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Comparative Evaluation Of Microleakage In Class II Restorations Using Open Sandwich Technique With RMGIC And Zirconomer As An Intermediate Material-An In-Vitro Study

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Abstract
Background: *Evaluation of microleakage is important for assessing the success of new restorative materials and methods.*
Aim & Objectives: *Comparative evaluation of microleakage in class II restorations using open sandwich technique with different intermediate materials .*
Materials and Methods: *Standardized mesio-occlusal class II tooth preparations were prepared on 20 maxillary 1st premolars and samples were randomly divided into four groups for restorations. Group 1: restoration with composite resin, Group 2: restoration with Zirconomer, Group 3: open sandwich technique with RMGIC(resin modified Glass ionomer cement) at the gingival third with composite over it, and Group 4: open sandwich technique with Zirconomer at the gingival third with composite over it. After restorations & thermocycling, apices were sealed and samples were immersed in 0.5% basic fuchsin dye. Sectioning was followed by stereomicroscopic evaluation.*
Results: *According to the results, in this study group I (composite) exhibited the highest micro leakage followed by Group II, IV and III.*
Conclusion: *In class II restorations, at the cervical area RMGIC below composites gives better results than Zirconomer or Composite alone.*

I. Introduction

The apparent inability to seal the gingival margins of class II restorations has always been a displeasing and lasting obstacle. These areas are critical to the bonding process because of minimal or total absence of enamel. Several alternative clinical techniques have been introduced to counter the sealing and stress problems in Class II cavities. Among these are the replacement of a substantial part of the resin composite with a glass-ionomer cement (GIC) base in the so-called "composite-laminated GIC" or "sandwich"restoration.[1]

Nowadays, resin composites are increasingly used for restorative purposes of class II cavity because of good esthetic and the capability of establishing a bond to enamel. However, like all dental materials, composites have their own limitations, such as polymerization shrinkage leading to the gap formation, specially at the cervical margins.[2] The bond between resin and enamel is generally satisfactory. Composite may not bond adequately to dentin, therefore during polymerisation; it may lead to formation of a v-shaped defect at the cavity margin situated in cervical region due to less enamel.[3] McLean and Wilson first described the open-sandwich technique in 1977, proposing it as a method to improve adhesion of resin composite restorations in cervical area by placing GIC in cervical and composite where enamel was sufficient.[4] Thus, GIC acted as a buffer zone minimizing shrinkage at the gingival area.

Traditionally, the filler of the sandwich was GIC, but GIC undergoes a acid-base reaction and needed time to set so, RMGIC was introduced which has superior mechanical properties and bonding strength to dentin.[5] The open-sandwich technique failed clinically when conventional GI's were used to restore the cervical margins of Class II restorations, mainly because of a continuous loss of material. Also RMGIC benefits in lowering microleakage due to its thermal expansion, which is similar to that of dental structures; its bacteriostatic function; molecular bonding to dentin and enamel; & a low setting shrinkage.[6] Amalgam has been a successful material in class II restorations but because of esthetic reasons and mercury hazards it is being replaced by composites. Recently, a newer material ZIRCONOMER (Zirconia +GIC) which has been reinforced with ceramic and zirconia fillers has been introduced to combat the disadvantages of composites and amalgams. It is known to exhibit the strength and durability of amalgam with the protective benefits of glass ionomer, while completely eliminating the hazards of mercury.[7]

So this investigation was designed to evaluate microleakage of a zirconomer & RMGIC-Composite at the gingival seat in comparison with zirconomer-composite combination used in class II open-sandwich technique. Composite was used as a control.

II. Materials and Methods

In total, 20 sound maxillary premolars, with neither carious lesions nor restorations, which were recently extracted for periodontal reasons were selected for this *in vitro* study. Each tooth underwent scaling and root planing with an ultrasonic device to remove residual organic tissue. Then, the teeth were immersed in 2.6% sodium hypochlorite solution and rinsed with running water for 10 min.

Cavity preparation

A standardized Class II cavity preparation was made involving the proximal and occlusal surfaces using No.245 tungsten carbide bur in a high-speed airotor handpiece with water spray. The overall dimensions and depths of cavities were standardized (occlusal floor, width 4 mm, length 5 mm; axial wall, width 4 mm, height 3 mm; gingival floor, width 4 mm, depth 2.5 mm. The proximal boxes ended in dentin, at the CEJ.

