Original Research Paper

Volume - 13 | Issue - 03 | March - 2023 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Dentistry

AN IN-VITRO EVALUATION OF MICROLEAKAGE IN CLASS II CAVITIES RESTORED WITH TWO DIFFERENT MATRIX SYSTEMS AND NANO FILLED COMPOSITE.

Dr Moksha Nayak	MDS PhD, Principal and professor, Department of conservative dentistry and endodontics, KVG Dental college and hospital Sullia, Dakshina Kannada Karnataka, India 574327
Dr. Vishnuja V R Nair*	Postgraduate student, Department of conservative dentistry and endodontics, KVG Dental college and hospital Sullia, Dakshina Kannada Karnataka, India 574327 *Corresponding Author
Dr Deepa Singh	Postgraduate student, Department of conservative dentistry and endodontics, KVG Dental college and hospital Sullia, Dakshina Kannada Karnataka, India 574327
Dr Swathi Pai	Reader, Department of conservative dentistry and endodontics, KVG Dental college and hospital Sullia, Dakshina Kannada Karnataka, India 574327

ABSTRACT **Aim:** To evaluate and compare, the microleakage in class II cavities restored with bulk fill posterior composite resins using two different matrix systems. **Materials And Method:** Twenty extracted premolars were used to assess the microleakage of Filtek bulk fill posterior composite using two different matrix system namely, Group 1: (n = 10): Bioclear Matrix system and Group 2: (n = 10): Palodent Sectional Matrix system. Each group was evaluated for microleakage in mesio-occlusal cavities of specific dimensions. Both groups were then subjected to thermocycling (300 cycles at 5, 37, and 55°C), followed by immersion in 2% methylene blue for 24 hours. After washing, drying, and sectioning, the samples were observed under a 40X stereoscopic microscope. Marginal adaptation was evaluated at the tooth-composite resin interface. **Results and Statistical Analysis:** Statistical analysis of the data between groups was carried out by paired and unpaired T test. Among the two study groups, 70% of the sample showed no die penetration where as in group 1, 30% dye penetration at less than half of the gingival wall and group 2 showed 40%. **Conclusion:** The Choice of the restorative material, separation technique and matrix system used plays a very important role while restoring class II cavities. The class II cavities restored with nano filled composite using transparent matrix systems exhibited better result than that with sectional matrix. However, there is no statistically significant difference between the two matrix systems on the microleakage.

KEYWORDS : Class II Cavity, Restoration, Bioclear matrix system, Palodent sectional matrix system, Nanofilled composite Filtek (3M ESPE), Microleakage

INTRODUCTION

Restoring lost tooth structure is important to re-establish form and function[1]. The fundamental objective of any restorative procedure is to recreate the proper anatomy of the tooth including proper proximal contact and contour along with maintenance of the health of soft tissues[2]. Ideal proximal contact prevents food impaction and thus provides a healthy periodontium by self-cleansing areas of teeth. Improperly restored contact area will cause displacement, lifting forces and causing rotation of teeth, deflecting occlusal contact and also leads to periodontal diseases[3-5]. Hence the restoration of proximal surface cavities is always challenging, especially for creating a tight anatomic proximal contact[6].

This is due to insufficient adaptation of the matrix towards the adjacent tooth, polymerization shrinkage of the composite material and also due to effects on the tooth position due to the elastic behaviour of the Rubber dam [7-8]. In addition to this, the other major controversies of composite that puzzles the practitioners include the moisture sensitivity and the clinical wear[9-11]. It can subsequently lead to microleakage by deterioration of the bonding agent which links the filler particles to matrix of the composites[12].

A concealable marginal seal is achieved ideally by a firm bond between the restorative material and the tooth surface. If it is violated, then microleakage can occur along the margins of the cavity[13,14]. In the past, composites were more of an incremental approach to placing resin, but nowadays many new restorative materials are marketed as "bulkfill" composites. Bulkfill composites allow dentists to place composite material in increments of 4 or 5mm to speed up the restoration process[12-14]. To avoid a massive polymerization shrinkage, an incremental filling technique must be used to ensure a thorough polymerization of the resin.

