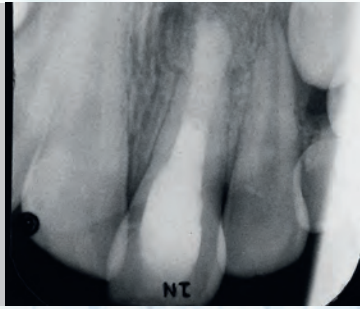


Septodont Case Studies Collection

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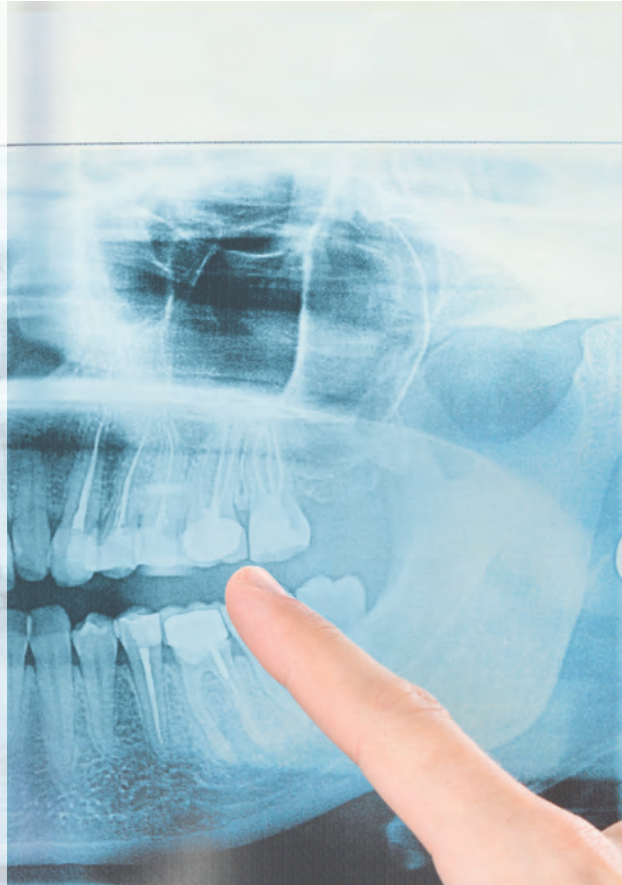
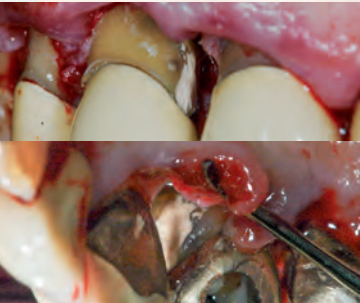
BIODENTINE™
Apical Osteolysis Treatment
Dr. M. Kaup



BIODENTINE™
Deep Cavity Treatment
Dr. P. Robotta



BIODENTINE™
Cervical Resorption Therapy
Dr. P. Robotta



BioRoot™ RCS

The new
biomaterial
for root canal
filling

Dr. S. Simon
Dr. A.C. Flouriot



Editorial



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Since its foundation Septodont has developed, manufactured and distributed a wide range of high quality products for dental professionals.

Septodont recently innovated in the field of gingival preparation, composites and dentine care with the introduction of Racegel, the N'Durance® line and Biodentine™, which are appreciated by clinicians around the globe.

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.

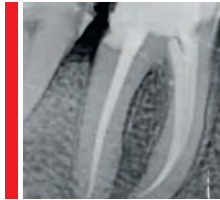
Over the past 4 years, authors from more than 15 countries have generously contributed to the success of our magazine that is now distributed on the 5 continents.

Each new issue of the Case Studies Collection is the opportunity to discover new clinical challenges and their treatment solutions.

This 13th issue features new Biodentine™ cases and introduces a new Septodont Innovation : BioRoot™ RCS

- BioRoot™ RCS is the new paradigm for endodontic obturations. Its outstanding sealing properties combined with antimicrobial 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.

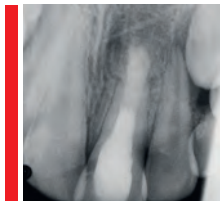
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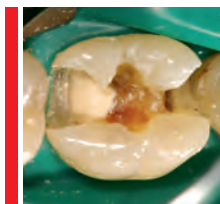
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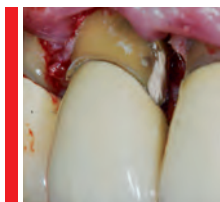
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BioRoot™ RCS a new biomaterial for root canal filling

Dr. Stéphane Simon & Dr. Anne-Charlotte Flouriot

Introduction

Due to progresses in scientific knowledge, endodontic treatments provide now highly predictable results. However, such results are closely tied to the respect of a number of steps that are nowadays clearly identified as key elements for endodontic treatment success. Notably, the filling of the root canal is one of them. In clinical application, it requires both knowledge and thoroughness (Ray and Trope, 1995).

Sterilizing and obtaining a root canal free of bacteria, following disinfection, is, so far, impossible to obtain (Siqueira et al 1997). Apart from disinfecting, the obturation act is responsible to trap residual bacteria, fill the pre-disinfected space and ultimately seal it, in order to avoid any bacterial leakage into the periapical area. Modern techniques for filling the root canal are based on the association of gutta percha (the core of the filling) and a sealer. The latter acts as a sealing material and, because of its fluidity, it is able to spread into any free space, notably

those which were not enlarged during the mechanical root canal preparation.

Depending on the technique used by the practitioner, the gutta percha is compacted differently: laterally when used with cold lateral condensation or vertically when used with a warm vertical compaction. Both techniques provide good long term results, as the root canal is filled with a high proportion of gutta percha with a small volume of sealer. The quantity of the latter needs to be minimal, as being degradable, it may lead to a canal bacterial contamination over time.

