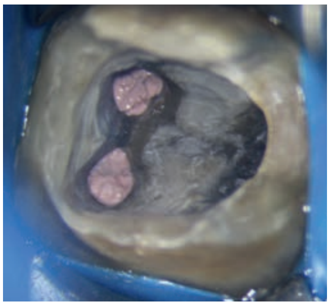


Fig. 9: Access cavity cleaned.

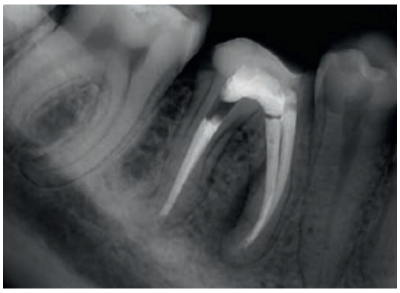


Fig. 10: Post-operative radiograph.

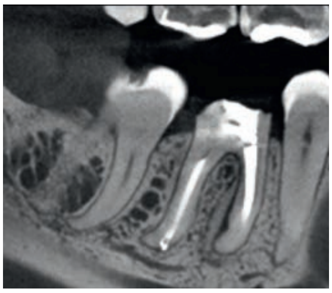


Fig. 11: CBCT sagittal image (5-month follow-up).

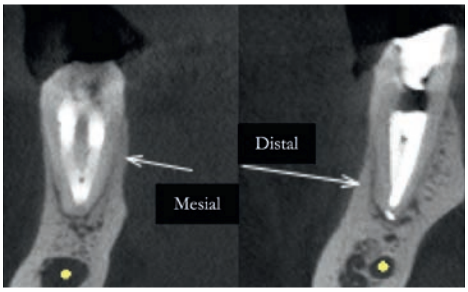


Fig. 12: CBCT coronal images (5-month follow-up).

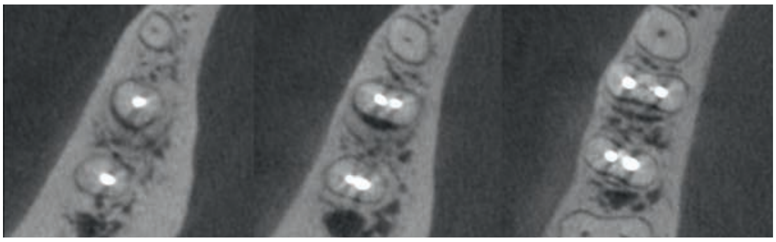


Fig. 13: CBCT axial images (5-month follow-up).

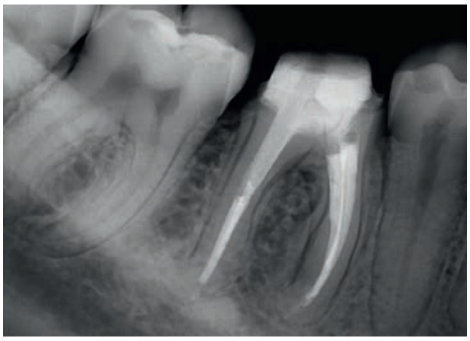


Fig. 14: 7-month post-op showing complete periapical healing.

Discussion

Correct cleaning and complete instrumentation of root canals are the factors that influence the success of endodontic therapy. Regarding the clinical management of the root canal system, the literature reports the importance of resources such as computed tomography for diagnosis, microscopic magnification, and the use of ultrasonic tips. In addition, preparation with rotatory NiTi systems is indicated, mainly due to the curvatures that may be present these root canals. All these resources were used in the present clinical case.

The final goal of endodontic therapy is a root canal filling that allows impermeability of the system with a non-irritant material that stimulates periapical healing (7). Gutta-percha associated with a sealer has been considered the choice material due to good tissue tolerance, good adaptation to root canal walls, satisfactory dimensional stability, radiopacity and easy removal. Currently, bioceramic endodontic sealers have been a material of choice mainly due to their bioactive property, inducing proliferation and binding of cells close to cement and have the potential to induce angiogenesis and osteogenesis, which are prerequisites for the regeneration of periapical tissues. (8)

BioRoot™ RCS has been increasingly popular since its introduction and has become one of the materials of choice in cases of open apices and extensive periapical lesions (9). Its popularity is due in large measure to its excellent biocompatibility, remarkable sealing properties, hydrophilicity, and its capacity to promote both healing and tissue mineralization (10,11). Due to these excellent properties, a simplified technique can be used to fill the root canals. The single cone technique, using cones with greater taper, can be applied in most cases, and because it is simple to perform, it facilitates and optimizes this step.

The biocompatibility of the sealer is also apparent in this case: despite the puff that were produced in the distal root canal, the patient remained completely asymptomatic. In addition, the repair that occurred after 5 months shows its bioactive potential by stimulating bone neo-formation. The success observed in the present clinical case shows that the use of BioRoot™ RCS endodontic sealer with a single cone technique is an excellent option for filling the root canal system.

Conclusion

The endodontic obturation performed with BioRoot™ RCS bioceramic sealer combined with the single cone technique, allowed to achieve success in endodontic retreatment in a case of symptomatic apical periodontitis with extensive bone loss.

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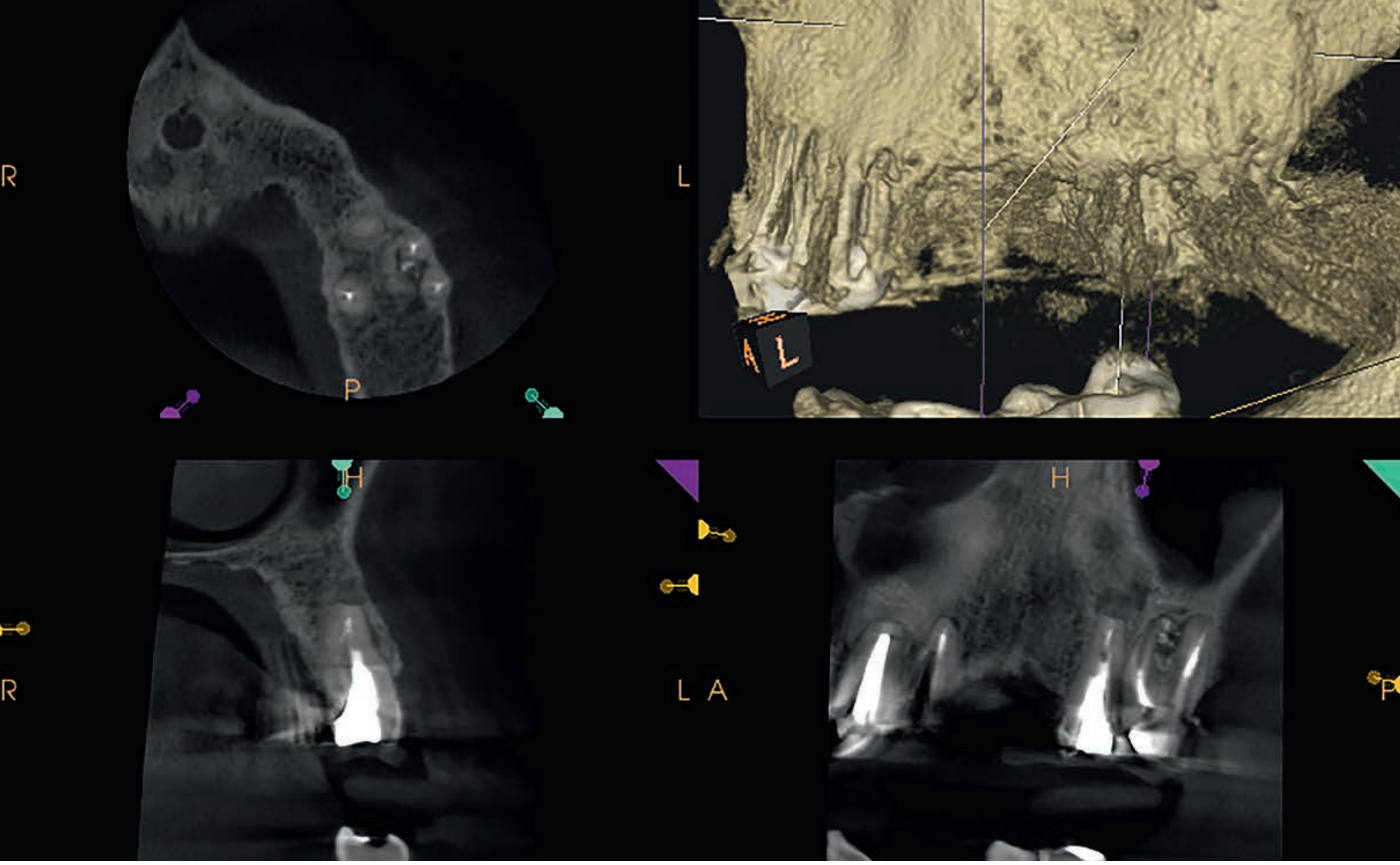
BioRoot™ RCS

Indications: Permanent root canal filling in combination with gutta-percha points in case of inflamed or necrotic pulp.
Permanent root canal filling in combination with gutta-percha points following a retreatment procedure.
BioRoot™ RCS is suitable for use in single cone technique or cold lateral condensation.