At present, circumferential matrix systems are used popularly, but show shortcomings regarding the creation of looser proximal contacts and their improper proximal matrix form and ultimately leads to food impaction and secondary caries[15,16]. It was shown that when placing Class II resin composite restoration, the use of sectional matrix systems and separation rings resulted in tighter proximal contacts than when traditional circumferential matrix systems, without separation rings, are applied[17-19]. The newer advert of transparent matrices and translucent wedges also helps to provide tight proximal contacts. Hence the Choice of the restorative material used, matrix system and separation technique plays an important role in class II cavity preparation. Against this background, till date no studies were performed to evaluate invitro microleakage in class II cavities restored with different matrix systems and nano filled composite.

MATERIALS AND METHODOLOGY

This in-vitro experimental study was designed and conducted in the Department of Conservative dentistry and Endodontics, KVG Dental College and Hospital, Sullia Karnataka. The study was approved by the Institutional Ethical Committee attached document Reference Number: IECKVGDCH/SS03/2022-23.

Sample preparation:

Twenty intact human premolar teeth extracted for periodontal reasons or orthodontic reasons from patients of any gender were included in the study. The teeth were thoroughly cleaned to remove debris, calculus, and soft tissues. Following the pumice slurry cleaning, the teeth were thoroughly rinsed with water. Teeth were stored at room temperature in 0.1% thymol solution. Using a water-air cooled high-speed handpiece with inverted cone diamond burs (No. 014) and carbide burs #245 (Mani Inc., Japan), standardized mesio-occlusal cavities were prepared on (MOs) on extracted teeth.

After consecutively preparing four specimens, the burs used for cavity preparation were replaced with new ones. A single operator prepared all teeth specimens. Cavities were uniformly prepared with bucco-lingual width of 3.0-3.5mm at the gingival wall and 2.0-3.0mm at the occlusal wall. Cavity depth at the occlusal portion was 2.5mm, axial wall depth was 2mm, and gingival margin was 1.0-1.5mm above cemento-enamel junction. Using a William's graduated periodontal probe, we verified the uniformity of cavity dimensions. Cavosurface margins were 90°, and all internal angles were rounded. To simulate the clinical situation for placing restorations, a restoration template was constructed.

Each tooth was mounted between two artificial teeth in a stone cast to simulate the geometric configuration of the approximal site. The specimens were randomly assigned to two different groups (n=10) according to the matrix used.

Group 1: (n = 10): Bioclear Matrix system with translucent wedges.
Group 2: (n = 10): Palodent Sectional Matrix system with wedges (DENTSPLY)

Matrix fit was checked with a magnifying glass. The prepared mesio-occlusal cavities were rinsed with water and air-dried with an air/water syringe. After application of a matrix band (Bioclear and palodent sectional matrix), enamel and dentin of all the prepared cavities were etched with 37% phosphoric acid (Scotchbond Universal Etchant, 3M ESPE, St. Paul, USA) for 15s, followed by rinsing with water for 10s. Subsequently the cavity was air dried softly to leave the dentin surface slightly moist; two consecutive layers of dentin bonding agent (Single Bond 2, 3M ESPE, St. Paul, USA) was applied.

The excess solvent was evaporated by gentle air blowing for 10s leaving a thin uniform layer of bonding agent. Then it was light-cured for 20s. After the bonding procedure, all the mesio-occlusal cavities were restored with Filtek bulkfill posterior restorative composite using teflon coated composite instruments followed by curing using 3M ESPE LED composite curing light of wavelength 430-480 nm for 40 seconds. The restoration was finished and polished using Shofu dura green stones, dura white stones and composite polishers. In distilled water all samples were stored for 24hours.