The single cone technique, a procedure introduced in the past, is still very popular among practitioners being quick and easy to perform. This technique consists in employing a single cone with a large amount of sealer, which acts as a filling material. Unfortunately, the currently used sealers are poorly resistant to dissolution. As a consequence, with time, the canal is again contaminated with bacteria, leading to treatment

failure and the growth of an apical lesion. Thereby, although being easy to accomplish, the single cone technique is not recommended for root canal filling (Beatty 1987; Pommel et Camps 2001).

However, the single cone technique may be re-opened and provide new reliability with new proposed biomaterials based on bioceramics, developed in the last decades and launched on the market as root canal sealers.

Bioceramics properties

Bioceramics are specifically designed for medical and dental use with the prefix 'bio' referring to their biocompatibility. In the orthopedic field, inert bioceramics are used for prosthetic devices, while the active and re-absorbable ones are applied in the endodontic field.

They are composed of alumina, zirconia, bioactive glass, glass ceramics, coatings, composites, hydroxyapatite, resorbable calcium phosphates and radiotherapy glasses (Dubock 2000; Best et al 2008). Among them, calcium phosphate-based materials are used for filling bone defects. Calcium silicates and bio-aggregates (Mineral Trioxide Aggregate for example) were introduced for apical plug in apexification procedures but also for coronal/root repair in case of perforations (Trope and Debelian 2014, Koch and Brave 2009). Three basic types of bioceramics must be distinguished: (1) bio-inert high strength ceramics (alumina, zirconia and carbon), (2) bioactive ceramics which form direct chemical bonds with the bones or soft tissues of a living organism (Bioglass and glass ceramics) and (3) biodegradable/soluble/re-absorbable ceramics (calcium phosphate based ceramics) that actively participate in the metabolic processes of an organism.

According to the manufacturers, such sealers could be used alone or combined with a gutta percha point using a single cone technique in the context of an endodontic treatment or retreatment (Koch and Brave 2009 part 3). These sealers are mainly composed of tricalcic silicate, calcium phosphate monobasic, calcium hydroxide, and zirconium oxide that closely resemble the composition of MTA (Tyagi et al., 2013). The premixed form facilitates their use in good conditions, with decreased risk of heterogeneity in the preparation (Yang and Lu, 2008).

Bioceramics have shown remarkable properties in terms of biocompatibility and antimicrobial activity with an excellent bioactivity, capable to induce mineralization of periapical tissues (Zhang et al., 2009; Zhang et al., 2010). Indeed, the bioceramics specific physico-chemical properties are what make them so interesting for the endodontic field. Firstly, because of their hydrophilic profile, they can set in a humid environment, such as dentin, which is made of nearly 20% of water (Koch and Brave, 2010, part 2). Secondly, due to their wettability, a decreased viscosity and a higher quality sealing is present in bioceramics when compared with all the currently marketed sealers.

Specific properties and composition

BioRoot™ RCS is the newest endodontic sealer based on tricalcic silicate materials benefiting from both Active Biosilicate Technology and Biodentine™.

The first provides medical grade level of purity and, unlike "Portland cement" based materials, it ensures the purity of the calcium silicate content with the absence of any aluminate and

calcium sulfate. BioRoot™ RCS is a mineral based root canal sealer using tricalcium silicate setting system. The powder part additionally contains zirconium oxide as biocompatible radiopacifier and a hydrophilic biocompatible polymer for adhesion enhancing. The liquid part contains mainly water, calcium chloride as a setting modifier and a water reducing agent.

BioRoot™ RCS is bioactive by stimulating bone physiological process and mineralization of the dentinal structure (Camps 2015, Dimitrova-Nakov 2015). Therefore it creates a favorable environment for periapical healing and bioactive properties including biocompatibility (Reichl 2015), hydroxyapatite formation, mineralization of dentinal structure, alkaline pH and sealing properties.

BioRoot™ RCS is indicated for the permanent root canal filling in combination with gutta-percha points and is suitable for use in single cone technique or cold lateral condensation (Camilleri, 2015). BioRoot™ RCS was designed to be used by mixing powder part with the liquid part by

simple spatulation: there is no need for a mixing machine. The working time is around 15 minutes and the setting time is less than 4 hours in the root canal. In addition, BioRoot™ RCS displayed a tight seal with the dentin and the gutta-percha (Xuereb 2014) and an appropriate radiopacity. The paste is of smooth consistency with good flow and adequate adhesion to instruments in order to enable an optimal placement in the root canal.

Thanks to the use of Active BioSilicate Technology which is monomer free, there is no shrinkage of BioRoot™ RCS during setting to allow a tight seal of the root canal.

Despite the similar composition in terms viscosity and texture with a sealer, BioRoot™ RCS must be considered as an adhesive root filling material. A fitted gutta-percha point is used as a plugger-like carrier to facilitate the flow of BioRoot™ RCS into the canal space. Indeed, BioRoot™ RCS is also recommended for facilitating the obturation removal in case of retreatment.

I A new concept of obturation

To achieve root canal filling and prevent any bacterial or fluid leakage, practitioners were always told to associate a core material with a sealer in order to fill the canal space. So far, gutta-percha is the most used material because it is a non-resorbable and well bio-tolerated. Unfortunately, gutta-percha has no intrinsic adhesive properties to dentin. Thereby, in order to ensure the seal of the final filling, the use of a sealer is required. The latter is also used for filling voids, flowing into anatomical irregularities, notably the ones which were not enlarged by the mechanical preparation (i.e. isthmus, lateral/accessory canals).

Nevertheless, sealers are subject to shrinkage, overtime degradation and have no chemical sealing ability to dentin. As a consequence, the use of a large amount of core material with the thinnest layer of sealer is recommended to improve the quality of the filling.

Among the obturation techniques, cold lateral and warm vertical compaction are the best ones. Indeed, they are both capable of pushing the sealer into the non-instrumented spaces, where residual bacteria may persist. However, the first technique leaves excessive cold sealer inside the canal irregularities (instead of leaving gutta percha) and the second one requires the placement of a plugger within 4 mm of the apex. Furthermore, with the warm lateral compaction, a large volume of coronal dentin needs to be removed causing concerns among practitioners as it may possibly weaken the tooth structure (Trope and Debelian 2014).

