Comparative evaluation of marginal adaptation of three different base materials used in closed sandwich technique for class 2 composite restoration : An In Vitro Study

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Abstract:

Objective:-The aim of the study is to compare the gingival microleakage of Biodentine, Ketac Molar and Fusion ultra D/C in posterior deep Class II closed sandwich composite restoration.**Materials& Methods:-**Conventional mesio-occlusal cavities were prepared on 40 extracted maxillary first premolars, each with dimensions of 2 mm buccolingually, and the gingival seat positioned at the cementoenamel junction level. The teeth were then divided into four groups (n=10). In the control group (Group 1), cavities were restored with composite(Tetric N ceram) using a self-etch bonding agent (IvoclarTetric N bond). In Groups 2, 3, and 4, a 0.8 mm thick liner of Fusion Ultra D/C, Ketac Molar and Biodentine respectively, was applied to the axial wall of the cavity. Subsequently, all cavities were restored with composite using the same self-etch bonding agent as in Group 1. After restoration, the specimens were immersed in a 0.5% aqueous solution of rhodamine B dye for 24 hours. Statistical analysis was conducted using the ANOVA test for intergroup comparison, followed by the Tukey's Post Hoc test for intragroup comparison**Results:-**Lower dye penetration was observed in Biodentine and Ketac molar when contrasted with the Fusion Ultra D/C.**Conclusion:-**In our study the microleakage scores were significantly lesser in those teeth where keatac molar &Biodentine were used as a liner as compared to Fusion Ultra D/C.

Keywords:-Biodentine, microleakage, Ketac molar, Prevest Fusion ultra D/C.

Introduction:-

Although composite resins are frequently utilized as tooth-colored restorative materials, they can present various challenges when employed for posterior restorations. One such issue is their tendency to contract during the curing process, leading to shrinkage that may result in the restoration becoming detached from the tooth structure.[1] Consequently, achieving optimal marginal adaptation remains a challenge for composite materials in Class II restorations.[2] Inadequate marginal sealing is linked with the infiltration of bacteria, liquids, and molecules through the interface between the cavity and the material, leading to issues such as marginal discoloration, sensitivity after treatment, secondary decay, pulp complications, and ultimately, failure of the restoration.[3]various methods have been explored to address the challenges related to polymerization shrinkage, including the open sandwich technique, which involves placing a liner beneath the composite restoration. However, a notable drawback of the open sandwich technique is the exposure of the liner to the oral environment. To mitigate this issue, the closed sandwich technique was developed, wherein a layer of composite is applied over the liner, offering enhanced protection.[1]

The sandwich technique involves strategically layering materials to achieve an optimal combination of desired properties during restoration. Within this category, two variants are commonly employed: the open and closed sandwich techniques. The concept of using glass ionomer liners/base as a substitute for dentine, combined with composite to replace enamel, was initially introduced by McLean and Wilson. In the open sandwich technique, the glass ionomer cement (GIC) lining is exposed to the oral environment at the cervical margin, Whereas in the closed sandwich technique, the GIC lining is totally enclosed by composite resin.[4,5]

Biodentine, pioneered by Septodont, has effectively addressed many of the drawbacks associated with MTA

(Mineral Trioxide Aggregate). With a quicker setting time of just 12 minutes, it offers improved efficiency. Its mechanical characteristics, including compressive strength and modulus of elasticity, closely resemble those of natural dentine, rendering it capable of withstanding occlusal forces. However, its slightly challenging handling characteristics and the absence of direct bonding with composite restorations are notable limitations.[6,7]

3M Ketac Molar Restoration is a well-known glass ionomer cement (GIC) designed specifically for posterior restorations. Ketac Molar offers high compressive strength, making it suitable for withstanding the forces experienced in posterior teeth. It provides excellent long-term durability, which is essential for posterior restorations where longevity is crucial due to the heavy occlusal forces. Like other glass ionomer cements, Ketac Molar releases fluoride over time, aiding in remineralization and helping to prevent secondary decay.

Prevest Fusion ultra D/C is a low viscosity, light and chemically cured, radiopaque, two component nano hybrid luting cement. It is a blend of polymerisable resins, difunctional monomers, silanated submicron barium borosilicate glass, surface modified nano amorphous silica, curing initiators, stabilizers in two component base catalyst paste.

As there are no published data evaluating the microleakage of Fusion ultra D/C as liner, the aim of the study is to compare the gingival microleakage of Fusion ultra D/C, 3M Ketac Molar and Biodentine in posterior deep Class II closed sandwich composite restoration.