Thermal cycling and microleakage testing:

A microleakage test was performed on the mesio-occlusal cavities of both groups. To simulate oral conditions, the restored samples were thermocycled 300 times between 50 and 550 C with a dwell time of 30 seconds. On all surfaces except for the restorations and a small area 1 mm from the margins, two layers of nail varnish were applied.

After drying, the teeth were immersed in a 2% methylene blue dye solution for 24 hours. Following removal from the dye, the teeth were rinsed, dried, and sectioned vertically through the restoration bucco lingually using a diamond disc. Two independent evaluators examined the sections at 40X magnification to assess dye penetration.

Evaluation of microleakage:

0-No dye penetration
1-Dye penetration along less than half of the gingival wall
2-Dye penetration along the gingival wall
3-Dye penetration along the gingival wall and less than half of the axial wall
4-Dye penetration along gingival and axial wall.

Table 1 shows the scoring criteria for the dye penetration occurring between the tooth and restoration interface. Stereomicroscope is used for the detection of dye penetration at 40X magnification[20]. Scoring for both groups was done by using the same criteria by two independent examiners.

Statistical Analysis

A SPSS software version 20 was adopted in this study. The mean and the standard deviation were calculated for each variable. Analysis of the data between groups were carried out by paired and Mann Whitney test. The results were inferred to be statistically significant if a p value of < 0.05 is obtained.

RESULT

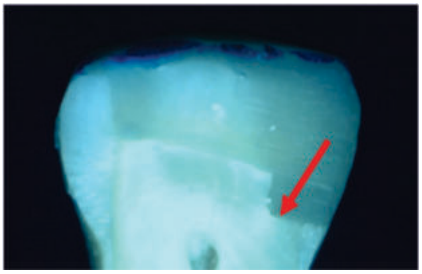

Figure 1 shows the microleakage score obtained from the Bioclear matrix system. It suggests score zero that is there no dye penetration was noted in this sample.

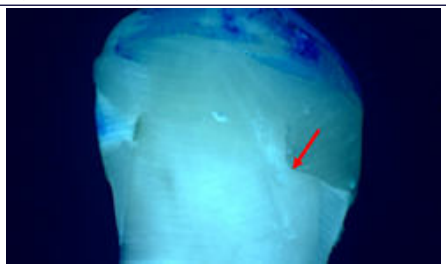

Figure 2 shows the microleakage score obtained from the Palodent matrix system. It suggests score zero that is there no dye penetration was noted in this sample.

Figure 3 shows the microleakage score obtained from the Palodent matrix system. It suggests score one that there is dye penetration along the gingival wall of the cavity restored using bulk filled composite was noted in this sample.

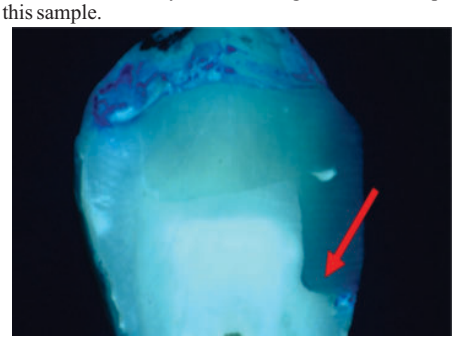

Figure 4 shows the microleakage score obtained from the Bioclear matrix system. It suggests score one that there is dye penetration along the gingival wall of the cavity restored using bulk filled composite was noted in this sample.

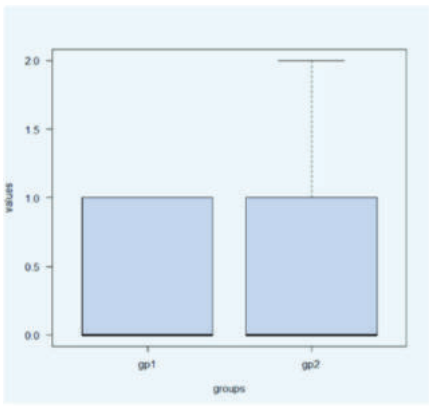

Figure 5 shows the graphical representation of dye penetration in group 1 and group 2. There is no statistically significant difference was seen in the dye penetration capacity between the 2 Groups. Though the values obtained from Bioclear transparent matrix system were greater than the Palodent sectional matrix system.