Moreover, these techniques are time consuming, highly operator-dependent and require the use of visual aids to ensure the best chances of success. As a matter of fact, most of the general practitioners still use the single cone technique, as it is easy and quick to perform. Due to the

introduction of Nickel Titanium tapered instrumentation, gutta-percha cones fitting in taper and apical diameter with last used file from a given system are now commercialized. The apical sealing ability of a single cone placed inside the root canal is achieved in such condition in the apical third, because of the concordance of the last file used and the gutta cone design. However, because of the non-circular shape of the canal section on the median and coronal thirds, the cone does not perfectly fit into an ovoid canal. Hence, the remaining space is filled with sealer or voids (Angerame et al., 2012; Schäfer et al., 2013; Somma et al., 2011). On this basis, the single cone technique cannot be considered as reliable since it provides an imperfect sealing.

Bioceramic sealers may be considered as an interesting solution to make the obturation steps reliable and easier to achieve, potentially replacing the ZnO-eugenol based sealers. In this context, they might provide a 3D tight and durable sealing all along the entire length of the root canal

without the need of any compaction procedure. Used in combination with an adjusted gutta-percha point and due to its excellent wettability and viscosity, the bioceramic could spread into any root canal irregularity and non-instrumented space. Furthermore, its adhesive properties to dentin and the reduced need of an excessive coronal tissue removal would provide an improved resistance to root fracture over time. This new class of materials could finally simplify the obturation stage, making it reproducible in every practitioner's hands with a reduced learning curve. Above all, such technique could provide equivalent clinical results, if not even better, when compared to the gold standards. Notably among them, BioRoot™ RCS is one of these new bioceramic materials. The purpose of the present article is to describe its properties and introduce a new way of considering this biomaterial, not as a sealer but as a true root canal filling material. If this material can be considered as reliable, we may assist to a true paradigm shift into the field of endodontics.

Description of the technique and case report

From an operational point of view, the procedure is very similar to the single cone technique. However, few indispensable differences justify the reliability of BioRoot™ RCS with such technique. Notably, the single cone technique seals a cone alone. Instead, here the cone is employed as a carrier, which is left in place to allow the material removal in case of retreatment. Indeed, it must not be considered as the core of the filling. The obturation is made by BioRoot™ RCS itself.

Case report :

A pulp necrosis was diagnosed on tooth #36 of a 47 years old male patient. (Fig. 1)

- After having shaped the root canal and obtained an appropriate tapered preparation, the canal was disinfected with a 3% sodium hypochlorite solution activated with mechanical agitation.



Fig. 1: Pre-operative X ray of tooth #36 on a 47 years old man.

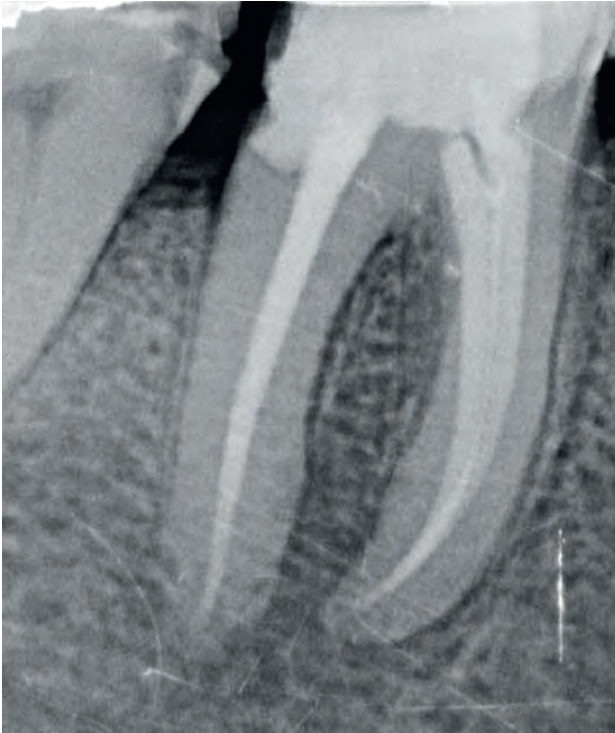


Fig. 2: Post-operative X ray after completion of endodontic treatment. Canals were shaped with WaveOne Gold (Dentsply-France), disinfected with 3% sodium hypochlorite solution and the filled with BioRoot™ RCS placement with the help of 6% taper gutta percha cone.

A final rinse with 17% EDTA and a final flush with sodium hypochlorite were completed before fitting the gutta percha cones.

- Canals were dried with paper points.
- BioRoot™ RCS was mixed, following manufacturer recommendations.
- Each gutta percha point was poured into the mixed material to largely cover the surface of the cone. Afterward, it was gently inserted into the root canal space until reaching the working length.
- The cone was cut at the entrance of the root canal with a heat carrier, and a slight plug was created with a hand plugger.
- The second and the third canal were filled in the same way (Fig. 2).
- The patient was referred to the general practitioner who restored the tooth with a post and core, and a crown.
- Patient was recalled at 6, 12 and 24 months after treatment. *NB: the patient was treated in the framework of a randomized clinical trial (see below), explaining why he was recalled three times (Fig. 3).*

