THE USE OF MINERAL TRIOXIDE AGGREGATE VERSUS CALCIUM HYDROXIDE IN THE TREATMENT OF NECROTIC IMMATURE TEETH

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Abstract: Due to their morphologic and structure features, immature permanent teeth represents a special entity with apical zone development in full swing. That is why the treatment of immature teeth with necrosis is a real challenge to induce root-end barrier formation using endodontic materials and providing good apical seal. Till now, the most appropriate material used has been calcium hydroxide but the recent putting in practice of mineral trioxide aggregate (MTA) with excellent biological and physical qualities seems to reduce the domination of calcium hydroxide in endodontics field. The aim of this study is to analyse and to compare the biological and microbial properties of both materials based on scientific evidence from previous literature.

INTRODUCTION

In apical and periapical zone there are unlimited repair potentials able to induce root-end finalization (apexification) or just hard tissue barrier formation (apexogenesis). In most clinical cases we confront with total lost of pulp vitality which requires standard endodontics procedures to neutralize bacterial toxins and to achieve appropriate conditions to induce barrier formation. Finally, the apical sealing consists in a tridimensional fibrous or hard plug which will delimitate root-canal from periapical zone.

Keywords: hidroxid de calciu, mineral trioxid agregat, apexificare, barieră apicală

Rezumat: Dinti premenenți tineri (DPT) reprezintă prin caracteristicile morfologice și de structură o entitate aparte aflată în plin proces de dezvoltare radiculară. Gangrena complicată la DPT cu pierderea totală a vitalității pulpore constă în provocarea în ceea ce privește inducerea acoperișului hidrofílc utilizând diverse materiale endodontice specifice cu scopul de a forma o barieră apicală care să sigureze definitiv canalele radiculare. Materialul de elecție utilizat în acest scop este hidroxidul de calciu dar apariția relativ recentă a mineralului trioxid agregat (MTA) grație calităților sale fizice, chimice și biologice pare să reducă încet dar sigur suprematia îndelungată a hidroxidului de calciu. Scopul acestei lucrări este de a analiza și compara pe baza datelor culese din literatura de specialitate, avantajele și dezavantajele celor două materiale utilizate în tratamentul gangrenei DPT în ceea ce privește propriițațile antimicrobiene și biologice.

PERSONAL CONTRIBUTIONS

This comparative study is based on scientific research selected from articles and studies most of them from the last ten years.

The dates were divided into groups which describe the physical, chemical and biological properties and also the specific techniques of apexification for both materials.

1. General characteristics

Calcium hydroxide, used in practice for the first time by Herman in 1920 for treatment of dental pulp, is a strong base that results from calcium oxide hydration. Well-conducted researches about the properties of calcium hydroxide, like histocompatibility, antimicrobial potential and ability of sealing give credibility to choose this medication in immature teeth necrosis. It is necessary to take into account the influence of vehicles on properties of calcium hydroxide and the time of action for express microbial control.(5)

The combination with saline solution or distilled water gives better results (approximately 60 % total reparation) than association with camphorated monomorophenol (CMPC) with only 20% total reparation.(11)

Mineral trioxide aggregate was developed by Dr.Torabinejad at Loma Linda University in 1990 and since then is used like an endodontic material. There have been many articles published in dental journals which confirm the excellent biological and physical properties.(26)

It is available as ProRootMTA but recently a new cement was laundred commercially labeled as MTA-Angelus.MTA is a white or grey powder of fine hydrophilic particles consisting of compounds of tricalcium silicate, tricalcium oxide, tricalcium aluminate and silicate oxide.(14)

Several studies have reported that MTA is similar to commercial Portland cement (PC) which represents 80 % and the rest of 20 % is bismuth oxide added for radio-opacity.(2)

On hydration both materials (PC and MTA) are forming a calcium silicate gel and calcium hydroxid in ratio 4:1, which can explain the similar mechanism of MTA and calcium hydroxide.

2. Physical, chemical and antimicrobial properties

Calcium hydroxide is considered in present the main endodontic material in treatment of necrotic immature teeth because of its properties:

- high alkaline pH (12,6) which explains antimicrobial properties able to destroy in just 1-6 minutes 99,9% of bacteria in contact with calcium hydroxid
- persistent root-canal secretions are stopped; Sjögren demonstrated that after 7 days root canals are completed sterilize
- low solvability in water determine a gradual release of hydroxyl ions and also a low

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Mineral trioxide aggregate:
- the major disadvantage of calcium hydroxid is higher resorabability which require periodic replacement till the complet root formation
- if the root-canal is not straight and large enough the application of material till apical zone can be difficult
- to destroy Enterococcus Faecalis, bacteria responsible for treatment failure, calcium hydroxide needs more time than for others bacteria
- it has a poor sealing ability.