Restorative procedures

All prepared samples were randomly divided into four experimental groups, with four teeth each according to the restoration material used: Group 1, Composite resin; Group 2, Zirconomer; Group 3, Resin modified Glass ionomer cement as a lining material with composite & Group 4, Zirconomer as a lining material with composite.

Group 1: The cavities were etched with 37% phosphoric acid for 30 seconds (Total Etch; Ivoclar Vivadent AG, Schaan, Liechtenstein), rinsed with air/water spray for 20 seconds followed by gentle drying for 5 seconds and bonded with Adper Scotchbond 1 XT (3M ESPE, St.Paul, MN, USA). The cavities were totally restored with a bulk fill composite using a horizontal incremental technique with 3 increments from the cervical to the occlusal surface (each increment being 2 mm). Each layer or increment was cured for 20 seconds from the occlusal surface with a LED curing light in softstart-polymerization mode (Celalux 2 High-Power LED curing-light, Voco GmbH, Cuxhaven, Germany) for 20 seconds at a light intensity of 1000 mW/cm2 according to manufacturers' instructions.

Group 2: The cavities were restored with Zirconomer (SHOFU INC. Kyoto, Japan) as per manufacturer's instruction.

Group 3: Resin modified Glass ionomer cement was used as an intermediate restoration upto pulpal floor and then entire cavity was filled with composite resin

Group 4: In this group, the gingival portion of the cavity was restored with Zirconomer upto pulpal floor, prior to the placement of the composite resin.

Figure.1.Zirconomer

The restored teeth were stored for 24 hours in distilled water, and thermocycled for 500 cycles between 5°C and 55°C with a dwell time of 30 seconds in each bath. The apices of the specimens were sealed with sticky wax, and all tooth surfaces were covered with two coats of clear nail polish with exception of 1.0 mm around the tooth-restoration margins and allowed to air dry. Specimens were then immersed in 0.5% basic fuschine dye for 24 hours. The teeth were sectioned along the mesio-distal direction, coincident with the center of the restoration, with a sectioning diamond disc under water spray from chip syringe. The dye penetration of the occlusal and gingival margins of each section was evaluated independently by the observer using a stereo-microscope (Olymbus SZ 60, Japan) at a magnification of X 10 and scored as follow [7, 8]:

Score	Tooth-restoration interface	Score criteria(in proportions)
1	No dye penetration	0.00
2	Dye penetration up to the first third of the prepared cavity wall	0.25
3	Dye penetration up to the second third of the prepared cavity wall	0.50
4	Dye penetration onto the entire prepared cavity wall	0.75
5	Dye penetration onto the entire prepared cavity wall and the pulpal wall	1.0