Conservative approach in patient with multiple periapical radiolucent lesions: Combined endodontic-surgical approach

Authors: Dr. Grano de Oro Cordero, Eugenio C. & Dr. Galán Hernández, Ramón J.

Summary

In this case report we present a 43-year old male patient with multiple periapical radiolucent lesions caused by endodontic failure in teeth supporting a metalloceramic prosthetic rehabilitation, who came to the office asking for any possibility of mantaining his teeth.

After clinical and radiological exploration with periapical x-rays and cone beam computer tomography (CBCT), we decided to use a combined endodontic-surgical approach.

Clinical evolution was favourable, and radiographs and CT scans showed complete healing of periapical radiolucent lesions.

Endodontic retreatment combined with periapical microsurgery are effective tools for conservative treatment in teeth with periapical lesions caused by endodontic failures.

Case report

A 43 year old male patient, with no relevant medical history, presenting prosthetic fixed rehabilitation with intraradicular posts and metal-ceramic crowns from upper right first molar (16) to upper left first molar (26), came to the office due to recurrent infections and fistulas in his anterosuperior teeth and upper left posterior area. The patient asked for the possibility of preserving his teeth, as the treatment previously proposed to him consisted on the removal of all the teeth followed by the placement of implants. The patient provides orthopantogramography (OPG) *(Fig. 1)*. Periapical radiographs were taken *(Fig. 2 and 3)* together with clinical examination including periodontal exploration of the affected teeth, without observing increased probing depths that could indicate endoperiodontal lesions.

To confirm the endodontic origin and the size of the lesions, tomographic explorations were made (voxel size: 75 microns) using CBCT CS8100 (Carestream Dental®), which revealed radiolucent periapical lesions on upper right lateral incisor (12), upper right central incisor (11), upper left central incisor (21) with bicortical deffect, upper left second premolar (25) and vestibular roots of 26 *(Fig. 4 to 8)*.

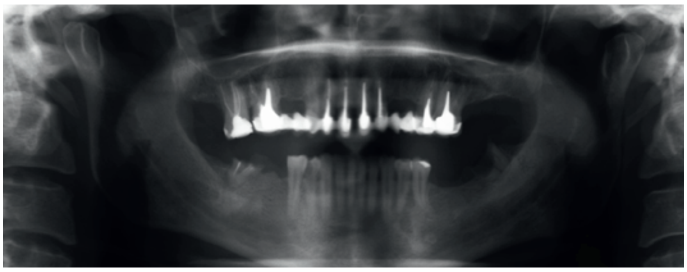


Fig. 1: Orthopantomography provided by the patient at the first visit.

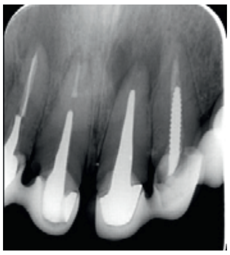


Fig. 2: Upper incisors preoperative periapical radiograph.

Fig. 3: Upper left second premolar and first molar preoperative periapical radiograph.

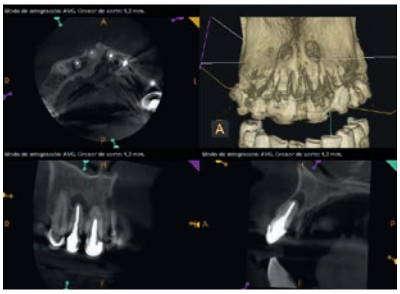


Fig. 4: Upper right lateral incisor preoperative CBCT image.

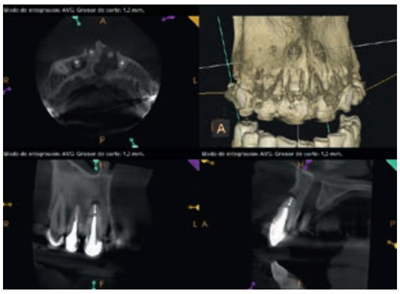


Fig. 5: Upper right central incisor preoperative CBCT image.

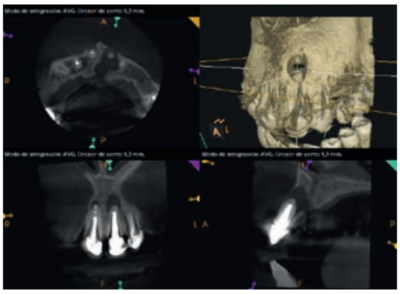


Fig. 6: Upper left central incisor preoperative CBCT image. Note the bicortical extension of the lesion and its relation with the nasopalatal canal.

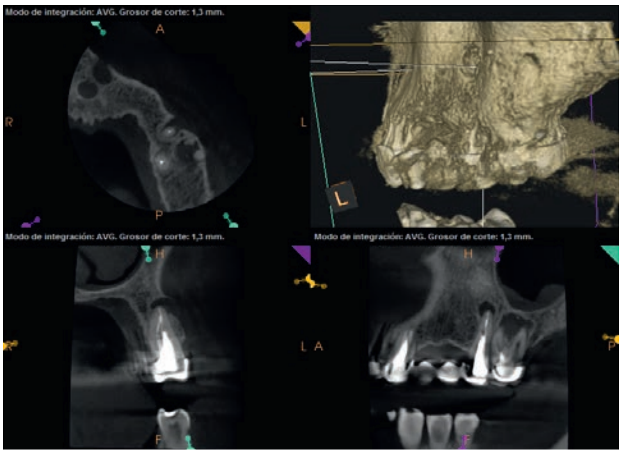


Fig. 7: Upper left second premolar and first molar preoperative CBCT image.

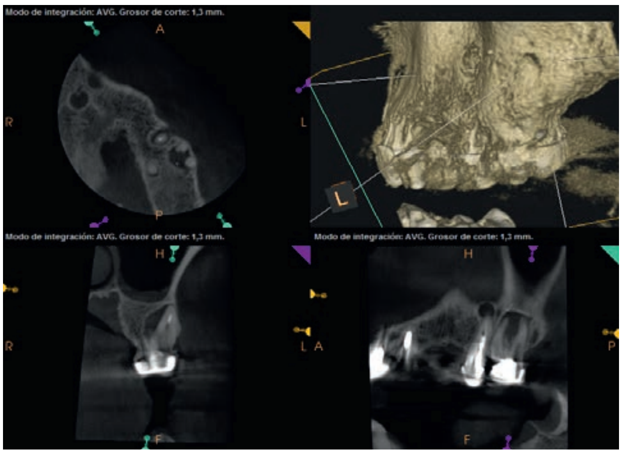


Fig. 8: Upper left first molar preoperative CBCT image. Note subobturation at mesiobuccal and distobuccal canals.

The patient was informed about the prognosis of his teeth, and we obtained his consent to perform apical microsurgery on the three affected upper incisors, as well as to use guided bone regeneration techniques in 21.

Furthermore, 26 showed clearly poor root canal treatment on booth buccal roots, which were some millimetres subextended. An omitted mesiopalatal (MB2) root canal was present. It was explained to the patient that these roots needed endodontic retreatment before to perform microsurgery on 25 *(Fig. 9)*.