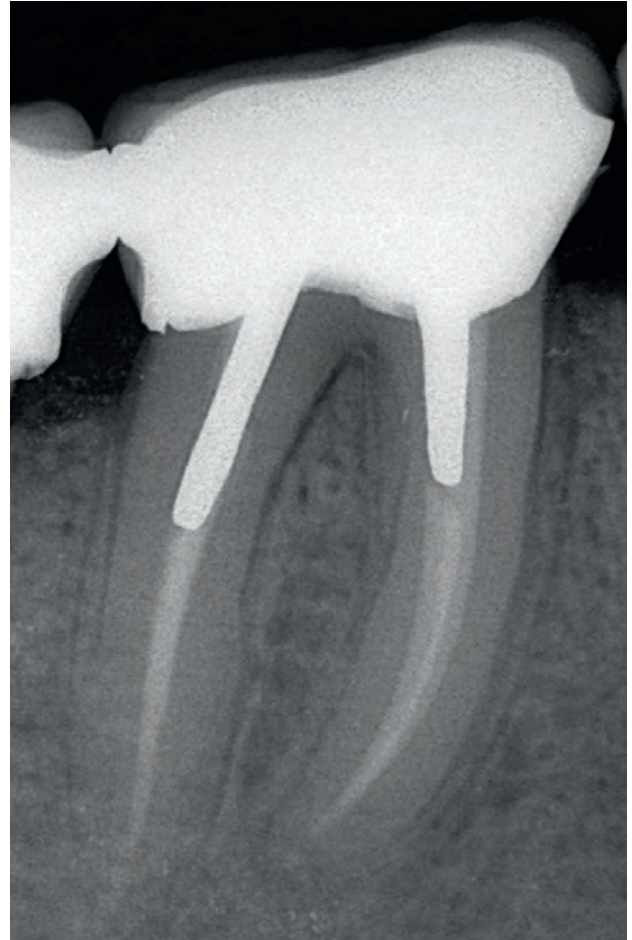


Fig. 3: 24 months post-operative recall.

On the 24 months follow up radiograph, there were no signs of bone inflammation. This event is associated with no claims of pain nor discomfort by the patient and that the tooth was functional. Thereby, the treatment maybe considered as successful.

This case report is one of the 22 clinical cases of a randomized clinical trial comparing the succes of an endodontic treatment using warm vertical compaction of Gutta percha versus the above described BioRoot™ RCS. Currently, as the 24 months follow up period is still ongoing, some of the clinical cases are still not complete. The RCT registration number is NCT01728532 and the full protocol is available on <https://clinicaltrials.gov>

The results are still under analysis and very encouraging, which it allows us to consider this technique as reliable enough to be described here.

Conclusion

Endodontics is continuously under evolution. In the last 20 years, instrumentation research and development have been very active. Currently, disinfection and irrigation procedures are the two most focused aspects of endodontic research.

The shaping procedures and root canal disinfection have considerably been simplified. Thereby, every practitioner interested in endodontics is now able to complete any easy/middle difficulty root canal treatment with reproducible results without

any issue. Obturation, the final step of the procedure, is usually the most difficult and time consuming operation. However, with this new approach of root canal filling, this milestone may be overpassed. Considering the fluidity of BioRoot™ RCS as a filler and not only as a sealer, this represents a true paradigm shift. The preliminary results of the randomized clinical trial are very encouraging. More clinical investigations will be necessary in the future to confirm this new vision of a simpler root canal obturation.



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BioRoot™ RCS

Root Canal Sealer

High seal, and much more



Treatment of apical osteolysis after anterior dental trauma in mixed dentition

OA [Senior Physician] Dr. Markus Kaup, Münster

Case history

In this case, a male patient, age 9 at the time of the accident, suffered anterior dental trauma following a fall from a bicycle. In the accident, the patient suffered a subluxation of tooth #21. No other injuries were found. Because the accident occurred whilst the patient was on vacation, initial care was handled by a local dentist. At this time, the healthy patient exhibited age-appropriate mixed dentition.

A dental radiograph (*fig. 1*) was obtained during the initial care.

The radiograph, which was focused on the affected tooth, #21, showed incomplete root growth and traumatic enamel chipping on the incisal edge. The radiograph obtained did not show any sign of root fracture or alveolar bone fracture on the affected tooth.

Because there were no further complaints and the further course was free of complications, the patient did not present to any follow-up examinations with a dentist at his place of residence.

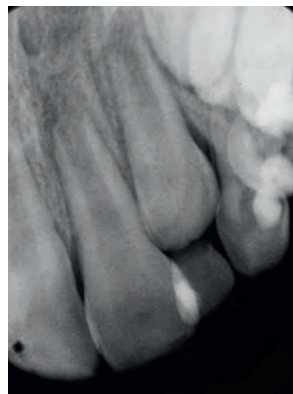


Fig. 1: Dental radiograph on the day of the accident: 9-year-old patient, status post anterior dental trauma.



Fig. 2: Tooth #21 with extensive apical osteolysis 24 months post trauma.

Two years later, the patient noted marked swelling in the area of the right upper lip. The patient did not experience any pain or chewing sensitivity. In this condition, the patient initially presented to the Polyclinic for Restorative Dentistry at the University Hospital Münster. Following detailed history and examination, a current dental radiograph was obtained (*fig. 2*).

Findings

The radiograph showed tooth #21 with still incomplete root growth and extensive apical osteolysis. Compared with the age-appropriate development of the root of tooth #11, the root length of the traumatized tooth was shortened. The lumen of the root canal also appeared enlarged on lateral comparison.

Following extensive consultation and discussion of the findings, the treatment options and alternatives were explained in detail to the patient. Due to the patient's age, the most atraumatic

and gentle approach possible was sought. The patient consented to the attempt to preserve the tooth by means of orthograde root canal treatment, and thus to primary conservative therapy. The objective was to apexify the root and cure the apical osteolysis on tooth #21 by repeated application of an alkaline calcium hydroxide preparation. In addition to the possibility that the planned therapy might not be successful, the patient was explicitly informed of the expected duration of treatment.

Therapy

The trepanation and visualization of the root canal lumen were carried out without difficulty. In addition to gentle instrumentation of the root canal walls with manual instruments, a chemical disinfection was carried out with a 1% sodium hypochlorite solution and - following intermediate rinsing with isotonic saline - a chlorhexidine solution (2%) was applied with ultrasound activation. Then, the tooth was treated with a calcium hydroxide insert (Calciumhydroxid pro analysi, Merck, Darmstadt), and the trepanation opening was provided with a bacteria-proof seal (dentin-bonded composite filling).

Even ten months after the start of treatment,

during which calcium hydroxide inserts were placed in the cleaned root canal at intervals of 4-6 weeks, the patient was free of complaints, but the root canal could not be dried. For this reason, another dental radiograph was obtained for further diagnosis (*fig. 3*).

