In pediatric dental care, we try to keep primary teeth free of caries until they are replaced naturally. However, extensive caries in contact with the pulp still occurs. In such cases, a timely endodontic procedure can enable us to avoid early extraction of primary teeth, thereby preserving the primary objective of dental caries treatment, which is to maintain the function of chewing, speaking, swallowing and esthetic appearance.

Why pulpotomy?

In primary teeth, pulpotomy is the most widely accepted pulpal treatment throughout the world. Above all, it is the complex root canal anatomy of the primary teeth, the proximity of permanent teeth and the absence of filling materials compatible with physiologic root resorption that determine this choice. A pulpotomy is based on the hypothesis that the inflammation and reduced vascularization, caused by bacterial invasion, are confined to the coronal pulp, while the root pulp remains vital (Fig. 1).
An ideal material for pulpotomy

An ideal pulpotomy material should be bactericidal, promote root pulp healing, provide a relatively stable environment for the dentin-pulp complex, stimulate dentin-pulp complex regeneration and not disturb the physiologic process of root resorption.

What the literature tells us

Despite its limited bactericidal action and potential toxicity, formocresol is regarded as the reference standard worldwide. Iodoform pastes which have a greater bactericidal action and are histologically better tolerated are less widespread and are used more on a regional level. At the same time, scientific evidence has emerged showing that pulpotomy performed with Mineral Trioxide Aggregate (MTA) produces better clinical and radiographic results than formocresol[1,2] (Fig. 2). Meanwhile, Biodentine™, a non-metallic, inorganic, tricalcium-silicate (Ca₃SiO₅)-based restorative cement, marketed and recommended as a “bioactive dentin substitute”, has been shown to have much better physical and biologic properties, such as material handling, faster setting time, better resistance to pressure, greater leak resistance and faster dentin bridge formation compared with MTA. Although clinical studies (long-term studies) are still rare, Biodentine™ appears to be an effective substitute for MTA in pulpotomy.

How to perform pulpotomy with Biodentine™

- Remove any caries and the pulp from the pulp chamber
- Control bleeding at the canal entrances
- Mix the material following the manufacturer’s instructions
- The material can be applied deep within the cavity with a spatula or amalgam carrier.

The material can be compacted using dry pluggers or cotton pellets.

On no account should the cotton pellets be moistened with water (!); any residual liquid from Biodentine™ (calcium chloride) may be used for moistening later, after which the cotton pellet should be squeezed out thoroughly using a towel.

![Fig. 2: Comparison of percentage success of formocresol and MTA](image-url)
Choice of filling material after pulpotomy

Biodentine™ can be used as a temporary filling material that can be exposed to saliva for 6 months. This can be an advantage for lengthy treatments or in uncooperative children. If the dentist wishes to make a permanent filling, he or she is then advised to wait 6 minutes until the material has completely hardened, after which bonding restoration can be performed. Studies have shown that etching the Biodentine™ surface with a $\text{H}_3\text{PO}_4$ gel for 15 seconds and applying a bonding layer achieves greater adhesive strength and less micro-infiltration. It is also possible to opt for a steel crown.

Case studies

All the cases described below took place under general anesthesia as part of a randomized clinical trial (RCT).

Case no. 1

In a 6-year-old girl, pulpotomy with Biodentine™ was performed on tooth 75. The radiograph at one-year follow-up showed no complications whatsoever (Fig. 3).

Case no. 2

In a 5-year-old boy in whom tooth 84 had been treated by pulpotomy with Biodentine™, the radiograph at 1-year follow-up shows complete obliteration (Figs. 4–5–6).

In the RCT in progress at the Pedodontics Department, obliteration is the most common observation when Biodentine™ is used for pulpotomy of primary molars. It is considered a positive sign as obliterated canal pulp usually does not cause any clinical complications.
Case no.3

A 3-year-old girl had been treated 1 year previously for multiple caries. Pulpotomy was then performed with Biodentine™ on tooth 75 (Fig. 7). After 6 months of follow-up, there were no complaints such as spontaneous pain, tenderness on percussion, tenderness on palpation, increased mobility or swelling. A sign of internal resorption on the mesial root was visible on the radiograph (Fig. 8). It was decided to follow up the tooth every 3 months.

After 9 months of follow-up, the patient had no pain and the tooth was in order clinically.

After 12 months of follow-up, the tooth was still not causing any problems. Early obliteration was visible on the radiograph in the place of the internal resorption (Fig. 9). The appearance of internal resorption after pulp treatment is attributed to inflammation of the residual pulp whereas obliteration results from increased activity of odontoblast-like cells. The formation of tertiary dentin leads to obliteration and should be considered an attempt by vital pulp tissue to heal. Consequently, in the case presented above, the incipient inflammation may have been halted, leading to a healing process.

Remarks

- Owing to limited radio-opacity, it can sometimes be difficult to see dentin bridge formation and it can be confused with natural dentin. In a 6-year-old girl, 3 pulpotomies were performed with three different materials. The radio-opacity of the 3 materials can be compared on the radiographs (Figs. 10, 11 and 12).

- A major advantage of Biodentine™ over MTA is the absence of grayish-black discoloration. Figure 13 shows a clinical view of a primary tooth treated by MTA pulpotomy a year earlier. Figure 14 shows a clinical view of a primary tooth treated with Biodentine™, also at 1-year follow-up. There is absolutely no discoloration.
Clinical Success

As a pulpotomy material, MTA has been shown to produce better clinical and radiographic results than formocresol. In the authors’ clinical study, no clinical or radiographic differences were found between Biodentine™ and MTA when used as a pulpotomy agent in carious primary molars.