Periapical microsurgery was performed on upper incisors using an operating microscope (Kaps™). Access to the apical lesions was gained through a modified Neumann flap. Once these lesions were eliminated using excavators and Gracey curettes, apicoectomies were performed resecting 3 mm on each root, followed by 3-mm-deep retrocavities using ultrasonic tips (Newtron®, Satelec) filled with a bioceramic cement (Biodentine™, Septodont). Moreover, a collagen membrane (Bioguide®, Geistlich) was placed on 21 at the palatal bottom and the defect was filled with porous bone substitute material of bovine origin (BioOss®, Geistlich). Another collagen membrane was placed at the buccal aspect before suturing the flap with simple stitches using polyamide 5/0 monofilament (Supramid®, Braun).

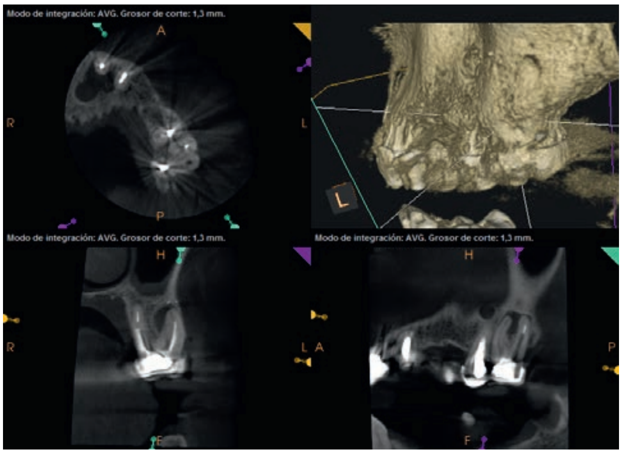


Fig. 9: Upper left first molar MB preoperative CBCT image where omitted MB2 root canal can be seen.

The next step was the endodontic retreatment of the buccal root canals on 26. Coronal access through the crown eliminating part of the core was performed to locate the omitted MB2 root canal and to desobturate mesiobuccal (MB) and distobuccal (DB) root canals. After cleaning and shaping, the three canals were obturated with bioceramic sealer (BioRoot™ RCS, Septodont) and gutta-percha.

The patient attended for recall six months later without symptoms at any treated teeth. Periapical radiographs revealed a reduction in the size of the pre-existing periapical radiolucent lesions *(Fig. 10 and 11)*. As the lesion in 25 still had to be treated, a CBCT scan was done to confirm the improvement of 26 *(Fig. 12)*, so microsurgery on 25 was programmed.

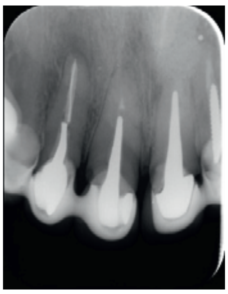


Fig. 10: 6 months control periapical radiograph after upper incisors microsurgery.

Fig. 11: 6 months control periapical radiograph after upper left first molar root canal retreatment.

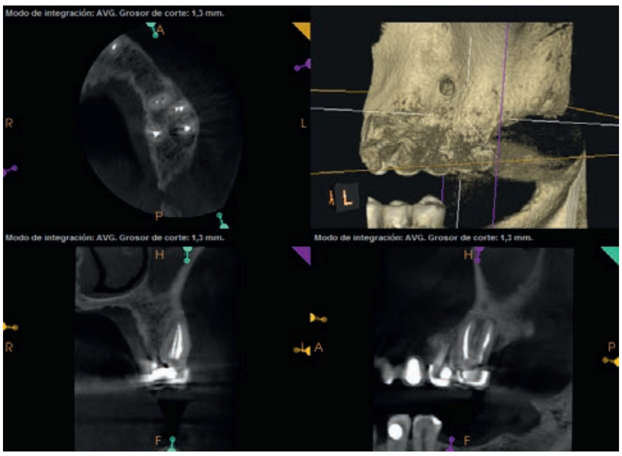


Fig. 12: 6 months control CBCT image after upper left first molar retreatment, which shows a clear reduction in the size of the previous periapical radiolucent lesion.

Once microsurgery on 25 was done, patient did not present any symptoms and CBCT scans at 12 months (in 25) and at 18 months on the remaining teeth showed the regeneration of the previous periapical radiolucent lesions in all the teeth treated *(Fig.13 to 16)*.

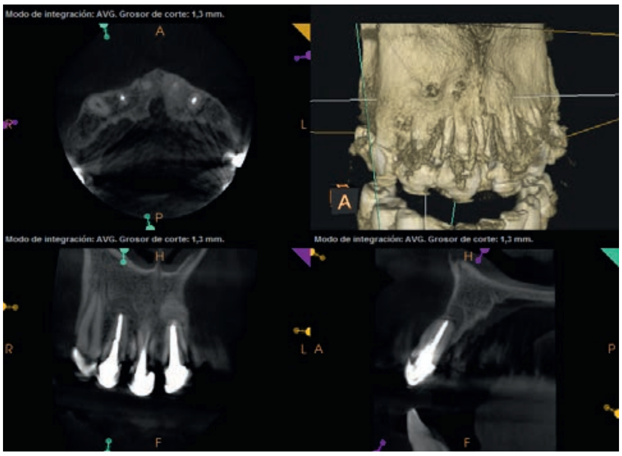


Fig. 13: 18 months control CBCT image of upper right lateral incisor after periapical microsurgery, showing complete healing of the previous periapical radiolucent lesion.

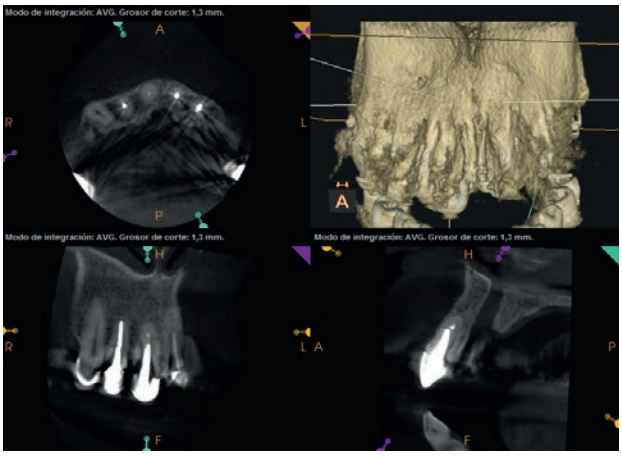


Fig. 14: 18 months control CBCT image of upper right central incisor after periapical microsurgery, showing complete healing of the previous periapical radiolucent lesion.

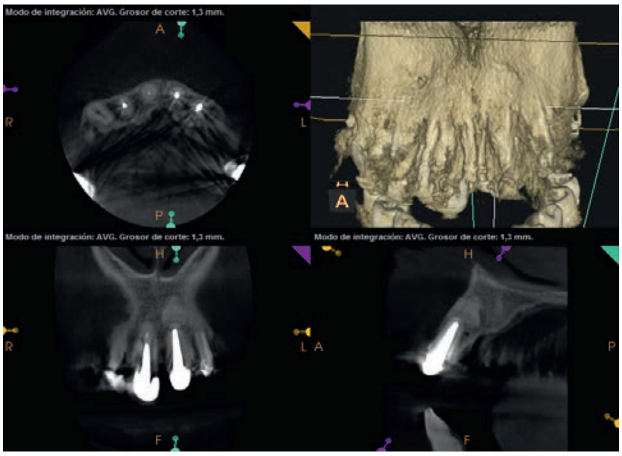


Fig. 15: 18 months control CBCT image of upper left central incisor after periapical microsurgery with guided bone regeneration, which shows healing of the previous periapical radiolucent lesion.