Compared with the initial film at the start of treatment, the radiograph showed a reduction of the apical osteolysis and of the radiolucency. This was taken to be progression of healing with osseous regeneration. Over another 12 months, gentle cleaning and disinfection were carried out as described above at four- to six-week intervals, and the affected area was again treated with calcium hydroxide inserts and bacteria-proof seals. The entry of fluid via the apical foramen decreased over the further course of treatment, but the root canal could still not be dried even 22 months after the start of treatment. No apexification with complete hard-tissue seal could be obtained in this case. The radiograph (*fig. 4*) obtained after 22 months shows nearly complete regeneration of the apical osteolysis present at the start of treatment. Trabecular structures in the previous lumen indicate resolution of the osseous defect. No growth in length or thickness of the root can be seen.

Given the already lengthy treatment, it appeared

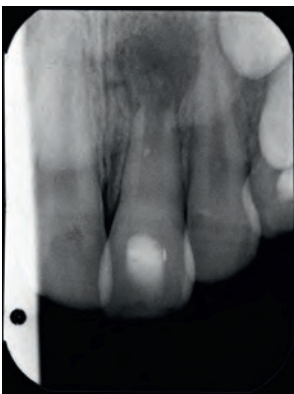


Fig. 3: Ten months after start of treatment and calcium hydroxide application: Reduction in apical osteolysis.



Fig. 4: Near-complete osseous regeneration of the osseous defect 22 months after start of treatment and calcium hydroxide application.

doubtful whether further calcium hydroxide treatments would result in a complete apical closure. For this reason, apical sealing with the bioactive, alkaline cement Biodentine™, a calcium silicate cement from Septodont, appeared a worthwhile option. Under the surgical microscope, Biodentine™ could be inserted with visualization and adapted without bubble formation. The apical third of the root canal was sealed with Biodentine™. After a curing period of approximately 15 minutes, the remaining root canal lumen was filled with a dentin-bonded composite, and the clinical crown was reconstructed. The composite, which extended apically over the level of the bone, was meant to stabilize the root, which was weakened due to a lack of hard substance, in order to avoid fractures. The final radiograph (*fig. 5*) showed obturation of the root canal lumen with tight margins and no bubbles. The film was obtained 25 months after the start of treatment. Compared with the prior film, further healing and increased radiopacity in the area of the previous apical osteolysis could be seen. The patient was free of complaints over the entire duration of treatment. By combi-

ning classical apexification treatment with calcium hydroxide inserts - which did not result in the formation of a complete hard-tissue barrier in this case - and apical sealing with the alkaline Biodentine™, osseous regeneration of extensive apical osteolysis was



Fig. 5: Status post apical filling with Biodentine™ and coronal reconstruction with composite.

demonstrated radiographically. The final reconstruction of the missing hard substances with adhesive composite technology allowed the tooth to be preserved by conservative measures. In a clinical follow-up examination approximately 12 months after completion of the root canal treatment, the tooth was clinically completely unremarkable; percussion and palpation tests were negative. Due to the age of the patient, the desired follow-up radiograph was not obtained, as his parents wished to protect him from further radiation exposure.

Discussion

The case presented combined a difficult initial situation of extensive apical osteolysis in a juvenile tooth with incomplete root growth. Classical root canal preparation techniques with the preparation of an apical stop and obturation with gutta-percha were not possible due to the wide open apical foramen. The thin, fragile dentine walls, which were at risk of fracture, made the initial situation even more difficult. The therapy of choice for the planned apexification treatment had previously been repeated insertion of calcium hydroxide preparations in order to induce an apical hard-tissue barrier that would ultimately allow for root canal filling without pressing on filling material.¹

Since 1999, Torabinejad et al. have recommended the use of an alkaline Portland cement (Mineral Trioxide Aggregate) as an artificial apical barrier in such cases.²

A significant advantage of this treatment method is a faster course of treatment with - generally - only a few treatment sessions. No definitive statement can be made as to the currently preferred treatment method for such cases. An evaluation of the available studies and meta-analyses reveals a cure rate of 95% with extensive clinical data and a few long-term results of clinical studies for the use of calcium hydroxide. In the case of Mineral Trioxide Aggregate (modified Portland cement), the same authors complain

of scarce data, in particular from long-term studies. The studies evaluated described an average cure rate of 89%. For this reason, in the opinion of Bakland and Andreasen, no definitive recommendation can yet be made in favor of the use of alkaline bioactive cements in lieu of calcium hydroxide because too few clinical data are currently available. Long-term clinical studies must be carried out before a definitive recommendation can be made.³

Additional meta-analyses with a view to clinical success and the formation of an apical barrier that compare the application of calcium hydroxide with Mineral Trioxide Aggregate show no statistically significant differences between the two methods.^{4,5}

When calcium hydroxide is used, embrittlement of the dentine, and thus an increased risk of fracture of the roots that in these cases are already damaged and weakened, is known.^{6,7} With alkaline modified Portland cement, this has been described in controversial terms. Some authors also observe weakening of the apical dentine,^{8,9} whilst others cannot confirm this based on their examinations.¹⁰

Thus far, clinical data are also scarce regarding

the Biodentine™ that was used. Because this is also an alkaline, bioactive cement that is capable of releasing calcium hydroxide, it is currently assumed that the mode of action and biocompatibility will be comparable.¹¹

In this case, the treatment method of classical apexification with calcium hydroxide was combined with the application of an alkaline bioactive cement after 22 months of treatment. In retrospect, the treatment could have been shortened by earlier use of Biodentine™, likely without any adverse effect on the treatment result obtained. By using Biodentine™ in the apical region, clinicians hope to obtain a stabilizing effect on the damaged root walls. In this author's own, yet unpublished, investigations, Biodentine™ obtained an adhesive force on the dentin that was on the order of that of the glass ionomer cement studied. The adhesion values for MTA were significantly lower. For the same reasons, no treatment with gutta-percha was carried out, either. By means of dentin-bonded reconstruction of the coronal portion of the root and the clinical crown, clinicians seek functionally stable restoration of the tooth. Long-term follow up, including radiographs, is desirable in this case.



