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Application Of Mta And Biodentine In Pediatric Endodontics: A Review

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ABSTRACT:

The dawn of a new era was seen in pediatric dentistry with the invention of calcium silicate-based materials like Mineral Trioxide Aggregate [MTA] and Biodentine [BD]. Their introduction into Pediatric endodontics as regenerative materials has made boundless productive changes starting from vital pulp therapies like pulp capping, apexogenesis to non-vital pulp therapies like apexification and revascularisation process. Excellent biocompatibility, regenerative property, low cytotoxicity, formation of chemical bond with the tooth structure, good radiopacity, easy handling characteristics make these materials an attractive option in pediatric endodontics. MTA and Biodentine materials have given remarkable prognosis in various clinical condition, the treatment of which once considered as impossible. This article aims to review the success rate of Biodentine and MTA in pediatric endodontics.

Keywords: MTA, Biodentine, Pediatric endodontics

INTRODUCTION:

The quest for newer materials to treat patients effectively and efficiently forms the basis of dentistry. For many decades calcium hydroxide has been the gold standard material for maintaining the vitality of pulp tissue, owing to its capability of stimulating tertiary dentin formation[1]. However its use has diminished over the years due to disadvantages such as existence of tunnel defects in induced dentinal bridges, poor adherence to dentine, and lack of long-term seal[2]. MTA and Biodentine have revolutionized the field of endodontics by its antibacterial and regenerative property, biocompatibility, bioactivity and ability to achieve excellent hermetic seal.

Mineral Trioxide Aggregate (MTA)

was introduced by Mohmoud Torabinejad at Loma Linda University, California, USA in 1993.It was given approval for endodontic use by the U.S. Food and Drug Administration in 1998. ProRoot MTA (Dentsply Tulsa Dental Specialities, Johnson City) was the first commercially available MTA product to be launched in the United States. MTA Angelus (Angelus, Londrina, Brazil / Clinician's Choice, New Milford, CT) was launched in Brazil in 2001 and received FDA approval in 2011[3]. Mineral trioxide aggregate (MTA) has been used as a retrograde filling material due to its hydraulic properties. Most dental materials exhibit a deterioration in physical properties upon contact with moisture. The oral cavity is not an ideal environment for most dental material due to the presence of blood and moisture. For example, amalgam restorations are sensitive to moisture and set less than adequately in case of moisture contamination. In order to counteract this problem, a hydraulic material used in the construction industry was introduced. Moisture plays an essential role in the hydration process of MTA, which is responsible for its setting and sealing process[4].Limitations of MTA include its longer setting time, manipulation difficulty, high cost and tooth discoloration. These drawbacks have prompted the development of new calcium silicate-based material with improved properties. Although various calcium

silicate-based products have been launched to overcome the disadvantages of MTA, one of these has especially been the focus of attention is **BIODENTINE** [BD]

Biodentine was first commercially available in 2009 (Septodont, http://www.septodontusa.com/) and was specifically designed as a 'dentine replacement' material. The material is actually formulated using the MTA-based cement technology with improvement of physical properties, setting time and handling properties[5].It is relatively more user-friendly material as compared to MTA. A good sealing ability, reduced setting time and improved handling properties, as compared to MTA, have made BD a promising alternative to MTA[6].

COMPOSITION OF MTA AND BIODENTINE:[7]

MTA:

MTA is a mixture of three powder ingredients**: Portland cement (75%), Bismuth oxide (20%) and Gypsum (5%)**

- tricalcium silicate ($3CaO.SiO_2$)
- dicalcium silicate ($2CaO.SiO_2$)
- tricalcium aluminate ($3CaO.Al_2O_3$), and
- tetra calcium aluminoferrite ($4CaO.Al_2O_3.Fe_2O_3$)
- Calcium sulphate
- Bismuth oxide
- Calcium oxide
- Silicon oxide
- Aluminium oxide

BIODENTINE:

POWDER:

- Tricalcium silicate (main core material)
- Dicalcium silicate ((second core material)
- Calcium carbonate (CaCO2)(filler)
- Zirconium Oxide (ZrO2) (radiopacifier)
- Iron oxide(colouring agent)

LIQUID:

- Calcium chloride (setting accelerator)
- Hydrosoluble polymer (water reducing agent)

SETTING TIME AND MANIPULATION:

MTA:

Mineral trioxide aggregate is a water-based dental cement. It is usually supplied in pre-dosed powder and liquid that are blended together to obtain a homogeneous paste. The recommended water/powder ratio is about 3:1 i.e. 3 parts of powder with 1 part of water to obtain putty like consistency.[4] The mixing time of MTA is crucial. If the MTA mixing is prolonged, it results in dryness of the mix. Sluyk et al reported the mixing time of MTA to be kept less than 4 minutes[8]. MTA should be inserted in place immediately after mixing to avoid dehydration. A lentulo spiral can be used for its insertion or alternatively a micro amalgam carrier, guttapercha plugger, Map system, Dovgan applicator, or ultrasound can be used[4].