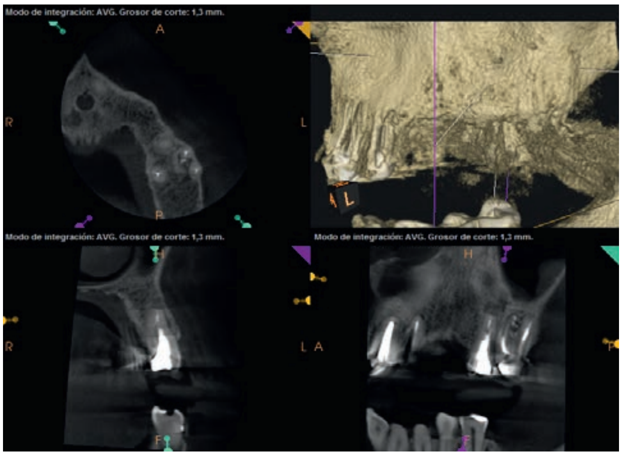


Fig. 16: 12 months control CBCT image after upper left second premolar after periapical microsurgery, which shows healing of the previous periapical radiolucent lesion.

Discussion

Good quality radiological images that show periapical radiolucent lesions location and real size are a key factor to make properly diagnosis. In our case, the patient provided an orthopantomography. This radiograph is not suitable for diagnosis in endodontics. Periapical radiographs show better definition, especially at the anterior teeth, presenting less distortion. Currently, CBCT scan is the most reliable radiology image, as it provides three-dimensional information that allows more precise diagnosis.[1, 2]

When there are failures in teeth with several previous treatments, as in the case described, it is important to perform diagnosis from a multidisciplinary point of view. A periodontal examination using a probe is essential to discard endoperiodontal lesions of periodontal origin, and also vertical fractures.[3]

Conservative treatment options in endodontic failures are non-surgical root canal retreatment and periapical surgery. Several studies have shown similar success rates (around 75%) with both treatments, so the choice between one or the other should be based on other aspects such as ease of access through the crown or root canal obturation quality on the previous endodontic treatment. [4, 5]

Removal of intracanal posts in the single-rooted teeth in our case, would have meant weakening the remaining tooth under the ceramometalic crowns. This was our main reason to decide to perform periapical surgery on these teeth. However, 26 showed some milimetres subobturated buccal roots, and CBCT scan also showed the presence of an omitted MB2 root canal, so we preferred non-surgical root canal retreatment for this tooth.

Authors such as Kim and cols. highlight the importance of some aspects of the current surgical techniques in relation to the traditional periapical surgery, such as the performance of 3-mm apicoectomy without bevel, apical retropreparation with ultrasonics and retrograde filling with bioceramic materials. Overall, the operating microscope is the most important tool that has led to a great improvement in the prognosis of these treatments. [6]

When we perform combined endodontic-surgical treatments, one of the factors to be considered is the need to apply, or not, combined techniques of guided bone regeneration (GBR). [7]

As in other reconstructions of maxillomandibular bone defects, we need to know if the defect has a critical size or not. [8,9] In the first ones, spontaneous regeneration by the patient will not take place, while in the second ones regeneration of the defect could occur under the right conditions. Among these conditions, the following factors should be present: [10]

- Maintenance of the volume of the defect we wish to regenerate.
- Presence of a stable clot inside this volume, which allows its organization and the migration of osteoblasts.
- Avoid invasion of fibroblasts or soft tissue around the area to be regenerated.

Another characteristic to determine the regeneration possibilities of the periapical bone defect is the number of walls affected by the infection. The same degree of spontaneous recovery cannot be expected if there are several walls bone defects, despite correct apical sealing and eliminating associated inflamed tissue, compared with single wall bone defects. [11]

In our case, we find different situations regarding periapical lesions, as these affect several teeth with different anatomies and different levels of failure in previous treatments.

In teeth 12, 11 and 25 the bone defect is small (estimated at 0.2, 0.03 and 0.05 cm^3 respectively) with the absence of only one wall. After removing the inflammatory tissue, they present a favourable condition for spontaneous regeneration, so the most reasonable approach was not to use biomaterials to improve bone regeneration.

On the other side, the initial situation of tooth 21, with a 0.35 cm^3 defect affecting both buccal and palatal walls and reaching nasopalatal pedicle, led us to consider a different approach. In this type of bone defect, the cavity generated after the removal of the apical lesion tends to collapse more easily than those at 12, 11 and 25, where there is no possibility of invasion by fibroblasts from the palatal side.

In tooth 21, after performing apicoectomy and apical sealing of root canal with Biodentine™ (Septodont), we applied complementary GBR techniques to maintain volume, using resorbable collagen membranes (Bio-Gide®, Geistlich) to avoid soft tissue invasion on both buccal and palatal sides, and filling the cavity with 0.5 gr of porous bone substitute material of bovine origin (Bio-Oss®, Geistlich) to avoid the collapse of the collagen membrane and to act as osteoconductive material. [12]

The patient was asked to recall at 6, 12 and 18 months, observing an absence of symptoms. CBCT images showed complete periapical healing, as well as stability in apical bone regeneration. Periapical radio-opaqueness was observed at 21 without loss of volume, and no invasion of the space preserved by the surrounding soft tissue. Although some authors have used plasma rich in growth factors (PRGF) associated with Bio-Oss® and Bio-Gide® in similar cases, we achieved a satisfactory result without applying PRGF as a complementary technique.[13] Regarding the remaining periapical lesions, due to their size they presented favourable spontaneous regeneration, proving that it is not necessary to carry out GBR on small-sized lesions that do not present tunnel defects, as other authors comment.[7,14]

Conclusion

1. Endodontic retreatment combined with periapical microsurgery are effective tools in the conservative treatment of periapical lesions of endodontic origin.
2. Multidisciplinary diagnosis is a key factor to determine the most suitable treatment in each case.

Clinical relevance

Advances in diagnosis and treatments in the field of endodontics and periapical surgery enable a conservative approach to manage lesions of endodontic origin, allowing preservation of teeth and recovery of bone lost.

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This article won the 1st position on Sanitas Dental Star

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Biodentine can be used both in the crown and in the root:

In the crown: temporary enamel restoration, permanent dentin restoration, deep or large carious lesions, deep cervical or radicular lesions, pulp capping, pulpotomy (reversible and irreversible pulpitis).

In the root: root and furcation perforations, internal/external resorptions, apexification, retrograde surgical filling.

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Indications: Permanent root canal filling in combination with gutta-percha points in case of inflamed or necrotic pulp.
Permanent root canal filling in combination with gutta-percha points following a retreatment procedure.
BioRoot™ RCS is suitable for use in single cone technique or cold lateral condensation.

Comparison of MTA and Biodentine™ apical plugs used in apexification procedures: a clinical study

Authors: Dr. María Monsreal-Peniche, Dr. Marco Ramírez-Salomón, Dr. Elma Vega-Lizama, Dr. María López-Villanueva, Dr. Gabriel Alvarado-Cárdenas, Dr. Cemil Yesilsoy, Dr. Oscar Bolaños, Dr. Gabriela Martin

Abstract

Objective: Apexification represents an alternative treatment option for the management of immature permanent teeth with necrotic pulp. The aim of the present study was to compare clinical outcomes of MTA and Biodentine™ apical plugs in apexification procedures.

Design: Twenty-six teeth with immature apices and necrotic pulps from different patients were selected for apexification treatment. In the first appointment, after irrigation with 5.25% sodium hypochlorite and EDTA, calcium hydroxide was placed in the canal and then an IRM temporary restoration. For the second appointment, the patients were randomly divided in two groups of 13 patients each: Teeth in Group 1 received MTA apical plugs and those in Group 2 received Biodentine™ apical plugs. The root canals were obturated with gutta-percha and Sealapex sealer. A composite resin was placed to seal the coronal access. Follow-ups were done at six, twelve and eighteen months; and treatment outcomes were evaluated based on Strindberg's Criteria and the Periapical Index (PAI).

Results: From a total of 26 teeth, 6 were excluded from the study for missing follow-up appointments (4 treated with MTA and 2 with Biodentine™). At the 6-month evaluation, Group 1 showed 55% success (Strindberg's Criteria) and 66.66% improvement based on the PAI. Group 2 results were, 54.54% and 63.63% respectively. At the 12-month follow-up, both groups exhibited 100% success. Clinical and radiographic outcomes were maintained at the 18-month evaluation.