Materials and Methods :

This in vitro study was carried out in the Department of Conservative dentistry and Endodontics of Rishiraj College of Dental Sciences and Research Centre, Bhopal, Madhya Pradesh, India. Forty intact human maxillary first premolars indicated for extraction due to orthodontic or periodontal concerns were chosen for this study and preserved in saline solution. Carious, previously restored, hypoplastic, and fractured teeth were excluded from the selection process. The teeth were stored in 0.01% (w/v) thymol at 4°C. The teeth were vertically embedded 2 mm below CEJ in a cylindrical auto-polymerizing acrylic resin.

Standardized Class II cavities were prepared, involving the proximal and occlusal surfaces, using No. 245 and 169 L tungsten carbide burs in a high-speed air rotor with water spray. The dimensions and depth of the cavities were standardized as follows: Pulpal Depth: 2.5 mm, Bucco-Lingual Width: 2 mm, Axial Wall Height: 3 mm extending to the cemento-enamel junction (CEJ), and Gingival Seal: 0.8 mm penetrating into dentin at the CEJ. The teeth were randomly divided into four groups with 10 samples each.

Group 1: A self-etch bonding agent (IvoclarTetric N Bond Universal) was applied to the entire cavity using an applicator tip and light-cured for 20 seconds. The cavities were then restored with composite resin and light-cured for 30 seconds.

Group 2: An approximately 0.8 mm thick liner ofFusion ultra D/C (PrevestDenPro Ltd)was applied to the axial wall. Then, a self-etch bonding agent (IvoclarTetric N Bond Universal) was applied to the entire cavity, including the liner, and light-cured for 20 seconds. Subsequently, the cavities were restored with composite resin, following the procedure described in Group 1.

Group 3: An approximately 0.8 mm thick liner of Ketac molar (3M ESPE) was applied to the axial wall. Then, a self-etch bonding agent (IvoclarTetric N Bond Universal) was applied to the entire cavity, including the liner, and light-cured for 20 seconds. Finally, the cavities were restored with composite resin, following the procedure described in Group 2.

Group 4: An approximately 0.8 mm thick liner of Biodentine (Septodont) was applied to the axial wall. Then, a self-etch bonding agent (IvoclarTetric N Bond Universal) was applied to the entire cavity, including the liner, and light-cured for 20 seconds. Following this, the cavities were restored with composite resin, following the procedure described in Group 3.

The apical foramen was closed by encapsulating the teeth within acrylic resin blocks, followed by the application of two layers of nail varnish covering the entire tooth surface, leaving only the restoration and a 1 mm margin around it exposed. Subsequently, the specimens underwent a series of thermocycling processes, alternating between temperatures of 5±1°C and 55±1°C for 1000 cycles, each lasting 30 seconds, to mimic oral environmental conditions.

Following storage in a humidor, the specimens were submerged in a 0.5% aqueous solution of rhodamine B dye for a duration of 24 hours. Subsequently, the root portions encased in acrylic blocks were carefully excised, and the specimens were bisected mesiodistally through the center of the restoration using a diamond disc while ensuring continuous water irrigation. The buccal half of the tooth section was retained for analysis, while the lingual portion was discarded. To achieve optimal flatness, the entire tooth section underwent polishing with aluminum oxide paste. The interface between the tooth and the restoration was examined for dye penetration extent utilizing a confocal laser scanning microscope set at 10X magnification and assessed accordingly.

Scores according to C J TREDWIN[8]

0 No dye penetration
1 Dye penetration upto1/3rd gingival seat axially
2 Dye penetration 1/3rd to 2/3rd gingival seat axially
3 Dye penetration in excess of 2/3rd gingival seat axially

4 Extensive dye penetration at the entire gingival seat upto axial wall.

Statistical Analysis:
The Mean microleakage values were subjected to statistical analysis using ANOVA test to assess variance among groups. Subsequently, Tukey's Post Hoc tests were conducted to determine significant differences between specific pairs of groups. Analysis was performed utilizing SPSS software version 26.0.(IBM. Chicago) A significance level of $p < 0.05$ was employed for all analyses.

Result:-

Table 1:Comparative evaluation of Mean microleakage among groups.

Group	Mean	Standard deviation	95% CI for mean		ANOVA "F' Value	P-value
			Lower bound	Upper bound		
Group 1	4.00	0.00	4.00	4.00	22.344	0.001(HS)
Group 2	3.30	0.68	2.80	3.86		
Group 3	2.40	0.40	1.96	2.56		
Group 4	2.60	0.57	1.89	2.80		

Table 1 / Figure 1 reveals **comparative evaluation of Mean microleakage among groups.**
Group 1 (no liner) exhibited the highest mean microleakage, followed by Group 2 (Fusion ultraD/C), Group 4 (Biodentine), and Group 3 (Ketac molar), respectively. Statistical analysis revealed a highly significant difference in mean microleakage among the groups. (P=0.001)