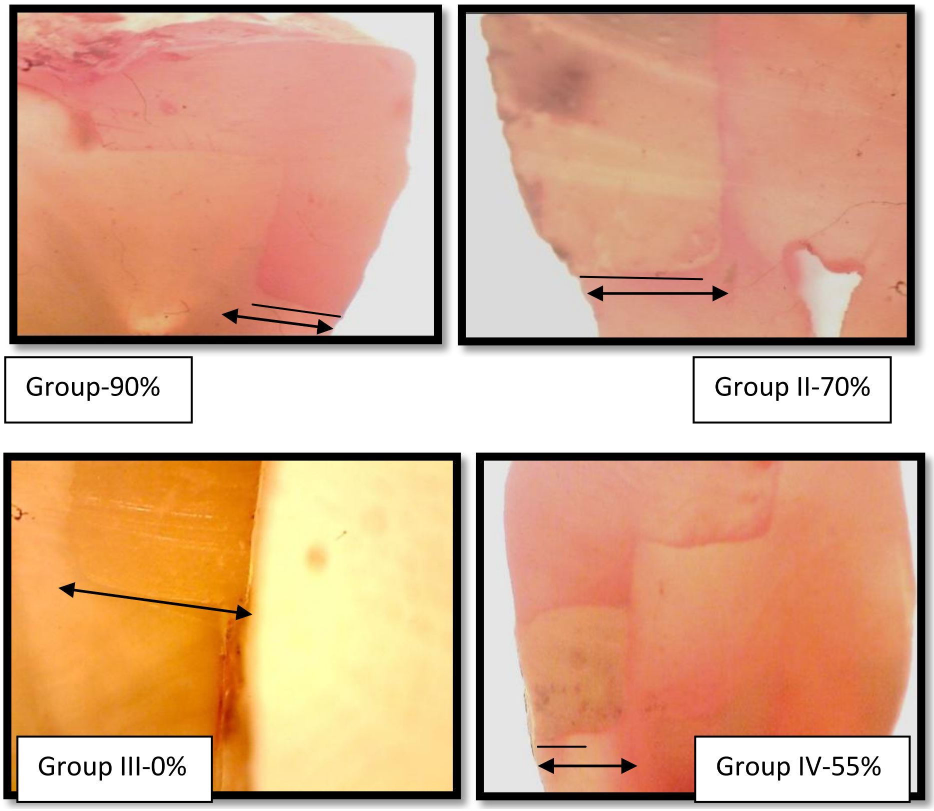


Fig. 2. Representative stereomicroscopic photograph of the different Groups (original magnification 10×).

III. Statistical Analysis

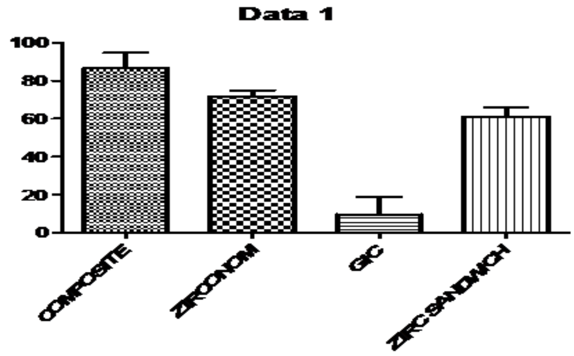
The microleakage data were analyzed by analysis of variance

GROUP	I (% of microleakage)	**II**	**III**	**IV**
1	90	72.6	0	59.8
2	99.4	70	2	68.6
3	81	76.7	10	60.5
4	82	69	22	62
5	80	70.66	15	55
N	5	5	5	5
X	86.480	71.792	9.800	61.180
S	8.237	3.043	9.121	4.906

Table 1

(ANOVA) at the significance level of 0.05.

Tukey's Multiple Comparison Test	**Mean Diff.**	**q**	**Significant? P < 0.05?**
COMPOSITE vs ZIRCONOMER	14.69	4.837	*
COMPOSITE vs RMGIC SANDWICH	76.68	25.25	***
COMPOSITE vs ZIRC SANDWICH	25.30	8.333	***
ZIRCONOM vs RMGIC SANDWICH	61.99	20.42	***
ZIRCONOM vs ZIRC SANDWICH	10.61	3.495	Ns
RMGIC SANDWICH vs ZIRC SANDWICH	-51.38	16.92	***



Graphical presentation of microleakage in different groups

IV. Results

The mean and standard deviation of micro leakage scores for all groups are presented in [Table1]. The ANOVA test revealed significant differences ($p<0.05$) in mean microleakage scores among the groups ($p= 0.000$). Group- III had lowest micro leakage score (9.8) than the Group- I Composite score (86.4), this different was significant ($p= 0.005$). Group- I Composite had higher microleakage. There was a statistically significant difference among all the groups except group II (zirconomer) and group IV (zirconomer sandwich) showed statistically non-significant difference.

V. Discussion

Restoring cervical lesions with resin composites has always been a problem, especially where a very thin layer of enamel is present in the gingival margin for bonding. So there is a constant search for the material and technique that ensures adhesion to the tooth structure in order to minimize the leakage potential.[9] This is the pioneer study checking the microleakage of the new dental restorative material that is zirconomer (white amalgam). So, present study was designed to evaluate the sealing properties of composite, white amalgam (zirconomer), GIC/composite & zirconomer/composite in sandwich technique.

The concept of using two different materials to form one final restoration is new to dentistry and leads to some confusion. The rationale behind the technique is to make the most of the biological, physical and/or aesthetic properties of each material and, in the presence of adhesion, to achieve as close as possible to a single monolithic reconstruction of a tooth.[10] McLean and Wilson first described the open sandwich technique in 1977, proposing it as a method to improve adhesion of resin composite restorations. The technique was developed to limit the shortcomings of posterior composite restorations, particularly their lack of permanent adhesion to dentine, which could result in microleakage and postoperative sensitivity. So we also restored two groups with sandwich techinique to compare with the teeth restored completely with the one material.[4]