Conclusion: Based on the resolution of apical periodontitis and the absence of clinical signs and symptoms, there was no difference between the Biodentine™ and MTA apical plugs.

Introduction

The apical foramen remains open in the roots of immature teeth until apex closure, about three years after tooth eruption (Sheehy and Roberts 1997). Open apex constitutes a challenge for dentists because they can make it difficult to successfully obturate with a three-dimensional seal. Different techniques are used to improve the probability of a good apical seal (Nayak and Hassan 2014). One example is apexification, in which calcium hydroxide pastes ($Ca(OH)_2$) are used to induce formation of a calcified barrier. However, this technique requires multiple sessions and may weaken the tooth (Andreasen et al. 2002).

The search for alternatives has led to consideration of calcium silicate materials, which have become common in dental therapy (Huang 2009, Shabahang et al. 1999). Among these materials is Mineral Trioxide Aggregate (MTA), a mixture of dicalcium silicate, tricalcium silicate, tricalcium aluminate, plaster, tetracalcium aluminoferrite and bismuth oxide. Initially introduced in the 1990s by Torabinejad, it exhibits biocompatibility and is now widely used (Shabahang et al. 1999). Immediately after mixing, MTA has a pH of 10.2, but this increases to 12.5 after three hours (Wang 2015). The advent of MTA led to advances in dentistry, such as the ability to complete an apexification in a single session (Simon et al. 2007). It is also used in retro-fillings, root perforations and pulp caps, among other applications (Lee et al.1993). Mineral trioxide aggregate has some disadvantages, including long setting time, difficult handling, discoloration, low resistance to compression and low fluidity capacity. Nonetheless, it remains the gold standard among dental bioceramics (Wang 2015, Laurent et al. 2012).

Biodentine™ is a bioactive cement introduced in 2009 by Septodont (Saint-Maur-des-Fossés, France) as a “dentine substitute”. Product presentation consists of a powdered portion (in capsules) containing tricalcium silicate, dicalcium silicate, calcium carbonate, calcium oxide, and zirconium oxide, and a liquid portion (in pipettes) containing a hydrosoluble polymer and calcium chloride as an accelerator. Its 12-minute setting time is substantially shorter than that of MTA (Vidal et al. 2016). Preparation involves using an amalgamator to mix five drops of liquid with the content of one capsule for thirty seconds. During the first day after application, Biodentine™ exhibits little or no crown discoloration (Valles et al. 2015), and has an initial pH of 11.7, with no significant changes for 28 days thereafter (Wang 2015). Biodentine™ is also reported to have a high calcium ion release rate, and excellent resistance to compression (Laurent et al. 2012). Flow cytometry analyses have shown that cell viability is higher in Biodentine™ and MTA extracts than in a glass ionomer (Zanini et al. 2012). There are also reports of osteoblast differentiation in different stem cells with Biodentine™. The formation of a homogeneous dentine bridge in pulp lesions has been shown in Biodentine™ and MTA groups (Rossi et al. 2014).

These qualities have led some to conclude that Biodentine™ has maximized MTA’s desirable properties by improving treatment time and material handling properties. The present study objective was to compare the outcome of Biodentine™ and MTA used as apical plugs in teeth with an open apical foramen.

Materials and methods

Clinical diagnosis was made, and radiographs were taken of open apex cases in patients who visited the Endodontics Specialty Clinic of the Autonomous University of Yucatan Faculty of Dentistry (FOUADY). After a description of the study, the patients were invited to participate and provided an explanation of ethical considerations. Those who decided to participate signed an informed consent form approved by the ethical committee. Inclusion criteria were patient consent (or of parents/guardians for minors) and presence of an open apex, while exclusion criteria were an after-treatment crown or root fracture and a missing a follow-up appointment. Cases of teeth with vital pulp were treated with apexogenesis while those with necrotic pulp were evaluated to determine if regenerative endodontics or an apical plug were most appropriate. The decision of whether to use regenerative endodontics or an apical plug was made based on the grade of apical foramen aperture according to Cvek´s established criteria (Cvek 1992). Grade 1 cases were treated with regenerative endodontics while Grade 2, 3 and 4 cases were treated with an apical plug.

Cases meeting the criteria for an apical plug were randomly divided into two groups: Group 1 were treated with MTA plugs; and Group 2 with Biodentine™ plugs. Procedures were done under magnification (Omnipico Dental Microscope, Carl Zeiss, Gottingen, Germany).

2.1 MTA apical plug (Group 1)

In the first session, anesthesia was administered, the tooth was isolated and a #6 carbide bur was used to access and open the chamber. Once the canals were identified and the root canal length established, the canal was irrigated with 5.25% sodium hypochlorite and 17% EDTA (Smear Clear, Sybron Endo, Orange, CA), and then with saline solution for intermediate and final cleaning. The canals were then filled with $Ca(OH)_2$, and a temporary filling of zinc oxide and eugenol cement (IRM; Dentsply, Konstanz, Germany) put in place. At the second session the $Ca(OH)_2$ was removed, and the canals carefully washed with 5.25% sodium hypochlorite (NaOCl) followed by saline solution. Collacote (Zimmer Dental Inc., Carlsbad, CA, USA) was then placed in the apical third of the canal, to a depth 1 mm short of original canal length. An average of 3 to 5 mm apical plug was then made with MTA (MTA-Angelus, Londrina, PR, Brazil), and placed in the canal followed by a moist sterile cotton pellet to promote set. A temporary zinc oxide and eugenol cement filling was put in place. On the third session, the cap and cotton were removed, and MTA set confirmed. The root filling was completed with gutta-percha and Sealapex cement (Sybron-Kerr, Romulus, MI, USA) and the access sealed with a composite resin filling (Tetric Ceram, Vivadent).

2.2 Biodentine™ apical plug (Group 2)

This treatment required only two sessions. In the first, the chamber was opened, the canals located and opened, and cleaned as described in the above protocol. Again, $Ca(OH)_2$ was placed in the canals and a temporary filling made of zinc oxide and eugenol cement. In the second session the $Ca(OH)_2$ was removed, the canals carefully cleaned with 5.25% NaOCl and saline solution, the canals checked, and a resorbable collagen sponge placed in the apical third 1 mm short of original canal length. Biodentine™ was then prepared by using an amalgamator to mix six drops of liquid with the contents of one capsule for 30 seconds. About 3 to 5 mm. of this preparation were placed in the apical third and its correct placement confirmed with a radiograph. Once Biodentine™ set was confirmed, the root filling was completed with gutta-percha and Sealapex cement, and the crown sealed with a composite resin filling.

After apical plug placement, the patients in both groups were reminded of the importance of the follow-up appointments at six, twelve and eighteen months to confirm treatment progress both clinically and via radiographs.

2.3 Follow-up appointments

At each follow-up appointment the teeth were evaluated clinically and radiographically based on the Strindberg´s Criteria and the Periapical Index (PAI) (Ørstavik et al. 1986). All evaluations were done by two endodontists trained in these criteria.

Results

A total of 39 open apex teeth were examined. Five (12.82%) had vital pulp and were treated with apexogenesis; eight (20.51%) met the criteria for regenerative endodontics and 26 (66.66%) met the study inclusion criteria and were treated with an apical plug. Of the latter, fifteen patients were women and eleven were men. Thirteen of the apical plug cases were treated with MTA (Group 1) and thirteen with Biodentine™ (Group 2). Not all patients came to all the follow-up appointments, six of them were eliminated (four in Group 1 and 2 in Group 2) (Table 1 and 2).

Progress was generally parallel in all groups. At six months, 55% of those in Group 1 had successful outcomes based on the Strindberg´s Criteria and 66.66% exhibited improvement in radiographs according to the PAI. In Group 2, 54.54% had successful outcomes and 63.63% exhibited improvement. By twelve months both groups had 100% successful outcomes and favorable PAI values. The same was true at eighteen months, however, 81.81% of the Biodentine™ group showed a two-level reduction of the PAI, while in the MTA group only 44.44% reduced two PAI levels (Table 1 and 2).