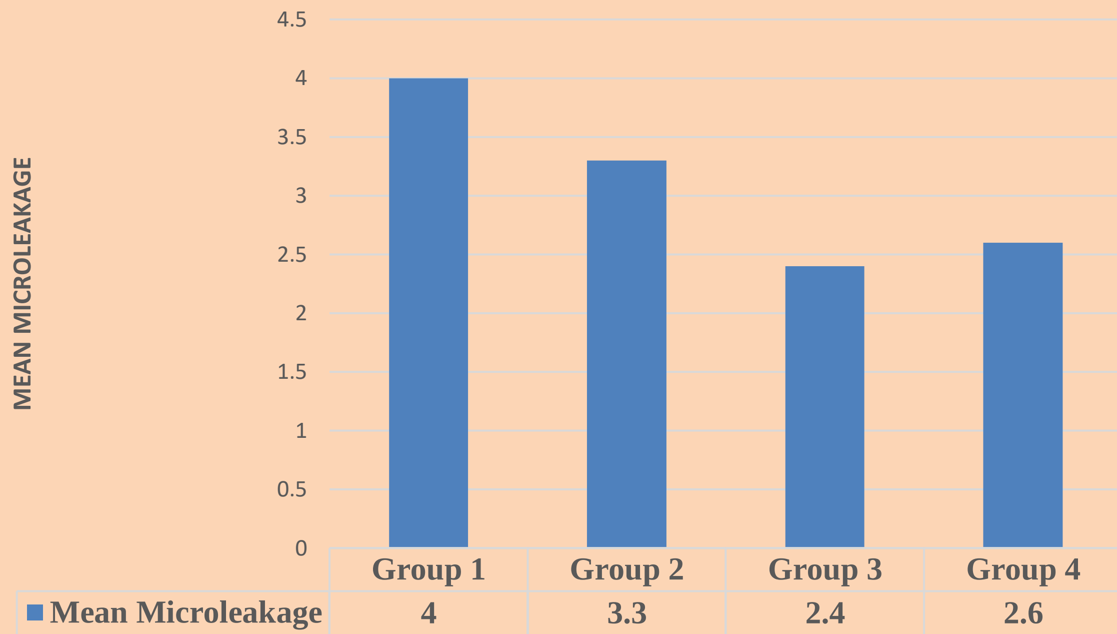
Table 2: Intergroup comparison between groups by Tukey's Post Hoc analysis.

Groups		Mean difference	P-value
Group 1	Group 2	0.70	0.004(HS)
	Group 3	1.60	0.001(HS)
	Group 4	1.40	0.001(HS)
Group 2	Group 3	0.90	0.002(HS)
	Group 4	0.70	0.02(S)
Group 3	Group 4	0.20	0.375(NS)

Table 2 reveals Intergroup comparison between groups by Tukey's Post Hoc analysis**.** To identify significant differences between pairs of groups, pairwise comparisons were conducted using the Tukey's Post Hoc AnalysisStatistically significant differences in mean microleakage were observed between Group 1 and Group 2 (p=0.004), Group 1 and Group 3 (p=0.001), Group 1 and Group 4 (p<0.001), Group 2 and Group 3 (p=0.002), and between Group 2 and Group 4 (p=0.02). However, no significant difference was detected between Group 3 and Group 4 (p=0.375)

Pak Heart J 2023:56(02)
ISSN:0048-2706 E-ISSN:2227-9199

Figure 1: Comparative evaluation of Mean microleakage among groups



Discussion:-

The rise in the popularity of tooth-colored restorations, coupled with growing apprehensions about mercury toxicity, has sparked a significant decline in the utilization of amalgam restorations. As a substitute, resin composites have emerged as the primary choice. This preference stems from their aesthetic appeal, minimal need for preparation, satisfactory durability, and cost-effectiveness. Nonetheless, resin composites are characterized by relatively high surface roughness, limited polishability, susceptibility to staining, and suboptimal bonding at the interface between the tooth and the restoration. These factors, compounded by polymerization shrinkage, have led to issues such as margin degradation and microleakage.[9]

At present, there are various methods to measure microleakage (Alani and Toh, 1997) Some newer advancements with microleakage testing are radioisotopes, dyes, air pressure, neutron activation analysis, pH changes, and scanning electron microscopy.[10,11]

A variety of materials and methodologies have been devised to mitigate shrinkage, such as employing non-shrinking resins, adjusting filler particles, incorporating low elastic modulus liners, employing diverse layering techniques, and manipulating the degree of conversion of monomer systems through variations in curing sources and techniques.[12]

Ozcan *et al*. (2013) evaluated *in vitro* marginal adaptation of class II resin composite restorations with and without a liner and concluded that Ionolux (resin-modified glass ionomer group) showed less microleakage than the other liner groups.[13] Stereomicroscope is a simple and effective method that enables to view of objects by enhanced visibility from the illumination option.