Setting time: 2hrs 45 min

MTA Angelus has been shown to set in less than 50 minutes , as opposed to ProRoot MTA which was reported to have a setting time of over 2 h.[4]

BIODENTINE:

Biodentine is a two-component material [powder and liquid]. By mixing 5 drops of liquid to the powder present in the capsule, the material is being prepared. These components are then pulverized using an amalgamator for 30 s at 4000 rpm leading to the formation of a mix with creamy consistency. The presence of Calcium chloride [setting accelerator] permits the material setting in 12 minutes and the presence of a water reducing agent prevents the formation of cracks within the material[9].

CLINICAL APPLICATION OF MTA AND BIODENTINE:

PULP CAPPING:

Pulp capping can be of two types: Direct pulp capping[DPC] and Indirect pulp capping[IPC]. Indirect pulp capping is the vital pulp treatment where the deepest decay is left in place to avoid a pulpal exposure and the tooth restored to prevent microleakage[10].Direct pulp capping is defined as the procedure in which the exposed vital pulp is covered with a biocompatible material placed directly over the site of exposure in an attempt to preserve vitality. Ideal pulp capping material should preserve the pulpal vitality and promote the formation of reparative dentin. For Direct Pulp Capping (DPC) Biodentine and MTA are effectively used and they are capable of regenerating relatively damaged pulp tissues and hard dentine bridge formation[11]. But DPC in primary teeth has been a controversial due to various reasons. The high cellular content of pulp tissue in primary teeth is responsible for failure of direct pulp capping procedure. In response to caries or the pulp-capping material, the undifferentiated mesenchymal cells stimulate the formation of odontoclastic cells resulting in internal resorption. The high pulpal cellular content leads to increased inflammatory response and increased incidence of internal resorption in primary teeth[12]. Milcheva et al[13] performed DPC with MTA in primary dentition for treatment of reversible pulpitis. Total number of teeth included in the investigation were 35. Pulp was exposed up to 1 mm in diameter. The small pulp exposure was covered with MTA paste and the cavity was finished with lining of GIC and compomer and adhesive system as a permanent filling. The success rate after 24 months follow up is 82.86% . Bodem et al[14] presented a case in which pulp capping was performed on right first mandibular primary molar in a 7-year-old male patient. MTA was used for pulp capping. There were no pathological findings clinically and radiographically after a period of 18 months, and the tooth remained vital after capping with MTA. On examining the inflammatory cell response and hard tissue formation following the placement of biodentine in pulp capped primary pig teeth, normal pulp tissue without any signs of inflammation was reported[15]. Swarpoop et al[16] studied the response of pulp-dentin complex after DPC with MTA and biodentine in carious teeth. MTA and biodentine showed 91.7% and 83.3% success rate, respectively, based on the subjective symptoms, pulp sensibility tests, and radiographic appearance. A systematic review and meta-analysis was done to evaluate the clinical outcome of MTA, Biodentine and calcium hydroxide as a direct pulp capping agent in 2018 by A.Huria et al[17] and concluded that MTA and Biodentine had high clinical success rate compared to calcium hydroxide. Another systematic review done by Mahmoud et al[11] evaluated the clinical outcome of MTA and Biodentine and reported Biodentine and MTA to have a similar effect on dentin bridge formation.

Indirect pulp capping [IPC] is a non-invasive treatment option for symptom-free primary teeth with deep carious lesions without signs of irreversible pulp inflammation. A clinical trial conducted by Artura et al[18] evaluated the clinical and radiographic outcomes of Biodentine and a light-activated calcium hydroxide [Ca(OH)2]-based liner as indirect pulp agents for vital primary molars with deep carious lesions. The combined clinical and radiographic success rates were 98.3 percent for Biodentine and 95 percent for Ca(OH)2 .Another study done by George.V et al[20] assessed the effectiveness of mineral trioxide aggregate (MTA) compared to Dycal in IPC of primary teeth and concluded that clinically both MTA and Dycal are good IPC agents in primary teeth. Radiographically, MTA is superior to Dycal as IPC medicament in primary teeth. Dentin deposition was more in teeth treated with MTA. Chauhan.A et al[19] clinically and radiographically compared the outcomes of IPC when a layer of calcium hydroxide (Dycal), MTA or Biodentine was placed over the affected dentin in primary molars and the results showed 100% clinical success in all the groups. However, the highest amount of

tertiary dentin deposited was recorded with Biodentine radiographically. The amount of tertiary dentin deposited was more in the first 3 months than the last 3 months in all the groups.