Table 1. Group 1, MTA apical plugs

Case No.	Sex	Age	Tooth	Initial		6 months		12 months		18 Months		Final		PAI Final-Initial
				PAI	Strindberg	PAI	Strindberg	PAI	Strindberg	PAI	Strindberg	PAI	Strindberg	
1	F	7	19	5	Failure	3	Success	3	Success			3	Success	-2
2	M	10	29	5	Failure	4	Doubtful	3	Success	2	Success	2	Success	-3
3	F	10	19	5	Failure	3	Success	3	Success	2	Success	2	Success	-3
4	M	11	30	4	Failure	4	Doubtful	3	Success			3	Success	-1
5	F	19	9	4	Failure	3	Success	2	Success			2	Success	-2
6	F	12	31	4	Failure	4	Doubtful	3	Success			3	Success	-1
7	M	10	9	5	Failure	3	Success	2	Success	2	Success	2	Success	-3
8	M	20	29	4	Failure	3	Success	3	Success			3	Success	-1
9	F	16	9	4	Failure	4	Doubtful	3	Success			3	Success	-1

Table 2. Group 2, Biodentine™ apical plugs

Case No.	Sex	Age	Tooth	Initial		6 months		12 months		18 Months		Final		PAI Final-Initial
				PAI	Strindberg	PAI	Strindberg	PAI	Strindberg	PAI	Strindberg	PAI	Strindberg	
1	M	13	8	5	Failure	4	Doubtful	3	Success	3	Success	2	Success	-3
2	M	8	30	5	Failure	5	Doubtful	3	Success	2	Success	3	Success	-2
3	F	20	8	5	Failure	4	Success	3	Success	2	Success	2	Success	-3
4	F	20	9	4	Failure	4	Doubtful	2	Success			2	Success	-2
5	F	12	13	4	Failure	2	Success	2	Success			2	Success	-2
6	M	30	31	4	Failure	4	Doubtful	3	Success			3	Success	-1
7	M	8	10	5	Failure	3	Success	3	Success	3	Success	3	Success	-2
8	M	10	9	4	Failure	3	Success	3	Success			3	Success	-1
9	F	16	8	4	Failure	3	Success	2	Success			2	Success	-2
10	F	13	8	4	Failure	2	Success	2	Success			2	Success	-2
11	F	12	11	5	Failure	5	Doubtful	3	Success	2	Success	2	Success	-3

Discussion

Apexification is a method for inducing a calcified apical barrier or an apical development in an incompletely formed root in teeth with necrotic pulp (Rafter 2005). This was traditionally done using $Ca(OH)_2$ placement inside the canal until a calcified barrier was observed in the apical sector. However, Shabahang found that prolonged $Ca(OH)_2$ use could weaken tooth walls eventually leading to root fracture (Shabahang 2013). Even in the 1980s, it was clear that most apical periodontitis cases required apical plugs to ensure a proper seal and prevent bacterial filtration into the periapical zone (Holland 1984). Introduction of MTA in the 1990s opened the possibility of its use in root canals, pulpotomies, pulp caps, and apical plugs to induce apical barriers in immature permanent teeth (Torabinejad et al. 1997).

In 1999, Shabahang showed that MTA promotes high pH and an antimicrobial environment, thus inducing formation of a calcified barrier. One study reported no differences between the calcified barriers formed by MTA and those formed by calcium hydroxide. However, the time required for barrier formation was much less with MTA (Shabahang et al. 1999). Biodentine™ has been shown to induce differentiation in odontoblastic cells, murine proliferation in the pulp and biomineralization. It also simulates collagen fibers and induces fibroblast formation (Zanini et al. 2012) and is known to have higher push-out bond strength than MTA (Wang 2015).

No research has been done to date comparing the performance of Biodentine™ to MTA in apical plugs. The first report of Biodentine™ use in apical plugs was in 2014 (Nayak and Hassan 2014), followed by another in 2016 (Vidal et al. 2016). Both reported favorable outcomes and a notable decrease in the number of sessions required for treatment since the filling can be completed in one session with Biodentine™.

The present study is the first comparison of the performance of MTA and Biodentine™ in apical plugs. Clinical outcomes did not differ between these two bioceramics with 100% improvement in all cases, also the same happened at a radiographic level. Both clearly promote complete wound healing in real world scenarios. However, Biodentine™ exhibited superior performance in terms of ease of handling and placement, and set time, which all contributed to a shorter overall treatment time.

Biodentine™ apical plug group, tooth #11

Fig. 1a: Preop Tooth #11

Fig. 1b: Postop

Fig. 1c: Recall 18 months

MTA apical plug group, tooth #8

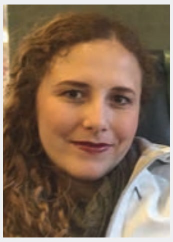
Fig. 2a: Preop Tooth #8

Fig. 2b: Postop

Fig. 2c: Recall 18 months

Conclusion

Both MTA and Biodentine™ produced complete treatment success in clinical and radiographic terms. All patients were asymptomatic after eighteen months and exhibited a clear increase of a visible apical barrier in the radiographs. However, Biodentine™ is easier to handle than MTA and sets in twelve minutes, much less time than MTA. This allows treatment completion in fewer sessions, with consequent advantages to both care providers and patients.



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Biodentine™

Biodentine can be used both in the crown and in the root:

In the crown: temporary enamel restoration, permanent dentin restoration, deep or large carious lesions, deep cervical or radicular lesions, pulp capping, pulpotomy (reversible and irreversible pulpitis).

In the root: root and furcation perforations, internal/external resorptions, apexification, retrograde surgical filling.

Biodentine™ Full Pulpotomy in Mature Permanent Teeth with Irreversible Pulpitis and Apical Periodontitis

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Abstract

Vital pulp therapy, including direct pulp capping and partial and full pulpotomy, is primarily indicated for immature or mature permanent teeth with reversible pulpitis. Mature permanent teeth with irreversible pulpitis are frequently treated with root canal therapy. This report presents two cases of full pulpotomy using Biodentine™ in mature permanent teeth with irreversible pulpitis and acute apical periodontitis. The periapical radiograph illustrated a deep carious lesion extended to the pulp with apical radiolucency lesion or widened periodontal ligament space. Full pulpotomy with a tricalcium silicate-based cement was chosen as the definitive treatment. After decayed tissue excavation under a rubber dam, the exposed pulp tissue was amputated to the level of the canal orifice with a new sterile bur. Biodentine™ was applied as the pulp capping agent after hemostasis was obtained and for temporary restoration. The clinical signs disappeared quickly after the treatment. After one month, the coronal part of the temporary restoration was removed, and a composite resin was placed over the capping agent as a final restoration. At two-year follow-ups, the teeth were asymptomatic. Radiographs showed healing of the periapical lesion and periodontal ligament. Biodentine™ full pulpotomy of mature permanent teeth with irreversible pulpitis and apical periodontitis can be an alternative option to root canal therapy.

Introduction

The maintenance of the vitality of the dental pulp is one of the crucial targets of modern dentistry, based on the concept of minimally invasive dentistry. The dental pulp presents capacity for repair, depending on the intensity of damage and the pulp inflammation. Two regenerative mechanisms, categorized as tertiary reactionary and reparative dentinogenesis, are involved in maintaining the vitality of the dentin–pulp complex. In the case of a carious lesion with relatively slow progression, the molecules that initially reach the pulpal tissue are able to induce dentin regeneration [1]. The dentin can be regenerated as odontoblasts, which are located on the periphery of the mature pulp and solely responsible for dentin synthesis. These can up-regulate their secretory activity and produce a thick layer of reactionary dentin. This layer shows many similarities to the primary and secondary physiological dentins and contributes to the protection of the pulp tissue. Reactionary dentin synthesis is promoted by small amounts of pro-inflammatory cytokines and/or biologically active molecules responsible for the induction of embryonic odontoblast differentiation, such as TGF or BMP [2]. Reactionary dentin formation is inhibited by intense inflammation [3]. In response to a severe injury, such as a rapidly progressing carious lesion, the primary odontoblasts die beneath the lesion [4]. It is hypothesized that bacterial toxins, components released from the demineralized dentin, or local generation of high levels of proinflammatory mediators, cause this event. Subsequently, however, if conditions become conducive (e.g., if the carious infection is controlled or arrested), stem/progenitor cells within the pulp are signaled to target the site of the injury and to differentiate into odontoblast-like cells. These cells deposit a tertiary reparative dentin matrix, reportedly at a similar rate to that of primary dentinogenesis, and this clinically results in dentin bridge formation [5].

