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IN VITRO EVALUATION OF SEALING ABILITY OF CALCIUM SILICATE BASED MATERIALS AS LINING MATERIAL IN OPEN SANDWICH TECHNIQUE.

Dental Science

Dr Vineeta Nikhil	Professor and Head Dept. of Conservative and Endodontics, Subharti Dental College, Meerut (U.P.)
Dr Preeti Mishra *	Lecturer Dept. of Conservative and Endodontics, Subharti Dental College, Meerut (U.P.)*Correspondimng Author
Dr Parul Bansal	Professor Dept. of Conservative and Endodontics, Subharti Dental College, Meerut (U.P.)
Dr Shalya Raj	Reader Dept. of Conservative and Endodontics, Subharti Dental College, Meerut (U.P.)
Dr Rohit Ravinder	Reader Dept. of Conservative and Endodontics, Subharti Dental College, Meerut (U.P.)

ABSTRACT

Aim- To evaluate the sealing ability of resin-modified glass ionomer cements (RMGIC), Biodentine and mineral trioxide aggregate (MTA) at cervical margin and restoration interfaces. **Methods:** Standardized class II tooth preparations with gingival margins 1mm below cementoenamel junction were made on mesial and distal sides of 15 non-carious, extracted permanent mandibular molar. The teeth were randomly divided into 3 groups **Group 1(n=10)**-RMGIC + Composite. **Group 2(n=10)**-Biodentine + Composite **Group 3(n+10)**-MTA + Composite. After thermocycling, sealing ability testing was done using Rhodamine B dye. **Results:** Best results were obtained with RMGIC followed by Biodentine and MTA at dentin interface as well as at restoration interface. **Conclusion**: Biodentine can be a viable alternative to resin-modified glass ionomer cement, especially when placed in deep class II proximal lesions, however, MTA failed as an alternative.

KEYWORDS

Biodentine,calcium silicate based materials, MTA, nanocomposite.

Introduction

Increasing demand for esthetic treatment options in restorative dentistry has led to a growing interest and dependence on resin composites for restorations.[1] However, restoring the peripheral seal especially in deep class II tooth preparation with gingival margin extending on to the root still remains a critical goal for adhesive dentistry.[2] Factors accounting for marginal failures at this location include no or poor enamel quality, difficult isolation and the difficulty of polymerization. This impaired marginal seal can lead to microleakage and other consequences.[3] These related problems have led to the development of open sandwich techniques. RMGIC is the most commonly used liners in this technique. Despite the satisfactory clinical results, RMGIC has poor mechanical properties. Furthermore, their marginal characteristics, surface properties, and color stability may cause problems.[4]

To the best of our literature search, none of the study had evaluated the use of MTA or Biodentine as a cervical lining material in class II restorations. Hence, this study was planned with the aim to evaluate and compare the microleakage at cervical margin and composite restoration interfaces of Biodentine and MTA with RMGIC when used as cervical liner in open sandwich technique.

Materials and Methods

Fifteen non-carious, extracted permanent mandibular molar teeth with no crack, decay, fracture, abrasion, previous restorations or structural deformities were selected.

Cavity Preparation

Standardized class II tooth preparation (Occlusal box; Depth 3mm, Bucco-lingual width 3mm, Mesio-distal width 2mm, Proximal box; Bucco-lingual width 3mm, Width of gingival seat = 1 mm) was done on mesial and distal sides of fifteen permanent mandibular molar teeth which was free of all defect. The tooth preparation was started using diamond round point with diameter 1mm, followed by straight fissure point with diameter 1.5mm. Subsequently, inverted cone diamond point of 1 mm diameter was used to make a flat pulpal floor and gingival seat.

Gingival seat of the proximal box was placed 1mm below the cementoenamel junction. Prepared teeth were randomly divided into 3 groups of 10 cavities on the basis of 1mm lining material.

Restorative Procedure

Group 1 (RMGIC) - RMGIC (GC Corporation, Japan) was placed to a thickness of 1 mm at the gingival seat and light cured for 40 seconds as per manufacturer´s instructions. A self-etching adhesive (OptiBond All- in-One Kerr, Orange, CA, USA) was applied over RMGIC and rest of the cavity surfaces and light cured for 10 seconds. The samples were then restored with composite (Nanocomposite - Filtek Z350 XT, 3M/ESPE, United States) in increments to a maximum thickness of 2 mm and light cured for 40 seconds for each increment.

Group 2 (Biodentine) - Biodentine (Septodont, Saint Maur des Fosses, France) was mixed as per manufacturer´s instructions and then placed to a thickness of 1 mm at the gingival seat without any dentin surface treatment. After 12 minutes, a self-etching adhesive and composite restoration was done same as in Group 1.

Group 3 (MTA) - MTA (Angelus Londrina, Brazil) was placed to a thickness of 1mm at the gingival seat without any dentin surface treatment. After 15 minutes, a self-etching adhesive and composite restoration was done same as in Group 1.