Table 2 shows the Statistical analysis of the data between groups which were carried out by paired and unpaired T test.

Among the two study groups, 70% of the sample showed no die penetration whereas in group 1, 30% dye penetration at less than half of the gingival wall and group 2 showed 20%. Group2 showed 10% of dye penetration along the gingival wall. No dye penetration was observed for score 3 and 4.

Groups	Number of samples	No die penetration	Dye penetration less than half of gingival wall	Dye penetration through the gingival wall	Dye penetration along the gingival wall and less than half of the axial wall	Dye penetration along the gingival wall and axial wall	P value
Group 1	10	7(70%)	3 (30%)	0	0	0	P = 0.888
Group 2	10	7(70%)	2 (20%)	1(10%)	0	0	

DISCUSSION

There has been an endless quest for suitable restorative material and restoration technique that ensures adherence of the filling material to the tooth surface. This will reduce the likelihood of microleakage. It is critical in maintaining the marginal seal for an extended period to minimize or at least stop potential problems that are encountered clinically such as marginal discoloration and secondary caries resulting from microleakage [20].

Dentine is a more complex substrate than enamel, making bonding to dentine more challenging and unpredictable[21]. Approximately 75% of it is composed of inorganic apatite crystallites in a collagen matrix with fluid-filled tubular structures connecting the pulp to the dentine-enamel junction. In addition to this, even after acid etching, the cementum's hypo mineralized and hyperorganic outer layer provides no micro retention for bonding agents. As enamel and dentine/cementum are different in composition and structure, there may have been more leakage at the dentine/cementum margins[21,22].

Total-etch systems combine a hydrophilic primer and hydrophobic resin into one application, resulting in a separate etching and rinsing step. Although increased technique sensitivity is reported for total-etch adhesives, similar clinical performance is achieved for both conventional and simplified total-etch adhesive versions[23,24]. Self-etch adhesives represent an alternative approach to enamel-dentin bonding. There is no requirement of a separate acid etch step as they are based on non-rinse acidic monomers. These simultaneously condition and prime dentin and enamel thereby eliminating the rinsing phase and application of the primer. Hence it results in reduced technique-sensitivity[25]. In this study, total etch adhesives have been used as self-etch adhesives do not remove the smear layer from dentin completely, so clinicians believe they cause less postoperative sensitivity than do total etch adhesives[26].

The most challenging issue faced by posterior resin restorations is microleakage along the tooth-restoration boundary [23]. The current study was done to evaluate in vitro the Microleakage in class II cavities restored with Bioclear transparent matrix system and Palodent sectional metal matrix systems using Filtek nano filled composite. In this study, microleakage was assessed using dye penetration method[23]. A variety of methods have been used to detect microleakage, including dyes, bacteria, artificial caries, radioactive isotopes, air pressure, neutron activation analysis, and scanning electron microscopy[24]. One of the most commonly employed methods is dye penetration. It is a reliable method for evaluating microleakage[23]. It provides information on how the restoration is sealed internally and can be used to inspect dye penetration depth directly under a microscope. Methylene blue dye was selected for microleakage assessment due to its low cost, ease of application, and low molecular weight. Because the molecular weight of the dye is lower than the average diameter of the bacterial cell, it can identify even small micro leaks and narrow marginal gaps which are present in the restoration.