Vital pulp therapy (VPT), which includes direct pulp capping and partial or full pulpotomy of exposed pulp in carious teeth, has been generally accepted as a minimally invasive approach [6,7]. Until recently, the indication of VPT had been reversible pulpitis in immature or mature teeth without periapical pathologies. Most cases of closed-apex permanent teeth with irreversible pulpitis are frequently treated with nonsurgical root canal therapy (RCT). If periapical signs and symptoms are added, RCT is the treatment of choice [8,9]. In this procedure, there is loss of dental hard tissue and subsequent weakening of the treated tooth, making it more susceptible to fracture [10]. Furthermore, several studies have highlighted that the actual failure rate of standard root canal treatments performed in general practice is significantly higher than expected [11–13]. Moreover, these treatments are lengthy and costly, and are often subject to retreatment [14]. Therefore, less invasive alternative strategies could be used to treat pulpitis, even when irreversible.

Many biological and clinical studies have shown that the pulp of mature teeth, which is exposed due to carious lesions, is able to be regenerated, and that VPT should not be limited only to young or asymptomatic teeth. Therefore, a more conservative approach of VPT has been proposed for teeth with irreversible pulpitis. A favorable outcome of this approach depends on two factors: the healing ability of the remaining vital pulp and the biocompatibility of the pulp-capping agents used [15–18].

Mineral trioxide aggregate (MTA) is the optimal choice when VPT needs to be carried out in closed apex teeth [19–21]. The ability of MTA to induce reparative dentinogenesis has been well demonstrated in animal studies in which direct pulp-capping was performed in mechanically exposed pulps [22,23]; compared with calcium hydroxide, MTA induces dentin formation at a greater rate and with a superior structural quality [24]. However, many complaints have been made regarding the difficulty of handling and mixing MTA, the long setting time, and tooth discoloration over time [25]. Several new calcium silicate-based materials have been developed [26,27], aiming to address the disadvantages of MTA [28].

Biodentine™ (Septodont, Saint Maur des Fossés, France) is among these materials, and is claimed to be able to be used as a dentin replacement material, in addition to having endodontic indications similar to those of MTA. Biodentine™ is resin-free and mainly composed of pure tricalcium silicate, which is able to set in wet conditions [29]. Biodentine™ has been shown to induce odontoblastic differentiation of dental pulp stem cells, and produce more uniform and thicker dentin bridge formations, with less inflammatory response and less necrosis of pulp tissue than calcium hydroxide [23,30].

The role of vital pulp therapy in the management of periodontal disease presenting in adult permanent teeth with irreversible pulpitis is controversial. The two cases below present the outcome of full pulpotomy, using Biodentine™, of permanent teeth with irreversible pulpitis and periapical lesion/widened periodontal ligament space.

Case 1

A 40-year-old female patient expressed her chief complaint as her spontaneous and lingering pain, pain on chewing in tooth number 45, starting one month previously. Clinical examination recorded that the affected tooth had a large carious lesion and sensitivity to percussion. The periapical radiograph illustrated a deep carious lesion involving the pulp and an apical translucency lesion ***(Fig. 1)***. Based on the clinical and radiographic examinations, the diagnosis was established as symptomatic irreversible pulpitis. The patient consented to the full pulpotomy treatment plan.

The tooth was anaesthetized with 2% Lidocaine Hydrochloride and Epinephrine 1:100,000 (Septodont, Saint-Maur-des-Fossés, France) before the placement of a rubber dam for isolation. The operating site was disinfected with gauze soaked in 5% sodium hypochlorite (NaOCl). Decayed tissues were removed using a sterilized high-speed round bur under water coolant. Then, the exposed pulp tissue was amputated by a sterilized high-speed round bur to the level of the canal orifice. The bleeding was arrested after about two minutes by gently pressing a sterile cotton pellet soaked in 2.5% sodium hypochlorite (NaOCl) into the chamber. The cavity was then filled with freshly prepared Biodentine™ (Septodont, Saint-Maur-des-Fossés, France) using an amalgam carrier, and gently pressed with a condenser ***(Fig.2)***. The patient was asked to return after one month unless progressive pain occurred.

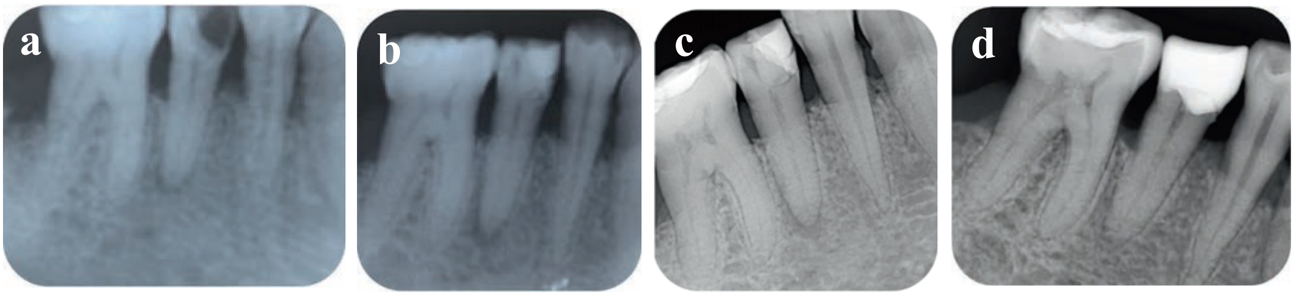

Fig. 1: Periapical radiographs: (a) preoperative; (b) after treatment; (c) 6 months postoperative; (d) 12 months postoperative.

At the next appointment, the patient reported that mild pain occurred on the first post-treatment day, but the pain was soon alleviated. Moreover, vertical percussion inflicted no pain. The superficial layer of Biodentine™ was removed, leaving a layer of approximately 3 mm. The tooth was finally restored with composite resin (3M ESPE, St Paul, MN, USA). Clinical and radiographic evaluation was completed at 6 months and 1 year postoperatively ***(Fig.1)***. The patient had no complaint about the tooth, and negative responses to cold and electric pulp tests, and periapical radiographs showed no periapical lesion after 1 year. At a 6-month follow-up examination, gaps were radiographically observed at the tooth–resin composite interface, so the old filling was replaced by an overlay composite restoration.

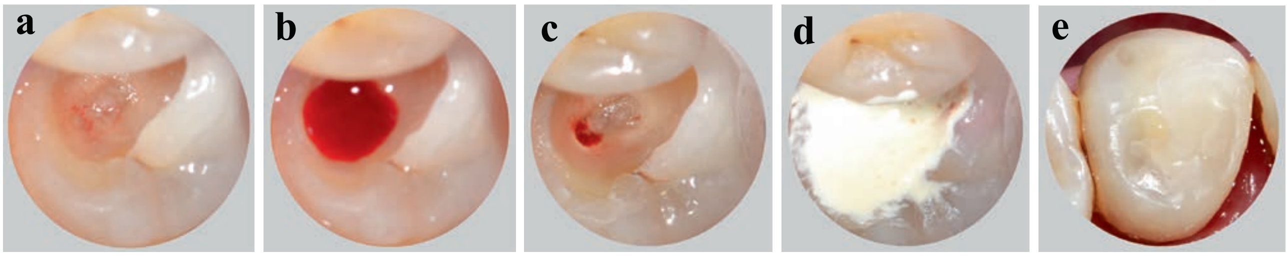

Fig. 2: Intraoral photographs: (a–c) access opening for pulpotomy procedure; (d) placement of Biodentine™; (e) composite resin restoration.