Conclusion

The era of formocresol and other mummification products for the treatment of deep caries of vital primary molars appears to be past. In regard to MTA, a modified Portland cement, there is already a fair amount of evidence in the literature. Biodentine™, with its superior properties in comparison with MTA, also appears to show this in clinical practice. Moreover, the absence of coronal discoloration is a major additional benefit.

References

Introduction

It is a well-known fact that calcium hydroxide has a major antibacterial action and thereby minimizes or eliminates bacterial penetration. While this has been recognized for decades, the healing mechanism has only recently been described. “Bone morphogenetic protein” and “bone transforming growth factor beta 1” play a very important role here, in both pulp healing and new dentin formation.

However, the disadvantages of calcium hydroxide are that it does not have good adhesion on its own, resulting in poor sealing, and that it is highly soluble.

MTA, well known as an aggregate of tricalcium silicate, dicalcium silicate and tricalcium aluminate, has, with water, calcium hydroxide as its principal reaction product. It is to this that MTA owes its biocompatibility. Moreover, a single seal with dental tissue is found, following a bioactive reaction. Another disadvantage is its high solubility and long setting time.

Three studies were published between 2003 and 2008 in which no clinical differences were found between calcium hydroxide and MTA, while 4 other studies considered MTA to be more effective. However, histologic studies revealed that there was less pulpal inflammation with MTA and that a tissue barrier with superior hardness was formed. A very recent (2013)
practice-based randomized clinical trial has established the superiority of MTA as a direct capping material. As regards BiodentineTM, various in vitro animal experiments have established its biocompatibility, bioactivity and ability to induce pulp healing. In a study on direct capping in piglets, BiodentineTM showed much faster hard tissue induction than calcium hydroxide in the short term (1 week). However, beyond 3 months, no further difference in barrier formation was observed. It was shown, via a “human dental culture model”, that Biodentine™ and ProRoot™ MTA both initiated reparatory dentin synthesis. The possibility of inducing cell proliferation as well as biomineratization was clearly demonstrated on immortalized murine pulp cells.

In a study of human pulp in which capping was performed on premolars due to extraction for orthodontic reasons, no difference between MTA and Biodentine™ was apparent. In both cases, complete dentin bridges were observed in the presence of inflammatory cells. Moreover, layers of odontoblasts and pseudo-odontoblastic cells forming tubular dentin were observed. Besides the good histologic reactions established since then, Biodentine™ has the added advantage that discoloration never occurs (unlike MTA) and that the material can act as a temporary filling material and be exposed to saliva for a certain number of months. This is comforting for both patient and practitioner.

### Case report

Patient A (7 years) presented for treatment of caries on tooth 46. He had not previously complained of pain. During curettage (see Fig. 1a), the pulp was almost exposed. After eccentric removal of all the caries, indirect capping was performed with BiodentineTM, after which the entire cavity was filled with it. Figures 1b and 1c show the radiographic image before and after. During follow-up, no subjective complaint was reported. After only a year, the continued formation of radicular apices was apparent on radiographs. The formation of hard tissue in the pulp chamber is also probable (Fig. 2b).

In patient B (14 years) very deep caries was found on tooth 47 during treatment (Fig. 3a). There had been no previous symptoms. Biodentine™ was placed inside the entire cavity (Fig. 3b). Figures 3c and 3d illustrate Biodentine™ in place immediately after treatment and a few weeks later, respectively. Due to its special properties, Biodentine™ can be used as a temporary
filling material, unlike MTA. Here also, there were no complaints of pain during the follow-up period. In patient C (12 years) who had absolutely no complaints previously, an occlusal lesion was treated and the pulp was almost exposed unexpectedly (Fig. 4a). Biodentine™ was placed here as a cap and cavity lining (Fig. 4b) and immediate restoration with composite was performed (Fig. 4c, d). The patient had no complaints of pain during the follow-up period. In patient D (11 years) deep caries on tooth 46 was detected radiographically, on which pulp exposure appeared inevitable (Fig. 5a). Direct capping with Biodentine™ was performed (Fig. 5b). There were no further complaints at follow-up. The control radiographs suggest the formation of hard tissue after 4 and 8 months (Fig. 5c, d).

Conclusion

Biodentine™ calcium silicate cement is suitable for use as a capping material for deep carious lesions and pulp exposure. The material can be used as a temporary filler and can be exposed to saliva for a certain number of months and act as a cavity liner, on which an immediate composite restoration can be placed. Clinical follow-ups reveal no complaints from patients at 2-3 years. Radiographs show continued maturation of immature molars and hard tissue formation can be seen in pulp chambers.

References

R.T.R. (Resorbable Tissue Replacement) is a highly pure β-tricalcium phosphate bone grafting material that helps to safely create new bone formation following an extraction or any bone loss (intrabony defect, sinus-lift...).

- **Resorbs progressively and fully:** R.T.R. releases calcium and phosphate ions helping to promote strong new bone formation.
- **Regenerates natural bone growth.** Osteoconductive micro and macroporous structures foster dense new bone growth.
- **Restores volume:** R.T.R. renews the bone integrity within 3-6 months.
- **Available in 3 presentations** (Cone, Syringe, Granules) to suit all clinical situations.

Improve your patients’ extraction therapy and bone loss repair to promote future implant success with R.T.R.

R.T.R. Cone contains collagen from bovine origin.