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Pulp protection in case of deep cavity treatment

Dr. Peter Robotta, Münster

Case history

A 38-year-old male patient attended because he had noticed a “hole” in tooth 46 one week earlier. Since then, he had been experiencing a slight pulling in the right lower jaw when eating, especially when eating sweet and cold foods.



Fig. 1: Initial clinical findings tooth 46.

Diagnosis and findings in relation to tooth 46

The patient, whose teeth had been conservatively treated, had a defective mesial-occlusal amalgam filling in tooth 46. A disto-approximal secondary caries was also clearly apparent, which had resulted in the collapse of the distal marginal ridge (*Fig. 1*). The vitality test gave a positive result and the percussion test gave a negative result, and the pocket probing depths were unremarkable. The pain described by the patient could be provoked by blowing a stream of air in the region of the defect. The pain disappeared immediately when the irritation (air stream) was removed.

Diagnosis

Suspected reversible pulpitis.

Therapy options

On the basis of the initial clinical situation and the history of pain, the primary objective should be to maintain pulp vitality. However, a final decision regarding therapy can only be made once the carious damaged tissue has been removed. Depending on how far the carious defect has progressed, or on the condition of the pulp tissue upon exposure, there are three possible therapy options.

- **“Deep cavity” treatment**

If complete excavation is possible without exposing the pulp, it is then possible to introduce a permanent filling after treatment of the dentin wound close to the pulp.

- **“Direct pulp capping”**

If, after complete excavation under aseptic conditions, there is relatively small exposure of the pulp, without bleeding or with only slight bleeding which can easily be stopped, permanent treatment with a filling can be carried out after direct pulp capping.

- **“Root canal treatment”**

If the pulp in the surrounding carious softened and infected tissue is exposed or if, despite complete excavation, bleeding from the pulp tissue cannot be stopped, the attempt to maintain pulp vitality should be discontinued.

Therapy

The existing mesial-occlusal filling was removed under local anesthesia and defect-oriented distal widening of the cavity was carried out (Fig. 2 and 3). After application of a dental rubber dam (Fig. 4), the carious dentin was removed completely. In the distal region, the defect was found to be

very deep, no exposure of the pulp occurring (Fig. 5). After washing of the cavity (NaOCl 3%), the dentin wound close to the pulp was covered with Biodentine™ (Septodont, St Maur des Fossés, France) (Fig. 6).

With the aid of a sectional matrix system



Fig. 2: Removal of the defective filling.

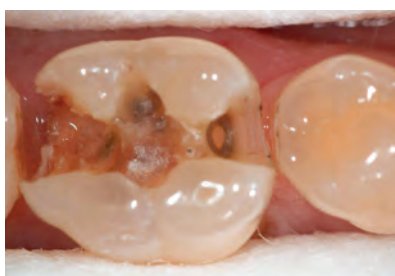


Fig. 3: Primary preparation and preparation of the defect.

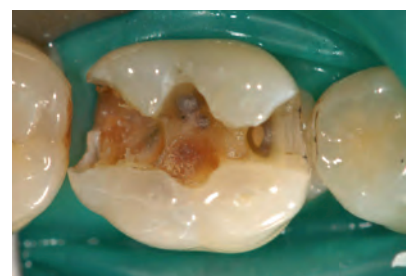


Fig. 4: Application of dental dam.

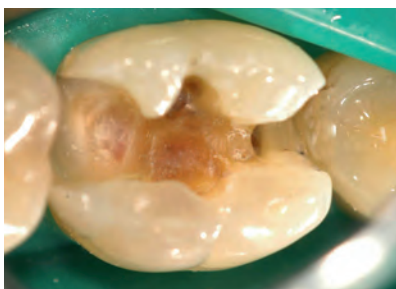


Fig. 5: Complete excavation down to the dentin close to the pulp.



Fig. 6: Treatment of the dentin close to the pulp with Biodentine™.



Fig. 7: Application of the distal matrix.

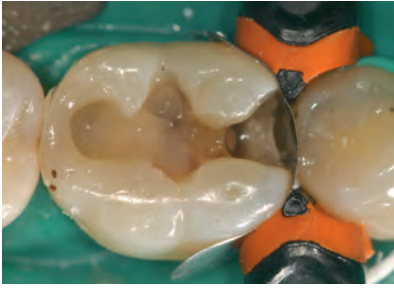


Fig. 8: Reconstruction of the distal wall and application of the mesial matrix.

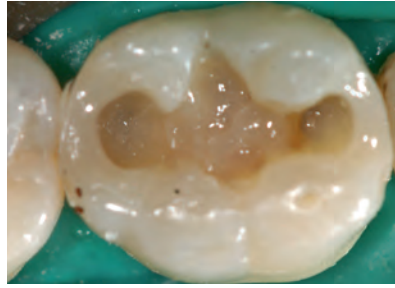


Fig. 9: Finished marginal ridges.

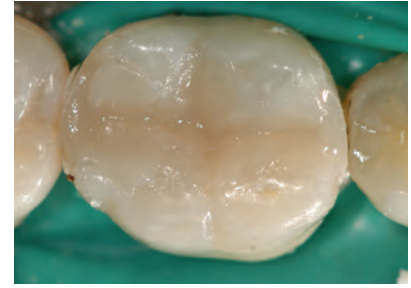


Fig. 10: Reconstruction of the chewing surface.



Fig. 11: Finished restoration after trimming and polishing.



Fig. 12: Clinical picture after one year.

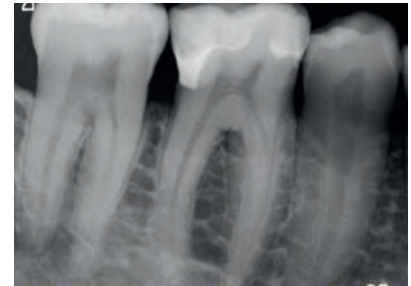


Fig. 13: X-ray findings 15 months after treatment, Biodentine™ immediately next to the pulp.

