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Characteristics of Surface Interface between Glass Ionomer Cement with MTA and Biodentine

[1]Manoj kumar K R,[2] Deepa Gurunathan,[3] Madhu Sudhan Vasantharajan, [4]Lakshmi T

[1]Under Graduate Student, Saveetha Dental College, Saveetha Institute Of Medical and Technical Sciences, Saveetha University ,Chennai. Tamilnadu,India

[2]Professor,Department Of Pedodontics ,Saveetha Dental College,Saveetha Institute Of Medical And Technical Sciences, Saveetha University ,Chennai. Tamilnadu,India

[3]Senior Lecturer,Department of Pedodontics,Saveetha Dental College, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai. Tamilnadu,India

[4]Associate Professor, Department of Pharmacology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai. Tamilnadu,India

[2]drgdeepa@yahoo.co.in

ABSTRACT:

INTRODUCTION: Biodentine was developed to overcome the shortcomings of MTA. It is produced in a smaller particle size and had being improved. Whereas MTA is still being widely used as a material of choice in many Endodontic procedures.This study will emphasise the use of BIODENTINE that can be a better replacement for any other biocompatible material regardless of its cost & technique sensitivity. AIM: The aim of this study is to evaluate the adaptability of Biodentine and MTA with Glass ionomer cement(GIC). OBJECTIVE: To evaluate the shear bond strength of GIC with two different types of restorative materials, mineral trioxide aggregate(MTA) & BIODENTINE. MATERIALS AND METHOD: The study materials consisted of 2 groups containing 5 samples each of MTA with GIC and Biodentine with GIC respectively. Group A- Biodentine (Septodont,France) with GIC type II , Group B- MTA (Pro root MTA,USA) with GIC type II. After the final set of the materials, the interface between the 2 materials were analysed under scanning electron microscope at various magnifications such as 50x,500x, 2000x and 3000x respectively. The interface layer was graded using the scoring system given by

Asrianti et al. The results were tabulated and then subjected to statistical analysis using G power software.
RESULT: The results indicate the bonding between GIC and biodentine (group A) had better bonding in comparison with GIC and MTA (group B), but the results weren't statistically significant (p>0.005).CONCLUSION: Biodentine is more bioactive when compared to MTA and relatively overcome most of drawbacks of MTA under specific circumstances , this study can propose that Biodentine could probably be a source of better alternative to MTA in general clinical practise.

Introduction:

Bioactive materials are the biomimetic materials that are highly developed in recent times. Bioceramics in Endodontics can be considered as a magnanimous entity which has changed the prognosis of many cases which were once considered as next to impossible. They can trigger the biological response of tissues and cells [1]. Some bioactive materials that are still being developed and redefined are calcium silicate based materials such as Mineral Trioxide Aggregate (MTA) and Biodentine. Calcium hydroxide has been considered as the "gold standard" of direct pulp-capping materials for several decades[2].This possess the repair mechanism which in part to the release of bioactive molecules from dentin matrix, including Bone-Morphogenetic Protein (BMP) and Transforming Growth Factor-Beta One (TBF-β1). Both have demonstrated the ability to stimulate pulp repair and dentin remineralization[3]. While (mineral trioxide aggregate, MTA) has become a better alternative [4].

A remarkable biocompatible material, MTA with exciting clinical applications was pioneered by Torabinejad and co-workers of Loma Linda University [5,6]. MTA can be used in both surgical and non–surgical applications, including direct pulp capping [7], temporary filling material, Perforation repairs in roots or furcations [8], apexification and root end fillings [9,10]. Despite the high clinical efficacy of this bioactive cement, there were always some issues which prevented the clinicians to use it for many cases. The major ones being very long setting time, difficulty in manipulation and delivery.

Biodentine was developed to overcome the shortcomings of MTA. It is produced in a smaller particle size and had been improved. Biodentine contains Tricalcium silicate and dicalcium silicate and acts as a bioactive dentin substitute on the crown or the root of a tooth using Active Biosilicate Technology [7]. Biodentine has a short setting time of up to 12 minutes and has biological and physical properties which are seen to be better than MTA and similar to physiological dentine. It has a pH of 11.7 and a 5μm particle size after setting [7,8]. The mechanical properties of Biodentine are more stable and it needs less water than MTA due to its water reducing agent. It is also more resistant to acids [8]. Biodentine has been formulated using MTA-based cement technology and hence; claims improvements of some of the properties such as physical qualities and handling, including its other wide range of applications like endodontic repair and pulp capping in restorative dentistry [9,11].