Case 2

A 25-year-old female patient presented with a main complaint of severe spontaneous and lingering pain in tooth number 36, occurring several times over the previous two weeks. Pain was provoked by chewing or cold drinks. Clinical examination recorded caries extending to the pulp tissue, and the tooth was also sensitive to vertical and horizontal percussion. Periapical radiograph demonstrated widened periodontal ligament space at the mesial root ***(Fig. 3)***. The tooth was diagnosed with irreversible pulpitis.

After receiving the informed consent from the patient, the same procedure as above was applied. The coronal pulp was removed to the level of the canal orifices. Bleeding was confirmed from all root orifices. After hemostasis was obtained, the pulp chamber was filled with Biodentine™ as a capping agent and temporary restorative material.

The patient reported mild pain on the operation day, but the pain was reduced from the following day. One month later, the patient did not feel discomfort upon chewing, although vertical percussion caused a slight pain. The superficial layer of Biodentine™ was removed, then the tooth was permanently restored with composite resin. After 6 months, there was no sensitivity to percussion and the periodontal ligament space improved. A 24-month examination indicated the periodontal ligament space had returned to the normal state, the tooth had no symptoms, and showed negative responses to cold and electric pulp tests.

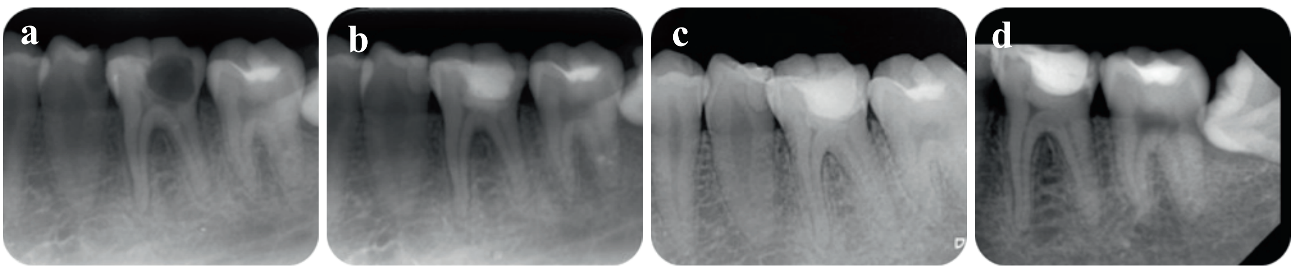

Fig. 3: Periapical radiographs: (a) preoperative; (b) after treatment; (c) 6 months postoperative; (d) 24 months postoperative.

Discussion

Until recently, the remedy for irreversible pulpitis has been endodontic treatment. Non-surgical endodontic treatment is considered to be an invasive and non-biological treatment because it removes the entire inflamed, infected, and healthy pulp, thus losing its reparative/regenerative potential, proprioceptive properties, and innervation [31]. Therefore, a more conservative approach with VPT has been proposed for teeth with irreversible pulpitis [15–18].

The successful outcome of both cases provides additional clinical evidence of the effectiveness of full pulpotomy in teeth with clinical signs and symptoms of irreversible pulpitis with apical periodontitis. Taha et al. (2017) reported that the success rate of MTA pulpotomy in mature permanent teeth presenting carious pulp exposures was 100% at one-year follow-up, and 92.7% after three years [20]. In another prospective study on Biodentine™ involving full pulpotomy in mature permanent teeth with irreversible pulpitis, the authors found a high clinical success rate after one year of close to 100%, and a radiographic success of up to 93.8% [32]. Cushley et al. (2019) evaluated the clinical success rate of full pulpotomy in permanent teeth with signs and symptoms of irreversible pulpitis by a systematic review. They found a success rate of full pulpotomy of 97.4% clinically and 95.4% radiographically at 12-month follow-up [33]. However, VPT for mature permanent teeth with irreversible pulpitis and periapical lesion remains controversial.

In the current case report, the adult patients had spontaneous pain, lingering pain, and percussion sensitivity, which have long been clinical predictors of the irreversible stage of the pulp [34]. Furthermore, radiographically, these teeth presented a carious deep lesion and apical lesion or widened periodontal ligament space. In both cases, clinical signs and symptoms improved one month after Biodentine™ full pulpotomy. We also recorded complete radiographic healing. In the first case, the apical radiolucency was improved after 6 months and completely healed after 12 months. The periodontal ligament space in the second case was in a normal state after 6 months.

The pulp tissue can remain vital, even in teeth with the presence of periapical radiolucency; this vital pulp tissue has the potential to recover in the presence of an adequate material [35]. Periapical inflammatory responses are related to the diffusion of bacterial products into the periapical tissue, causing a complex interaction of inflammatory mediators, cytokines, and neuropeptides [35]. Studies have shown that apical periodontitis can be associated with irreversible pulpitis. The finding of apical periodontitis in radiographic images does not necessarily mean that the pulp is necrotic. The inflamed vital dental pulp causes an immunological response, which could lead to local changes in peri-apical connective tissues [17,36,37]. Hence, clinical signs and symptoms of the patient do not reflect the actual extent of inflammation in the pulp tissue. In addition, the healing of teeth with irreversible pulpitis and a peri-apical lesion following vital pulp therapy has been demonstrated in few studies [11,18,32]. A widened periodontal ligament via an infectious pathway was reported in teeth with pulpitis, pulpo-periapical lesions, or even vital pulps with minimal hyperemic involvement [38,39]. However, the management of periodontal ligament widening in the teeth with irreversible pulpitis has rarely been mentioned in previous studies.

Accurate clinical diagnosis is significant in VPT, but it has been shown that clinical examination gives only a temporary diagnosis that may be incorrect [40,41]. The control of bleeding after removal of the infected pulp tissue has been suggested as an additional diagnostic indicator for the evaluation of the degree of inflammation and the healing potential of the remaining pulp tissue [15,42]. The ability to control bleeding within 5–10 min suggests the presence of mild to moderate inflamed pulp, which can heal in a conducive environment [18]. In both cases, bleeding occurred within 2 min, thus indicating VPT.

In our case report, Biodentine™ was used as a pulp capping agent. Our previous in vivo studies demonstrated that Biodentine™ provides an optimal environment for pulp healing, inducing the formation of a homogeneous dentin bridge at the injury site when applied directly to mechanically exposed rat pulps. In fact, the dentin matrix associated growth factors can signal mesenchymal stem cells in the pulp to differentiate into odontoblast-like cells and produce a mineralized barrier in continuity with the primary dentin protecting the underlying vital pulp tissue [23,43].

A histological study found that the pulp tissue a few millimeters from the necrotic pulp with bacterial colonization is usually free from inflammation and bacteria [41]. The radicular pulp is rarely inflamed. Therefore, as soon as the infected and inflamed tissue is removed and an appropriate capping agent is applied, a favorable environment for pulp wound healing is created. In addition to its good sealing properties, Biodentine™, like other cements in the tricalcium silicate family, is able to control pro-inflammatory factor secretion and decrease inflammatory cell recruitment [44].

Long-term failure after vital pulp therapy and endodontic treatment is mainly attributed to micro-leakage at the coronal tooth–restoration interface. Massler et al. (1978) demonstrated that the most important cause of long-term failure in vital pulp therapy is the presence of leakage during the healing process [45]. Biodentine™ presented good sealing ability, resisting micro-leakage [46], and its bond strength when bonded to resin composite was improved at a maturation time of 2 weeks [47]. Biodentine™ has been shown to improve setting time, handling, and mechanical properties, compared with MTA [48]. This cement can be used successfully in dental clinics as a restorative material for up to 6 months, and as a dentin substitute under a composite for posterior restoration [49].

Success assessment of VPT is based on clinical and radiographic follow-up. The tooth should be asymptomatic. The tooth with full pulpotomy is expected to be unresponsive to sensibility testing. However, it should be positive to testing in the case of pulp capping or partial pulpotomy. A negative response does not indicate pulp necrosis. Success is defined as the absence of symptoms and maintenance of pulp vitality after at least 1 year [50].

Conclusions

Based on the perspective of bioactive material and pulp biology, full pulpotomy inmature permanent teeth with irreversible pulpitis, and apical periodontitis or widened periodontal ligament space might be considered as an alternative treatment to root canal treatment.

Longer-term study is needed to confirm the future benefits of this treatment option.

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