Based on the present study, both matrix systems provide a close fit between the restoration and the tooth structure. Among the two study groups, 70% of the samples in both the group had shown no die penetration, whereas group 1 showed 30% dye penetration at less than half of the gingival wall and group 2 showed 40%. The results of the present study are in line with those of other studies, including Derhami et al. [26], Hilton et al. [27], and Demarco et al. As compared to occlusal margins, gingival margins on composite-restored class II teeth are potentially more likely to cause microleakage. The reason for this may be the reduced thickness of enamel along the cavosurface margin of the proximal aspect, which necessitates bonding restorative materials to dentin, which is more complex and unreliable than enamel. Another factor contributing to increased microleakage at gingival margins is the distance of the light source from the restorative material at the base of the proximal box, as compared with the occlusal surfaces. According to Coli et al[29] and Manuel et al[30], microleakage is not affected by incremental or bulk-filling techniques.

There is a minority of researchers who believe bulk curing is beneficial to reduce stress at cavosurface margins and limit polymerization shrinkage. Transenamel polymerization of composite resins and liner is suggested for better marginal adaptation[30]. Researchers have suggested that a layer of the composite may have been incompletely polymerized, resulting in reduced shrinkage of the composite during polymerization. Incomplete polymerization compromises mechanical properties and results in monomer leaching. The present study was an in vitro study, and future in vivo studies will be necessary to verify these findings. There is a need to evaluate clinically the properties of restorations, including durability, strength, and marginal adaptability.

CONCLUSION

The Choice of the restorative material, separation technique and matrix system used plays a very important role while restoring class II cavities. Within the limitation of the study, class II cavities restored with nano filled composite using transparent matrix systems exhibited better result than that with sectional matrix. However, there is no statistically significant difference between the two matrix systems on the microleakage. A long-term follow-up of restorations is necessary to determine to determine whether one matrix system is better than other.