Thermocycling and Dye penetration

The specimens were subjected to thermocycling for 500 cycles between 5 ± 2°C and 55 ± 2°C with a dwell time of 30 seconds in each bath and 20 sec interval between baths at ambient air. Teeth were then painted with 2 coats of nail varnish on the entire tooth except 1mm from the restoration margin and sealed with the sticky wax then soaked in 0.2% Rhodamine B dye for 24 hours. The teeth were sectioned mesiodistally into two halves in a vertical plane parallel to long axis of the tooth using diamond disc at slow speed with water spray. The sectioned specimens were mounted on slides and the degree of dye penetration was evaluated under a stereomicroscope at 10X. (Figure 1)

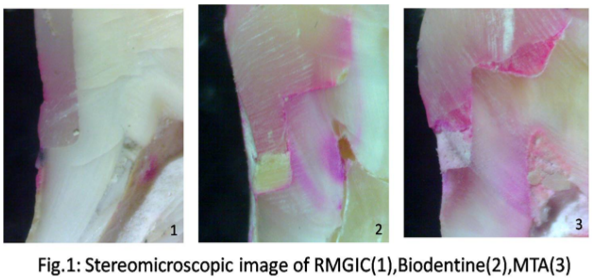

Fig.1: Stereomicroscopic image of RMGIC(1),Biodentine(2),MTA(3)

Microleakage Evaluation

Scores for microleakage were:

0 = no penetration

1 = leakage extending within first 1/2 of the cavity floor/restoration interface

2 = leakage extending beyond 1/2 of the cavity floor/restoration interface, but not as far as the axial wall
3 = leakage involving the axial wall

Statistical Analysis and Results

Dentin interface and restoration interfacial microleakage values were compared using the Kruskal Wallis analysis of variance (ANOVA). (Table 1)

Table No: 1 Microleakage scores at dentin interface and restoration interface

Material	*n*	Interface	Scores				Mean/ SD*
			0	1	2	3	
RMGIC	10	Dentin Interface	9	0	0	1	0.30 ± 0.95[a]
		Restoration Interface	8	0	1	1	0.50 ± 1.08[a]
Biodentine	10	Dentin Interface	3	1	4	2	1.50 ± 1.18[ab]
		Restoration Interface	7	1	1	1	0.60 ± 1.07[ab]
MTA	10	Dentin Interface	2	1	3	4	1.90 ± 1.20[b]
		Restoration Interface	2	2	2	4	1.80 ± 1.23[b]

*Values followed by different superscript letters (vertical reading) indicate statistically significant difference at $p<0.05$

In this study at dentin as well as restoration interface best results were obtained with RMGIC followed by Biodentine and MTA and the mean values for dye penetration were 0.30 mm,1.50 mm,1.90 mm and 0.50 mm, 0.60 mm,1.80 mm respectively.

Though the leakage was less in RMGIC group but the results were statistically insignificant compared with Biodentine and statistically significant with MTA at both the interfaces.

Results of Biodentine with MTA were statistically insignificant at both the interfaces.

Discussion

In present study sealing ability was evaluated with dye penetration method using Rhodamine B dye. Rhodamine B can penetrate through even the smallest gaps between the restoration-tooth interfaces and has great penetrability in dentin because of its low molecular size (less than 1 nm).[5] It is also not affected by alkaline pH of the material like Methylene blue, which may shows reduction in staining capacity when contact with alkaline material (MTA, Biodentine) and may alter the results.[6]

In our study best results were obtained with RMGIC at Dentin-RMGIC interface as well as RMGIC–composite interface.RMGIC bond to dentin by two mechanism, chemical interaction and micro-mechanical interlocking. RMGIC bond to composite due to presence of resin components (water-soluble polymerizable 2-hydroxyethyl methacrylate (HEMA)) in RMGIC which results in the formation of covalent bonds between the two materials.[7]

The dual-curing reaction of RMGIC materials is responsible for relieving the stress of polymerization shrinkage at interface. The loosely cross-linked structure resulting from the methacrylate polymerization at early stages allows the stress to be absorbed by the material; further maturation occurs later, which is attributed to the relatively slower ionic reaction[7]. Water sorption by the material may also relieve setting shrinkage. Moreover; relatively low modulus of elasticity of RMGIC may result in negating the shrinkage stress at the interfaces.[4]

In contrast to our study, some authors[4,8] have found results of Biodentine better than RMGIC but in our study results of Biodentine were inferior in terms of microleakage when compared with RMGIC but superior to MTA.

In present study, Biodentine showed less microleakage when compared to MTA. Biodentine has an ability to form hydroxyapatite crystals on the surface of the cement on hydration. This process helps to close the gap between the Biodentine-composite interface and the Biodentine-tooth interface.It micromechanically bonds to the tooth without any prior surface treatment of the tooth surface. Moreover; because of its high alkaline nature it causes caustic erosion of the dentin and penetrates into the dentinal tubules and adheres to the dentin.[8] Although there will be initial contraction of cement during hydration there will be secondary expansion of the cement, explaining the sealing ability.[4] Similar to Biodentine, when MTA is placed on to the dentine, hydroxyapatite crystals nucleate and grow, filling the microscopic space between MTA and the dentine surface. Initially the sealing mechanism is mechanical, but over a period of time, the reaction between hydroxyapatite and dentine leads to a chemical bonding also.[9]

Although bonding mechanism are common among Biodentine and MTA, Biodentine may produce lesser microleakage at the interface because of its smaller particle size, better handling properties, decreased pore volume and porosity of Biodentine as compared to MTA thus leading to its improved adaptation to cavity walls. Moreover; faster setting time of Biodentine may prevent prolonged leakage thus reducing the bacterial contamination. Both materials form a tag-like structure composed of the material itself or calcium or phosphate rich crystalline deposits. Han and Okiji found that tag formation in Biodentine was higher than MTA. Thus, enhancing its sealing ability.[10]

The result of present study was in accordance to study conducted by Bani *et al.*[11] and Radeva *et al.*[12] where the results of Biodentine were superior to MTA but were statistically non significant in terms of microleakage. In contrast to the result of present study another study conducted by Mandava *et al.*[13] reveals MTA showed less microleakage compared to Biodentine and results were statistically significant.

Conclusion

Within the limitations of the present study, it was found that Biodentine could be a viable alternative to resin-modified glass ionomer cement, especially when placed in deep class II proximal lesions, however, MTA failed as an alternative.

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