Various researches have been done to develop protective materials that will be in direct contact with calcium silicate based materials and do not interfere with the setting reaction or the characteristics of the materials. The contact between both materials can be observed through the interface layer. Evaluating the use of GIC as a protector that will be in direct contact with calcium silicate based materials has been studied through observing the interface layer. According to Nandini et al., glass ionomer cement can be placed 45 minutes after the application of MTA without affecting the setting reaction and the properties of MTA [12]. From the initial setting through the final setting of GIC, polyacrilic acid would be highly soluble to water (loosely bound water) and cements that set almost perfectly would reabsorb water (tight bound water) [13,14]. According to Ashraf et al., the working time of GIC's application to MTA did not affect the setting reaction of MTA, and both materials' interfacial adaptation increased over time leading to a good biological seal [15]. Some studies showed that the interface layer between MTA and GIC had a tendency to not converge, possibly due to the withdrawal of water from MTA to GIC resulting in the disruption of MTA's hydration and setting time. This also increased the porosity in the interface layer between MTA and GIC [16]. The setting reaction of GIC is known to form an acidic pH that ranges from 1.9–2. An acidic environment could affect calcium silicate based materials, thus reducing the strength and the hardness of MTA, as well as inhibit the setting time and increase the solubility leading to high leakage. Acidic conditions are also known to affect the quality of crystals produced by the hydration process [11]. This study attempts to compile and compare the adaptation of MTA and BIODENTINE with GIC for better clinical understanding.

Materials and Method:

The following materials were used in groups containing 14 samples each of MTA with GIC and Biodentine with GIC respectively. Group A- Biodentine (Septodont, France) with GIC type II, Group B- MTA (Pro root MTA,USA) with GIC type II. Fourteen polyethylene scaffold cylinder was prepared to length of 1 cm and diameter 0.5 cm. first 7 cylinders were filled with 0.5cm of Biodentine. Once the material is set after the ideal setting time of 6 mins recommend by manufacturer, Type II GIC(GC Fuji-2, capsules) is filled over it to the level of 1cm. Same way another set of 7 cylinders were filled with 0.5cm of MTA. After its setting time of 40 mins, remaining 0.5 cm is filled with Type II GIC(GC Fuji-2, capsules).

SEM ANALYSIS

After the final set of the materials, the interface between the 2 materials were analysed under scanning electron microscope at various magnifications such as 50x,500x, 2000x and 3000x respectively. The interface layer was graded using the scoring system given by Asrianti et al. The results were tabulated and then subjected to statistical analysis using G power software.

The scoring was based on the scoring system proposed by Asrianti et al. According to this previous study by Asrianti et al Score I- Blending (unification of 2 materials), Score II- No blending (materials not fused together), Score III- Cracking (separation between 2 materials creating empty space between)

The data recorded using excel sheet(Microsoft Excel) providing details of the sample size, no of sample showing blended interface, no of samples showing non blended interface, no of samples showing cracked interface in Group A&B respectively, were calculated using G power software. The results indicate the bonding between GIC and biodentine (group A) had better bonding in comparison with GIC and MTA (group B), but the results weren't statistically significant (p>0.005).

Results:

Photographs were taken of the SEM analysis of the interface in Group A and Group B respectively (fig 1,2,3,4). The results of the study are tabulated below (table 1).

GROUP	**Sample size(N)**	SCORE I	SCORE II	SCORE III	p value
GROUP A- (Biodentine (Septodont, France) with GIC type II)	7	6	1	0	>0.005

GROUP B- (MTA (Pro root MTA,USA) with GIC type II)	7	5	1	1	

Table 1: Table 1 dictates that GROUP A contains 7 samples out of which 6 fell under score 1, 2 fell under score 2 and 1 fell under score 3. In GROUP B , 5 fell under score 1, 1 fell under score 2 and 1 fell under score 3. With p value > 0.005

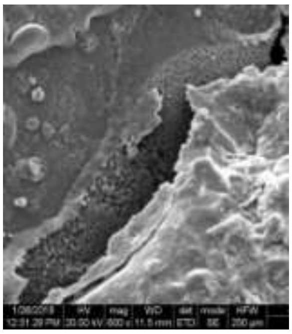

Figure 1(BIODENTINE - GIC); fig-1 shows interface of Biodentine and GIC under 600x magnification falling under score-1.

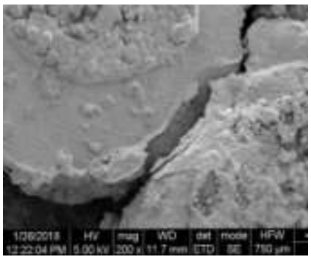

Figure 2(BIODENTINE – GIC(score 1)): Fig-2 shows interface under 200x magnification.

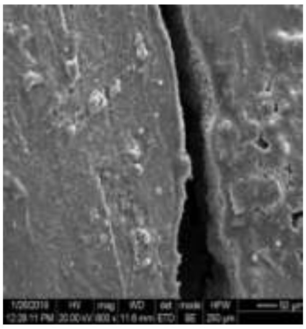

Figure 3(MTA-GIC) Fig-3 shows interface of MTA and GIC under 600x magnification falling under score 3.