The dye penetration method used for measuring sealing ability is the most popular. Various dyes can be used such as methylene blue, India ink, basic fuchsin and silver nitrate with developer. It is an established method for the determination of marginal leakage *in vitro*, mostly performed after cutting the teeth in a longitudinal direction.[11] However, the longer the penetration time is, the higher might be a risk of dye diffusion into the adhesive resulting in stained adhesive layers might be interpretated as gaps.[12] The immersion in basic fuchsin solution for 24 h appears to be sufficient time for assessment of leakage with no impairment of adhesive interface, which is in agreement with the work of Cenci et al. and Pazinatto et al.[13, 14] In this study, thermo-cycling was done to mimic intra-oral temperature variations compatible with oral cavity.[15]

Now-a-days patients are more concerned regarding the aesthetic hence, composite is commonly used as a restorative material in dentistry. So we included this in our study.With the decline in popularity of amalgam in recent years and drawback of composite there is a need for an equally strong & bondable material ease of replacement. Zirconomer, a new class of glass ionomer restorative material, exhibiting strength and durability of amalgam, along with bondable and fluoride releasing property of glass ionomer cement at the same time it eliminates the hazardous property of amalgam because of mercury.[7]Addition of zirconia as filler particle in the glass component of Zirconomer improves mechanical properties of the restoration by reinforcing structural integrity of the restoration in load bearing areas where amalgam is material of choice. Combination of outstanding strength, durability and sustained fluoride protection deems with chemical bonding, it is ideal for permanent posterior restorations in patients with high caries incidence as well as cases where strong structural cores and bases are required.[16]

So, in the present study we evaluated the sealing properties of composite, white amalgam (zirconomer), GIC/composite & zirconomer/composite in sandwich technique by using dye penetration method.

According to the results, in this study group I (composite) exhibited the highest micro leakage because of formation of V-shaped defect at the gingival margin, followed by Group II, IV and III. On comparing group I and II with group III and IV, group III and IV i.e. restoration with sandwich technique, showed less dye penetration into the cervical area. This may be attributed to the difference in bonding of different materials to dentine and enamel.

In the present study Composite restoration showed highest microleakage which may be attributed to its shrinkage during polymerization which creates stress on the network and its bonding system. This leads to marginal staining, poor marginal seal and recurrent caries, which affects the longevity of the restoration. Unlike dental amalgam, which can be a very forgiving material technically and can be condensed against a matrix band to create a proximal contact, proper placement of composite restorative materials present a unique set of challenges for the operative dentist. There are some steps in the placement process that cause difficulty and ultimately lead to a less than desirable end result.[17] The present study is in concurrence with the study of E Karaman et al (2014), who evaluated the polymerization shrinkage of different types of composite resins and microleakege with and without liner in class II cavities. He found that all teeth showed microleakage, but the placement of RMGIC line reduced microleakage.[18]The present study is not in concurrence with the study of Mayank.U.Patel (2015), who evaluated found the microleakage of posterior teeth restored with amalgam, composite and zirconomer. He found that Zirconomer exhibited the highest microleakage as compared to composite and amalgam.[7]Resin modified Glass Ionomer cement in sandwich technique showed the least microleakage. This may be attributed to the chemical bonding of Glass ionomer cement with dentin which is not satisfactory in case of composite restoration. These resin-modified glass ionomer liners have the ability to both micromechanically and chemically interact with dentin.[19] They are easy to mix and place, release high sustained levels of fluoride, have antimicrobial properties,[20, 21]have very low solubility,[22, 23] and have a favorable modulus of elasticity and coefficient of thermal expansion and contraction (i.e., similar to that of dentin).[24]

It can be concluded from the results of the present study that all materials showed some microleakage at the cervical margin of restoration. However, Group III exhibited lowest microleakage followed by Group IV, II and I. But for clinical relevance further in-vitro studies and with a larger sample size are required.

VI. Summary

The present study was conducted to compare and evaluate the microleakage in class II restorations using open sandwich technique with RMGIC and Zirconomer as an intermediate material. Class II cavities were prepared on 20 maxillary premolars and all prepared samples were divided equally into 4 groups of 5 teeth , Group I was restored with composite, Group II was restored with zirconomer complete, Group III-RMGIC as an intermediate material, and Group IV- Zirconomer as an intermediate material. The restored teeth were thermocycled and immersed in 0.5% basic fuschine dye for 24 hours. The teeth were sectioned along the mesio-distal direction and visualized under stereomicroscope at a magnification of 10X. To reach at a conclusion as to which material exhibited lesser microleakage, results were statistically analysed by using ANOVA test.