(Composi-Tight 3D ring with sectional matrix band, Garrison, Übach-Palenberg, Germany), first the approximal walls and then the chewing surface were reconstructed with composite (Venus Heraeus Kulzer, Hanau, Germany) by the adhesive technique (iBond, Heraeus Kulzer, Hanau, Germany) (Fig. 7-10).

After removal of the dental rubber dam, the occlusion could be checked and the filling could be trimmed and polished (Fig. 11). In the clinical follow-up, the symptom-free tooth 46 still exhibited positive sensitivity after one year (Fig. 12). X-ray examination 15 months after the end of treatment did not show any abnormalities (Fig. 13).

Discussion

Pain originating from the endodontium is the most frequently occurring pain which dentists face in everyday practice. The main cause is to be regarded as carious lesions. However, trauma, hypersensitivity or traumatic occlusions can also lead to endodontic pain. In the treatment of reversible pulpitis, the primary objective is to eliminate the cause or noxa of the pain and to maintain pulp vitality. If a carious lesion is the cause, treatment in the sense of a “caries profunda” or direct pulp capping may be indicated.

It must thereby be ensured that the transition from treatment of the dentin close to the pulp to direct pulp capping is seamless. It is to be assumed that, in the treatment of the dentin, exposure of odontoblast extensions always

occurs and direct access to the pulp is thus ultimately created. The pulp-dentin complex designation therefore seems more appropriate. It is expedient to use magnifying loupes when inspecting the finished cavity, so that even very small point-like areas of exposed pulp tissue do not go unnoticed.

Preparations based on calcium hydroxide are currently the best documented and safest materials for treating the pulp-dentin complex and are considered to be the “gold standard”.¹ However, the mechanical instability of calcium hydroxide owing to its absorbability and the associated formation of so-called tunnel defects, which can be a portal of entry for microorganisms, must be regarded as a disadvantage.²

In the meantime, “biocompatible cements” based on calcium silicate have also become established for treatment in the dentin region close to the pulp. A main constituent of such cements is tricalcium silicate which, as well as being biocompatible, is also bioactive and can thus induce the formation of hard tissue.³ Mineral trioxide aggregates (MTA), Portland cement and Biodentine™ are representatives of such calcium silicate cements⁴ and have shown in tests that they are biocompatible⁵, have good material properties¹ and, on account of their basic pH, have an antibacterial action during the setting phase⁶.

When trying to maintain pulp vitality, it is important, in addition to using biocompatible materials for treating the pulp-dentin complex, to use aseptic conditions even during the excavation (dental rubber dam). Furthermore, establishing the correct indication is critically important to the likelihood of success. An attempt to maintain pulp vitality is indicated only when the pulp is free of inflammation and when clinical and X-ray examinations show that there are no symptoms. These requirements were met in the present case. The therapy was therefore carried out as described.



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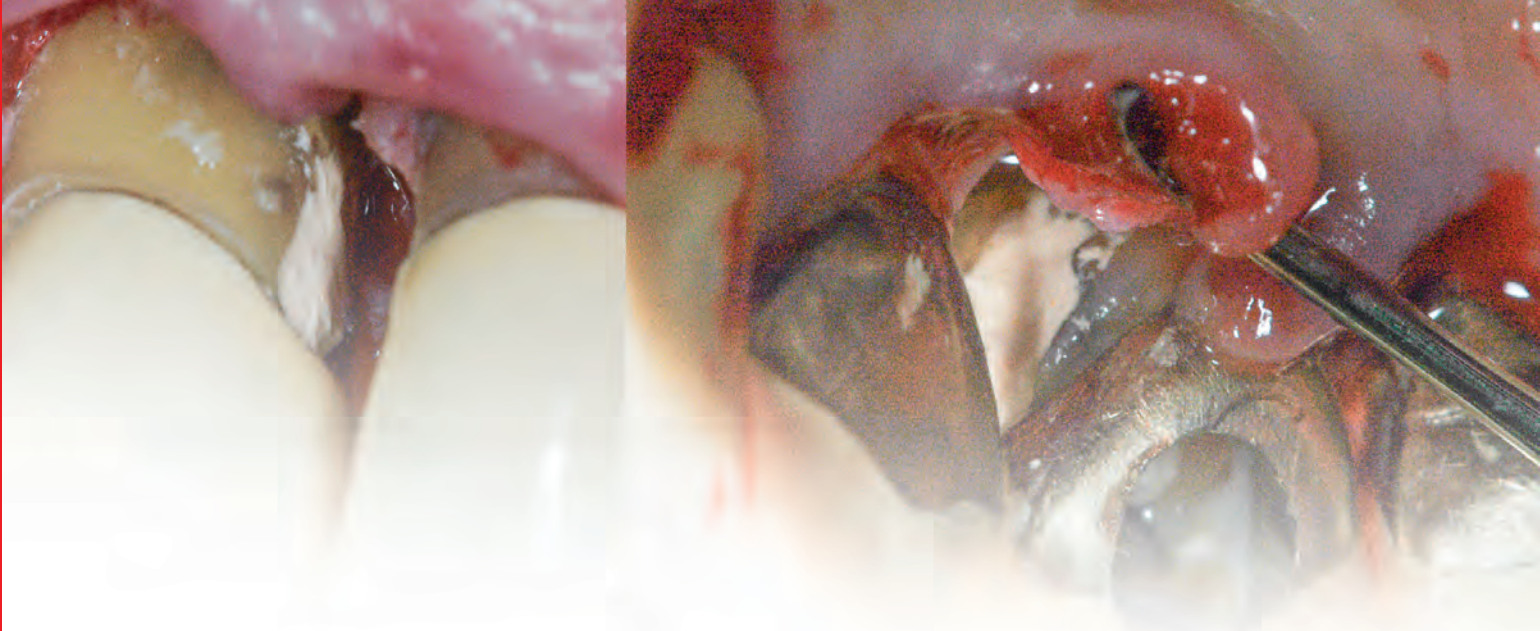
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Therapy of a cervical resorption

Dr. Peter Robotta, Münster

Case history

During a dental check-up, a healthy 58-year-old female patient reported a recurrent, non-painful swelling (*Fig. 1*) as well as occasional bleeding of the gums in the approximal region of tooth 11 and 21.