Disadvantages:
- neither white nor grey form of MTA has genotoxicity and overgrowth with minimum or absent inflammatory histologycal exams evidenced stimulation of cementum but not quantity.(21)
- barrier formation with a high consistency as regards quality MTA stimulated hard tissue deposition and mineralized root-canals.(16)
- periapical healing when is used properly on disinfected more studies demonstrated that MTA determine complete resorbability.
- excellent sealing ability against facultative microorganisms and a good apical root-end filling material.(14)
- histological exams evidenced stimulation of cementum overgrowth with minimum or absent inflammatory response.(3)
- neither white nor grey form of MTA has genotoxicity and citotoxicity properties (19) although MTA has no specific indication in chronic periapical lesions is proved to be very efficient in certain clinical cases, complete healing occurring after an important period of time.(9)
- the most frequent reaction after one week treatment with MTA is proliferation of granulation tissue with a few inflammatory signs.(3)
- a recent study showed that MTA does not affect phagocytosis and ability of two macrophage subtypes, to eliminate microbes.(17)
- MTA is considered now the ideal material used for nonsurgical treatment of radicular furcation and perforation.(9)

4. The use of MTA and calcium hydroxid in apexification

Apexification is defined as a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incomplete root in teeth with necrotic pulp.(1) To induce apexification calcium hydroxide is considered the most indicated endodontic material but it has several disadvantages:
- variability of treatment time, number of appointments and radiographs difficulty in patient follow-up, delayed treatment.(21)
- possibility of increasing tooth fractured after calcium hydroxide was used for extended periods.

Mineral trioxide aggregate represents an alternative because of his multiple advantages:
- reduction in treatment time and possibility to restore tooth with a minimal delay and thus to prevent the fracture of root and also avoiding changes in the mechanical properties of dentine because of prolonged use of calcium hydroxide. (22)

If the root canals are not appropriate prepared and deinfected the secondary effects which appear are the absence of apical hard tissue barrier, inflammatory reactions and finally root-canal and bone resorbtion

5. The technique of apexification

Calcium hydroxide is associated with the most common technique which consists in mechanical and chemical root-canal preparation and filling with an endodontic material.
After clinical steps the patient needs to be follow-up from 3 to 3 months (the complete apexification is done in at least 6-24 months). Periapical pathology, secondary pain or destroyed filling are factors that increase the period of treatment. Failures of this technique may be caused by a repeated overfilling with a high pH which induces a necrotic zone in periapical tissues (15).

That is why several authors are recommending the new technique one visit apexification, which consist in an apical plug of MTA placed in the last 5 mm of incompletely root canal. Obturation of root-canal and immediately placement of a coronal restoration are possible and are regarded as key elements for the long term conservation of treated tooth.(24)

The protocol followed for apexification with MTA

To use MTA the powder is mixed for 30 seconds with a drop of distilled water. The mixture should be homogeneous and with a consistency similar to wet sand, If the MTA is not use immediately after mixing its deshydration can be prevented by covering the mix on the glass slab with a wet gauze. It is optional if MTA is placed into canals after the use of calcium hydroxide for one week. After preoperative radiograph (Picture no.1) and isolation with of tooth with rubber dam, should be followed the next steps:
1. Chemical and mechanical debridement with sodium hypochlorite (5,25%), EDTA 17% and chlorhexydine 2% and irrigation sodium hypochlorite 5,25%.
2. Drying of the canal with a sterile paper point on the work
length determined previous ( Picture no. 2 )

**Picture no. 1 Aspect of immature tooth (6) with pulp necrosis**

3. The proper size plugger choice so that can be neither too large to stuck in the root walls or to small to penetrate the plug of MTA

4. Placement of collagen matrix to the apical zone (CollaCote) as an organic foundation for MTA (Picture no .3)

5. Apical zone sealing with MTA plug in the last 3-4 mm and after radiological examination the adjustment if needed with an endodontic plugger (Picture no. 4 )

**Picture no. 3 Radiotransparent periapical CollaCote matrix (6)**


(6)

**Picture no. 4 Apical sealing with MTA plug followed by complete filling with gutta-perca(6)**

**Picture no. 5. The aspect of apical and periapical zone after 2 years. It showed complete root maturation and periapical lesions healing (6)**

The MTA is use in apexification after the complete remission of acute symptoms because the low pH of inflammatory lesions from apical zone compromise the healing and the barrier hard tissue formation.

## CONCLUSIONS

The importance of calcium hydroxide in endodontic developed occurred due to specially its biological properties that should not be neglected. Scientific investigations should be carried out frequently to evaluate materials recommended for use in endodontic. It is necessary whenever to give time for calcium hydroxide paste to manifests its potential action on microorganisms present in endodontic infection.Despite efficacity of this dressing some authors criticize the quality of the hard tissue bridge formed with calcium hydroxide, claiming tunnels defects, which can compromise the protecting efficiency of bridge.(5)

Based on the results of previous studies mineral trioxide aggregate is an advantages alternatives of calcium hydroxide being more biocompatible and with a greater sealing capacity. Although MTA is the most investigated material in dentistry, producing remarkable results, the majority of studies were made in labs or using animals. The research must be continued for clinical evaluation in human subjects.(12) MTA reacts with fluids from tissues to induce apical hard tissue barrier(27).The cellular response and the mechanism of hard tissue barrier induction are still little known and necessitate more investigations. At 6 months, 1 year and 2 years follow-up periods the clinical and radiographic appearance of teeth showed the resolutions of periapical lesions and continued root end formation in all except the cases in which the MTA was extruded out the apex (4).

As regard association of MTA with calcium hydroxide in treatment of immature permanent teeth several studies showed that the regeneration of periapical tissues appears in a shorter period and the healing is complete.(10)

**In conclusion**, most of scientific researches done by now demonstrated the efficacy of both endodontics materials, with advantages and disadvantages, the choice of one depending on clinical situations, apexification technique and social-economics conditions.

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