Mahajan S et al study showed that microleakage was minimum with (Group IV) Nanohybrid with Biodentine and maximum with Group II (Nanohybrid with GC fuji IX) when gingival margin is at CEJ in Class II restorations as compared to other groups. The glass ionomer maintains its bulk volume through internal microcracks.[14]

Tolidis et al[15]evaluated that the underlyingresin-modified glass ionomer appeared to be able to absorb some of the polymerization stressesof the composite resin setting, reducing the stressaccumulation in the dentin-restoration interface.Other authors suggest that the use of resin-modifiedglass ionomer could change the configurationfactor to a more favorable internal shape, minimizingthe polymerization contraction effects.[16,17]

An important point to be noted is solubility of biodentine due to pronounced ion release. However the deposition of substances such as hydroxyapatite on the material surface when it comes in contact with tissue fluids will compensate for that release.[18,19]

Conclusion:

Use of a liner below composite restoration in deep class 2 cavities decreases microleakage. In our study microleakage was lesser in Ketac molar & Biodentine as compared to Fusion ultra D/C. However none of the materials were able to completely eliminate microleakage.

References:-

1. Bausch J, de Lange K, Davidson C, Peters A, & de Gee A. Clinical significance of polymerization shrinkage ofcomposite resins.Journal of Prosthetic Dentistry 1982; 48(1): 59-62.
2. Ehrnford L, &Derand T. Cervical gap formation in class II composite resin restorations Swedish Dental Journal 1984; 8(1): 15-19.
3. Qvist V. Resin restorations: Leakage, bacteria, pulp Endodontic Dental Traumatology 1993; 9(4): 127-152.
4. Chuang SF, Jin YT, Lin TS, Chang CH, García-Godoy F. Effects of lining materials on microleakage and internal voids of class II resin-based composite restorations. Am J Dent 2003;16:84-90.
5. Suwatviroj P, Messer LB, Palamara JE. The effects of cavity preparation and lamination on bond strength and fracture of tooth-colored restorations in primary molars. Pediatr Dent 2003;25:534-40.
6. Qureshi A, Soujanya E, Kumar N, Kumar P, Hivarao S. Recent advances in pulp [8]capping materials: An overview. J ClinDiagn Res. 2014;8(1):316-21.
7. Camilleri J. Hydration characteristics of biodentine and theracal used as pulp [9]capping materials. Dent Mater. 2014;30(7):709-15.
8. Tredwin CJ, Stokes A, Moles DR. Influence of flowable liner and margin location [11]on microleakage of conventional and packable class II resin composites. Oper Dent. 2005;30(1):32-38.
9. Burke FT. Amalgam to tooth-coloured materials—implications for clinical practice [14]and dental education: governmental restrictions and amalgam-usage survey results. J Dent. 2004;32(5):343-50.
10. Alani AH, Toh CG: Detection of microleakage around dental restorations: a review . Oper Dent. 1997, 22:173- 85.
11. Derkson GD, Pashley DH, Derkson ME: Microleakage measurement of selected restorative materials: a new in vitro method. J Prosthet Dent. 1986, 56:435-40.
12. Kaup M, Dammann CH, Schäfer E, Dammaschke T. Shear bond strength of [15]Biodentine, proroot MTA, glass ionomer cement and composite resin on human dentine ex vivo. Head Face Med.2015;11(1):1.
13. Ozcan S, Yıkılgan I, Bala O. The effect of different liners on the microleakege of class II restorations after thermocycling and occlusal loading. Marmara Dent J 2013;2:71-5.
14. Mahajan S, Kumar N, Rathee K, Singh AK, Sundan A, Verma V. Comparison of Microleakage with Three Different Intermediary Base Materials Used in Open Sandwich Technique for Class II Composite Restorations- An In-Vitro Confocal Analysis.. Ann. Int. Med. Den. Res. 2019; 5(3):DE78-DE84.
15. Tolidis K, Nobecourt A, Randall RC. Effect of a resin-modified glass ionomer liner on volumetric polymerization shrinkage of various composite. Dent Mater 1998;14:417-423.
16. Carvalho RM, Pereira JC, Yoshiyama M, Pashley DH. A review of polymerization contraction: the influence of stress development versus stress relief. Oper Dent 1996;21:17-24.
17. Davidson CL. Glass-ionomer bases under posterior composites. J Esthet Dent 1994;6:223-236.
18. Gross JD, Retief DH, Bradley EL. Microleakage of posterior composite restoration. Dent Mater. 1985;1:7-10.
19. Al-Shekhli AAR, Al-Aubi I, Jaafar NA, Al-Nuami MM. Sorption and solubility of biodentine new restorative material. Pakistan Oral & Dental Journal. 2016 Jan-Mar;36(1):126-9.