Diagnostics and findings relating to tooth 11

At the time of the examination, tooth 11 had been treated prosthetically with a metal ceramic crown. Probing of the periodontal apparatus revealed an increased pocket depth mesial to 11.

The percussion test and the sensitivity test gave a negative result. The diagnostic X-ray image (*Fig. 2*) showed a vertical bone loss and also a hard tooth tissue defect in the mesio-cervical region beneath the prosthetic crown of tooth 11. The root dentin appeared to be very



Fig. 2: Initial X-ray findings with cervical root defect.



Fig. 1: Swelling regio 11.

compact over the entire root, a root canal was not discernible by X-ray. The apical regions of the depicted teeth are found to be unremarkable on this image.

Within the context of the case history it was found that the front teeth of the upper jaw were crowned following a trauma to the front teeth about 15 years ago.

Diagnosis

Cervical root resorption

Therapy options

In principle, there are four different therapy approaches for the treatment of cervical root resorption¹:

- Conservative therapy if the resorption is associated with periodontitis
- Resection therapy after surgical defect preparation
- Regenerative periodontal therapy
- Mandibular orthopedic extrusion, if surgical intervention to expose the resorption area is to be avoided.

Discussion of the therapy options

• Conservative therapy

Depending on the extent or depth of the defect, sufficient cleaning cannot be achieved by closed periodontal therapy of the root region.

• Resection therapy

In order to achieve thorough removal of granulation tissue and sufficient defect closure, resection therapy offers a good treatment option. When choosing the filling material, a material should be used which, where possible, does

not exhibit cytotoxicity and promotes the regeneration of the tooth cementum.

In case of surgical interventions in the region of front teeth there is a risk of esthetic degradation postoperatively due to gingival recession and scar formation.

• Regenerative therapy

In principle, the aim should be to carry out regenerative therapy. The regeneration of periodontal structures appears to be all the greater, the deeper the initial defect and the more defect-delimiting bone walls are present.²⁻³ Regenerative methods are therefore indicated only if at least two defect-delimiting bone walls are present.⁴ Periodontal regeneration of one-wall defects, as in this case, cannot predictably be expected.

• Mandibular orthopedic extrusion

The objective of this method is to relocate the defect into the supragingival region by extrusion. Owing to the depth of the defect, however, this form of therapy was excluded because the remaining periodontal anchoring of the root would be too small.

Therapy

In order to comply with the patient's primary wish for an attempt of maintenance, the only remaining therapy option was the resection method. Under local anesthesia, the defect region was prepared by forming a mucoperiosteal flap after marginal incision (*Fig. 3*). The granulation

tissue present was removed and the cavity in the root was smoothed using rotating instruments (*Fig. 4 & 5*). In addition to the subcoronal access caused by the defect, tooth 11 was also trepanized in order to check whether a root canal lumen was to be found. This was not the case, however.

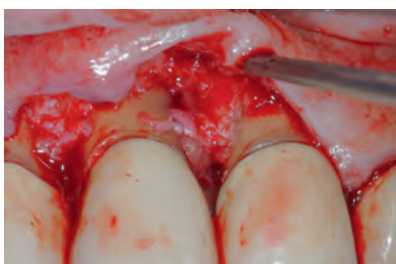


Fig. 3: Surgical preparation of the defect and of the granulation tissue.



Fig. 4: Condition after excochleation of the granulation tissue.



Fig. 5: Condition after excochleation of the granulation tissue.

The prepared cavity was filled with Biodentine™ (Septodont, St Maur des Fossés, France) (Fig. 6 and 7). This material has been found to be very biocompatible and does not seem to have a negative effect on cell differentiation or specific cell functions.⁵ Moreover, in vitro Biodentine™ appears to have a positive influence on the proliferation of periodontal ligament cells.⁶ After

closure of the trepanation opening with composite, the soft part was closed with simple interrupted sutures (Fig. 8).

The clinical and X-ray examination after 12 months shows non-irritated soft part and bone conditions (Fig. 9 and 10). The pocket probe depth mesial to tooth 11 is still found to be increased.

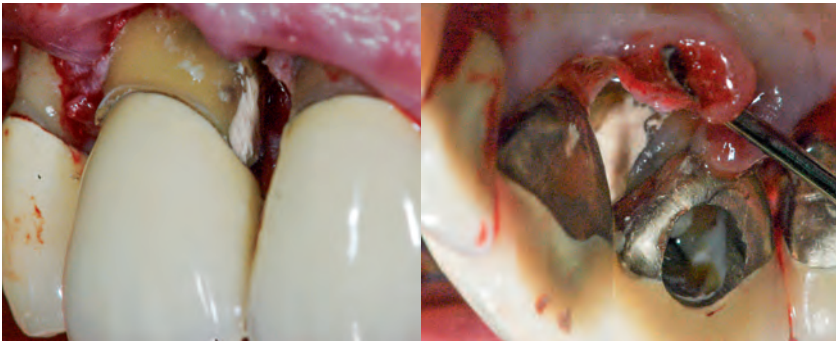


Fig. 6 & 7: Closure of the cavity with Biodentine™.



Fig. 8: Postoperative suturing.



Fig. 9: Clinical picture after 12 months.



Fig. 10: X-ray findings 1 year postoperatively.

Discussion

Cervical root resorption mostly occurs directly beneath the epithelial attachment and is caused ultimately by an injury to the periodontium.⁷ The predisposing factors include mandibular orthopedic treatment, internal bleaching processes

and trauma. Cervical resorptions can extend into the tooth crown where, due to the well vascularized granulation tissue, a “pink” discoloration of the tooth crown can occur, thus leading to the misdiagnosis of “internal root resorption”.⁸

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