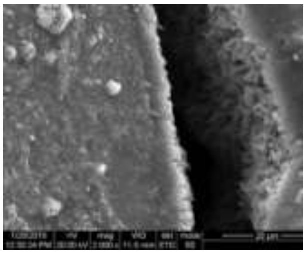

Figure 4(MTA-GIC (score 3)): Fig-4 shows interface of MTA and GIC under 2000x magnification.

The GIC with Biodentine(Group A) and GIC with MTA(GROUP B) interface were observed for adequate adaptation and tight seal with no cracks. Results from SEM analysis revealed that biodentine had better unification of 2 materials around 80% whereas MTA showed only around 60% of adequate bonding (score I). Both the groups had one sample each which showed no blending (score II). One sample of group B showed cracking (score III) whereas this was not seen in biodentine.

Discussion:

On account of clinical significance, antibacterial and antifungal properties of MTA and Bio dentine are attributed to the high pH of these materials. This high alkalinity has inhibitory effect on the growth of microorganism providing disinfection [19]. Biodentine comprises of a powder and liquid. The powder chiefly contains tricalcium and dicalcium silicate, as well as calcium carbonate. Zirconium dioxide serves as a contrast medium. The liquid component has calcium chloride in aqueous solution with an admixture of polycarboxylate. Biodentine sets in approximately 12 minutes after mixing [20]. In turn Bio dentine is found to be associated with high pH (12) and releases calcium and silicon ions, which stimulates mineralization and create “mineral infiltration zone” along dentin-cement interface providing a better seal. Caron G et al., found that Bio dentine exhibits superior sealing properties than MTA. A study found on comparing the response of the pulp-dentine complex in human teeth after direct pulp capping using Biodentine and MTA that Biodentine had a similar efficiency in the clinical setting and can be considered an alternative to MTA during vital pulp therapy. Laurent et al. [21] compared the biocompatibility of Biodentine with MTA and a hardening calcium hydroxide and reported that Biodentine is more biocompatible as this material has no adverse effect on cell differentiation and specific cell functions. And Bio dentine is stronger mechanically and is capable of producing tighter seals. [22]

MTA was first developed for the repair of root perforations, and now being used increasingly in various clinical treatments [23]. Recently it has been used commonly as root-end filling material [24,25] and also used in vital pulp therapies according to Torabinejad and Chivian [26]. MTA is available as a powder, which comprises of fine hydrophilic particles of tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicon oxide [27-29]. Camilleri et al. [32] showed the components of MTA to be tricalcium silicates and aluminates with bismuth oxide and also showed that the material was crystalline in structure through x-ray diffraction analysis [33]. MTA becomes a colloidal gel when it is mixed with water due to its hydrophilic or hydraulic tendency [30]. MTA has a setting time of approximately 3-4 hours. During the initial stages the pH is 10.2 and later when the material has set, it becomes 12.5 [31]. In laboratory studies, it was proved that the sealing ability of MTA is equivalent or superior in comparison to contemporary root-end filling materials [37,38,39] , Sluyk et al. [40] evaluated the push-out force of MTA and revealed that the bond strength of MTA increased gradually over time and suggested that the placement of the permanent restoration over MTA has to be delayed. Soundappan S et al., has conducted invitro study to compare the marginal adaptation of Bio dentine with MTA and Intermediate Restorative Material (IRM) using Scanning Electron Microscope and concluded that both the MTA and IRM were significantly superior to Bio dentine in terms of marginal adaptation when used as a root end filling material [35]. While again Torabinejad M reviewed a comprehensive literature to investigate studies regarding the leakage of MTA, concluded that MTA has good sealing ability and it seals well [26]. Where in other study by Ravichandra PV et al., evaluated that Biodentine provides better adaptation and seal than commonly used root-end filling material. However, Ozbay G et al., observed relatively less micro leakage with MTA than Bio dentine when analyzed by Fluid Filtration method. This study’s results were in contrast with a previous study by Savitri et al [43] but the discrepancies could be attributed to the fact that the present study used powder form Pro root MTA (PREVEST)[44] and not flow able MTA (MTA FLOW), And is conducted to delineate the interface of MTA and BIODENTINE with GIC wen compared with any other studies tends to facilitate the use of a better replacement for MTA by the outcome in such a way to provide the thought [45]of considering BIODENTINE which would be an actual replacement of other bioactive materials in spite of its drawbacks that would soon be overcome. This study samples also have drawbacks of less number of sample along with variations in the magnification which was not a constant through out the samples, in need of acquiring desired field of adaptation under SEM.

Conclusion:

In conclusion, this study showed the adaptation of GIC with Biodentine and MTA respectively, in which Biodentine had better adaptation with GIC when compared to MTA, though not statistically significant and demanding further studies on said topic with larger study samples, this study also indicates that Biodentine could probably be a source of better alternative to MTA in general clinical practise.

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