VII. Conclusions

The successful placement of a proximal restoration requires a predictable outcome that offers protection from further caries at the cavo margins. The RMGIC family of materials should be recommended for use in the open-sandwich technique when cervical margins are placed in dentine.

References

[1]. Pallesen U, Qvist V. Composite resin fillings and inlays. An 11-year evaluation. Clin Oral Investig. 2003;7(2):71-9.
[2]. Alptekin T, Ozer F, Unlu N, Cobanoglu N, Blatz MB. Invitro Evaluations of Microleakage Around Class I Amalgam and Composite Restorations. Operative Dentistry. 2010;35(6):641-48
[3]. Liebenberg W et al (2005). Return to the resin-modified glass-ionomer cement sandwich technique. Vol.71, no.10.
[4]. Mclean JW et al. The clinical development of the GIC II: Some clinical applications. Australian Dental Journal 1977;22:120-27.
[5]. Pereira LC, Nunes MC, Dibb RG, Powers JM, Roulet JF, Navarro MF. Mechanical properties and bond strength of glass-ionomer cements. J Adhes Dent 2002; 4(1):73–80.
[6]. M.S. Hagge, J.S. Lindemuth, JF Mason and JF Simon, "Effect of four intermediate layer treatments on microleakage of Class II composite restorations," Gen Dent. Sep-Oct; 49(5):489-95, 2001.
[7]. Patel MU et al. An in-vitro evaluation of microleakage of posterior teeth restored with amalgam, composite & zirconomer- A stereomicroscopic study-JCDR 2015 jul, vol-9(7):ZC65-ZC67.
[8]. Popoff DAV et al. Repair of amalgam restorations with composite resin and bonded amalgam: A microleakage study. Indian Journal of Dental Research. 2011;22(6):799-803.
[9]. Moezyzadeh M et al. Effect of different placement techniques on microleakage of class V composite restorations. Tehran University of medical sciences. J Dent 2009;6:3.
[10]. Preservation & restoration of tooth structure. Mount and Hume, 3rd edition.
[11]. Kokate SR, Pawar AM. An invitro comparative stereomicroscopic evaluation of marginal seal between MTA, glass inomer cement & biodentine as root end filling materials using 1% methylene blue as tracer. Endodontology. 36-42.
[12]. Ernst CP et al. Marginal integrity of class V restorations: SEM versus dye penetration. Dent Mater 2008;24:39-27.

[13]. Cenci M S et al. Influence of thermal stress on marginal integrity of restorative materials. J Appl Oral Sci 2008;16:106-10.
[14]. Pazzinato FB et al. Effect of the number of thermocycles on microleakage of resin composite restoration. Pesqui Odontol Bras 2003;17:337-41.
[15]. Vinay S et al. Comparative evaluation of microleakage of fifth, sixth and seventh generation dentin bonding agents: An in-vitro study. Journal of Conservative Dentistry. 2010;13(3):136-40.
[16]. Zirconia Reinforced Restorative. Available from: http:// www.shofu.com.sg/ downloads/pdf/Zirconomer%20Brochure.pdf
[17]. Qvist V (1993) Resin restorations: Leakage, bacteria, pulp. Endodontic Dental Traumatology 9(4) 127-152.
[18]. Karaman E et al (2014) Polymerization shrinkage of different types of composite resins and microleakage with and without liner in class II cavities.
[19]. Yoshida Y, Van Meerbeek B, Nakayama Y, et al. Evidence of chemical bonding at biomaterial-hard tissue interfaces. J Dent Res. 2000; 79(2):709-14.
[20]. DeSchepper EJ, Thrasher MR, Thurmond BA. Antibacterial effects of light-cured liners. Am J Dent. 1989;2(3):74-6.
[21]. Scherer W, Lippman N, Kaim J, et al. Antimicrobial properties of VLC liners. J Esthet Dent. 1990;2(2):31-2.
[22]. Powell LV, Gordon GE, Johnson GH. Clinical comparison of Class V composite and glass ionomer restorations. Am J Dent. 1992;5(5):249-52.
[23]. Croll TP. Visible light-hardened glass-ionomer cement base/liner as an interim restorative material. Quintessence Int. 1991; 22(2):137-41.
[24]. Mitra SB, Conway WT. Coefficient of thermal expansion of some methacrylate modified glass ionomers. J Dent Res. 1994;73:218.