PULPOTOMY:

Pulpotomy is defined as an endodontic procedure where the coronal pulp is removed and the vital radicular pulp is maintained within the root canals followed by placement of long term clinically successful medicament with good hermetic seal until natural exfoliation of the deciduous tooth. History of spontaneous pain, sinus tract, nocturnal pain, furcal abscess and pathologic mobility would warrant the tooth unfit for pulpotomy. Pulpotomy should be performed when the intracanal hemorrhage is bright red in colour and the control of bleeding should be achieved within 3–5 min[21]. MTA and Biodentine are regenerative agents whereas formocresol which is a gold standard pulpotomy medicament is a devitalizing agent. Both MTA and Biodentine showed promising results when used as pulpotomy medicament in long term follow up studies. However, biodentine demand less time for the pulpotomy procedure. MTA acts only as dressing material, which needs another restorative material to seal the pulp chamber. But biodentine acts both as dressing and filling material. Thus, biodentine removes the need for a filling material in the pulp chamber of pulpotomized teeth[22]. A systematic review and meta-analysis of clinical trials was done by Emyr et al in order to evaluate the clinical and radiographic success rates of primary teeth pulpotomy performed with biodentine, when compared to MTA. This systematic review concluded that there is no superiority of one material over other. But the study also emphasized the importance to evaluate the clinical performance of biodentine that overcomes the drawbacks of MTA (poor handling property, staining potential, long setting time).[23]H.N Nasseh et al[24] evaluated the efficacy of Biodentine™ as pulpotomy medicament on primary molars with physiological root resorption. A total of 35 primary molars in 31 healthy children aged from 8 to 11 years were included in the study. The clinical and radiographic success rates at 6 and 12 months were 100%.For Kusum et al[25]., the overall clinical success rate evaluated for MTA and Biodentine™ over nine months follow-up were 100%.A randomized clinical study was performed by C.Fernández et al[26] in children aged 4–9 years and he reported the clinical success rate in the MTA Group after 12 months to be 92 %, whereas the Biodentine Group obtained 97 %. Musale PK et al[27] compared the clinical efficacy of Biodentine, White MTA and formocresol [WMTA] .Based on the results he concluded that Biodentine showed clinical and radiographic success comparable to FC and WMTA and Pulp canal obliteration (PCO) was substantially higher with Biodentine than FC and WMTA. These findings were similar to Rajshekharan et al[28] who reported an 65% occurrence rate for pulp canal obliteration with BD and 26.09% with MTA. Niranjani et al[29]. compared MTA, Biodentine and laser in their pulpotomy study and reported that the highest success rate was seen in MTA group; however, there was no statistically significant difference between the groups.

APEXIFICATION:

Managing non-vital immature teeth is extremely challenging due to compromised crown root ratio, thin root dentine walls and wide-open apex lacking an apical stop against which root filling materials can be condensed[30]. Apexification is an endodontic procedure indicated to treat immature permanent teeth with loss of vitality. The procedure aims to form a calcified apical barrier which permits the canal to be filled in a conventional way. The traditional apexification technique used calcium hydroxide, $Ca(OH)_2$ which presents certain drawbacks such as multiple visits and loss of mechanical strength which increases the possibility of root fracture. Several clinical trials have indicated that MTA apexification offers a feasible alternative to achieve root closure in immature teeth. The time required for the formation of apical stop is remarkably less in teeth treated with MTA compared to teeth treated with $Ca(OH)_2$[31] . Mente et al[32] conducted a study with largest sample number treated with apexification (252 samples) and with a 10-year follow-up period and reported that the placement of apical plugs with MTA is an appropriate treatment option for teeth with an open apex. Chang et al[33] studied the effect of extruded MTA into the periapical region. Total resolution of the periapical radiolucent lesion around the extruded MTA was observed and reported that direct contact with MTA had no negative impact on healing of the periapical tissues. But intentional MTA overfilling into the periapical lesion is not recommended. Nosrat et al[34] analysed and reported that extrusion of MTA in peri radicular tissues may remain unactivated, and affect the healing process. A systematic review done by F.Guerrero et al[35] advocated MTA apexification as a

substitution to Ca(OH)2 apexification. Unlike MTA, Biodentine has easy handling properties and require less time for setting with excellent mechanical and biological properties. Single visit apexification with bioactive materials such as Biodentine and MTA can be considered an effective treatment option for teeth presenting with open apices[36]. Jerin jose et al[37] compared Biodentine and MTA apexification in non-vital central and lateral incisors with open apices in a single patient. The case report outlines the successful treatment of a 12- year- old female with maxillary central incisors and lateral incisor that had open apices and periapical lesions. MTA apical plugs were used in central incisor and Biodentine in lateral incisor. This study compared the healing efficacy of MTA and Biodentine apexification using Cone beam-CT and concluded that both Biodentine and MTA used as an apexification material. But faster bone deposition was seen in Biodentine apexification. The favourable clinical and radiographic outcome was reported by Karla Vidal et al[38] and concluded that Biodentine may be an efficient alternative to the conventional apexification materials.

CONCLUSION:

Biodentine and MTA had almost similar success rates in primary teeth with carious pulp exposure as a regenerating agent and as an apical barrier in immature permanent teeth. Disadvantages of MTA has given a way for the use of Biodentine with better results. The shorter setting time and easier handling of Biodentine may make it a preferred alternative to MTA. However, clinical trials with longer follow-up periods are required before any conclusive recommendations can be made.

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