REFERENCES

1. Raghu R, Srinivasan R: Optimizing tooth form with direct posterior composite restorations. Journal of Conservative Dentistry: JCD. 2011, 14:330. 10.4103/0972-0707.87192
2. Chuang SF, Su KC, Wang CH, et al.: Morphological analysis of proximal contacts in class II direct restorations with 3D image reconstruction. J Dent. 2011, 39:448-456. 10.1016/j.jdent.2011.04.001
3. Shivakumar AT, Kalgeri SH, Dhir S: Clinical considerations in restorative dentistry - a narrative review. J Int Clin Dent Res Organ. 201572, 122:129. 10.4103/2231-0754.164377
4. Beznos C: Microleakage at the cervical margin of composite Class II cavities with different restorative techniques. Oper Dent. 2001, 26:60-9.
5. Keogh TP, Bertolotti RL: Creating tight, anatomically correct interproximal contacts. Dental Clinics of North America. 20011, 45:83-102.
6. Sarmiento G, Ayala G, Watanabe R, Salcedo-Moncada D, Alvítez-Temoche D, Mayta-Tovalino F: Microleakage in premolar class I restorations between nanohybrid and microhybrid composites: A comparative in vitro study. of International:2021-1. 10.4103/jioh.jioh_330_20
7. Kampouropoulos D, Paximada C, Loukidis M, Kakaboura A: The influence of matrix type on the proximal contact in Class II resin composite restorations. Operative dentistry. 2010, 35:454-62.
8. Hernandes NM, Catelan A, Soares GP, Ambrosano GM, Lima DA, Marchi GM: Influence of flowable composite and restorative technique on microleakage of Class II restorations. J Investig Clin Dent. 2014, 5:283-8.
9. Kamath U, Arun CR: Comparative evaluation of Microleakage of class ii composite restoration by using 6th, 7th and 8TH generation dentin bonding agents: An in vitro study.
10. PeutzfeldtA, Asmussen E: Composite restorations: Influence of flowable and self-curing resin composite linings on microleakage in vitro. Oper Dent. 2002, 27:569-75.
11. Wilson EG, Mandradjieff M, Brindock T: Controversies in posterior composite resin restorations. Dental clinics of north america. 19901, 34:27-44.
12. Sakri MR, Koppal P, Patil BC, Haralur SB: Evaluation of microleakage in hybrid composite restoration with different intermediate layers and curing cycles. Journal of Dental and Allied Sciences. 20161, 5:14. 10.4103/2277-4696.185189
13. Coli P, Brännström M: The marginal adaptation of four different bonding agents in Class II composite resin restorations applied in bulk or in two increments. Quintessence Int. 1993, 24:583-91.
14. Kidd EA: Microleakage: A review. J Dent. 1976, 4:199-206.
15. Yantcheva SM: Marginal Adaptation and Micropermeability of Class II Cavities Restored with Three Different Types of Resin Composites—A Comparative Ten-Month In Vitro Study. Polymers. 2021, 13:1660.
16. Wirsching E, Loomans BA, Klaiber B, Dörfer CE: Influence of matrix systems on proximal contact tightness of 2-and 3-surface posterior composite restorations in vivo. Journal of dentistry. 2011, 39:386-90.
17. Loomans BA, Opdam NJ, Roeters FJ, Bronkhorst EM, Burgersdijk RC: Comparison of proximal contacts of Class II resin composite restorations in vitro. Operative dentistry. 2006, 31:688-93.
18. Chuang SF, Su KC, Wang CH, Chang CH: Morphological analysis of proximal contacts in class II direct restorations with 3D image reconstruction. Journal of dentistry. 2011, 1:448-56.
19. Sahu D, Somani R: Comparative evaluation of microleakage of various glass-ionomer cements: an in vitro study. Int J Prev Clin Dent Res. 2018, 5:17-20.
20. Moezyzadeh M, Kazemipoor M: Effect of different placement techniques on microleakage of class V composite restorations. J Dent. 2009, 6:121-129.
21. Yazici RA, Celik C, Ozgunaltay G: Microleakage of diferent resin composite types. Quintessence Int. 2004, 23:790-794.
22. Swift EJ Jr, Perdigão J, Wilder AD, Heymann HO, Sturdevant JR & Bayne SC (2001: Clinical evaluation of two one-bottle dentin adhesives at three years Journal of the American Dental Association 132 1117-1123. https://www.jdas.in/showcaptcha.asp?RedirectUrl=article&issn=2277-4696;year=2016;volume=5; issue=1;spage=14;epage=20;a....
23. De Munck J, Van Landuyt K, Peumans M, Poitevin A, Lambrechts P, Braem M & Van Meerbeek B (2005: A critical review of the durability of adhesion to tooth tissue. Methods and results Journal of Dental Research. 84:118-132.
24. Tay FR & Pashley DH : Aggressiveness of contemporary self-etching systems. I: Depth of penetration beyond dentin smear layers Dental Materials. 2001, 17:296-308.
25. Miller MB: Self-etching adhesives: solving the sensitivity conundrum. Pract Proced Aesthet Dent. 2002, 14:406.
26. Perdigao J, Geraldeli S, Hodges JS: Total-etch versus self-etch adhesive: effect on postoperative sensitivity. The. Journal of the American Dental Association. 2003, 1:1621-9.

27. Loguercio AD, de Oliveira Bauer RJ, Reis A, Miranda Grande RH: In vitro microleakage of packable composites in Class II restorations. Quintessence Int. 2004, 35:29-34.
28. Klein CA, Jr., da Silva D, Reston EG, Borghetti DL, Zimmer R: Effect of at-home and in-office bleaching on marginal microleakage in composite resin restorations using two adhesive systems. J Contemp Dent Pract. 2018, 19:248-252. 10.5005/jp-journals-10024-2246
29. Behery H, El-Mowafy O, El-Badrawy W, Nabih S, Saleh B: Gingival microleakage of class II bulk-fill composite resin restorations. Dental and Medical Problems. 2018, 55: 383-8. 10.17219/dmp/99264
30. Demarco FF, Ramos OL: Influence of different restorative techniques on microleakage in class II cavities with gingival wall in cementum. Oper Dent. 2001, 26:253-259.