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Original Research

Evaluation of Microleakage in Cervically placed Class II Restoration with an Alkasite Restorative Material and Bulk fill Composite Resin using Confocal Laser Scanning Microscope- An In-vitro Study

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Abstract

Aim: This invitro study aimed to evaluate the microleakage at occlusal and crevical margins 1mm above and below CEJ of class II cavities restored with an alkasite restorative material and bulk fill composite resin.

Materials and Method : Forty intact extracted molars were split into two groups of 20 each. Standardized class II box cavities were prepared mesially and distally with dimensions 4mm buccolingually and 2mm mesiodistally. Group 1- Class II cavities with gingival seat 1mm above CEJ. Group 2- Class II cavities with gingival seat 1mm below CEJ. All the prepared cavity surfaces were etched, rinsed, Tetric N bond applied and light cured. The samples were further subdivided based on restorative material. Subgroup A: Mesial box cavities restored with Cention N. Subgroup B: Distal box cavities restored with Tetric N Ceram Bulkfill. The specimens were thermocycled, submerged in 0.5% aqueous Rhodamine dye for 24 hours, mesiodistally sectioned, and the depth of dye penetration was assessed using Confocal Laser Microscopy (CLSM).

Result: The data was analysed using Mann Whitney test and Wilcoxon signed Rank test**.** Both Tetric N Ceram Bulk fill and Cention N showed microleakage along occlusal and cervical margins at both levels (1mm above and below CEJ) and this difference was not significant statistically**.** Mean microleakage at occlusal margin was lower thancervical margin in both groups restored with Cention N and Tetric N Ceram bulk fill and this difference was statistically significant. Gingivally mean microleakage was higher with the margin 1mm below CEJ with both materials compared to the margin 1mm above CEJ. And this difference was statistically significant.

Conclusion: Tetric N Ceram and Cention N performed comparable in terms of microleakage and may be preferred for class II restoration of posterior teeth considering the decreased working time and their favorable properties.

Keywords:*Alkasite restorative material; Bulk Fill Composite; Confocal LASER scanning microscope; Class II restoration.*

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INTRODUCTION

The success of a class II restoration is dependent on both the material used as well the operator's skill [1]. Currently, the primary concern regarding the performance of routinely used composite resins refers to their durability and marginal integrity especially in class II restorations and more so when the caries extends apical to the CEJ, as the bond to dentin and cementum is weaker [2,3]. One of the principal downsides of posterior composites is polymerization shrinkage that contributes to microleakage resulting in sensitivity, secondary caries, pulpal pathology and ultimate failure of restoration [4-6].

Various techniques and materials are implemented to minimize the polymerization shrinkage in dental composites [7]. These include various restorative placement techniques, increased filler content in the composition, use of ring opening monomer, liner under restoration and photocuring methods [8,9]. However, bulkfill composites has the advantage of simpler and easier application with a reduction in the number of clinical steps [7-10]. Tetric N Ceram is a Bulk fill composite resin that can be placed in 4mm thickness because of their reduced polymerization stress and high reactivity to light curing [7]. It has a low modulus of elasticity and increased wettability which could be helpful in absorbing stresses and reducing microleakage caused by polymerization shrinkage [11].

Cention N is a new category of tooth coloured, (also called alkasite restorative material) dual curing, bulk placement material [2]. According to the manufacturer, advantages are reduced polymerization shrinkage, fluoride, calcium and hydroxide ion release, bulk placement, durability, good handling and esthetics [12]. These properties may be of great value in cervically placed class II restorations in which cariogenic activity is high. Hencethis study used a confocal laser scanning microscope to assess the impact of a new dual cure alkasite restorative material and a light curable bulk fill composite on microleakage at the occlusal and cervical margins of class II restorations with gingival margin above and below the CEJ.

MATERIALS AND METHODS

Forty intact extracted molars were collected followed by thorough scaling and were placed in fresh 0.5% Chloramine-T. The specimens were randomly divided into 2 groups with 20 teeth in each group and were mounted to restore mesial and distal contact relation. Standardized class II mesial and distal box cavities were prepared on each sample using SF41 diamond bur with an air rotor handpiece. The dimensions of these preparations were 4mm buccolingually and 2mm mesiodistally, verified using a periodontal probe.

Group 1 - Class II MO and DO box cavities with the gingival seat prepared 1mm above the CEJ.

Group 2 - Class II MO and DO box cavities with the gingival seat prepared 1mm below the CEJ

After every five cavity preparations the bur was replaced. The prepared cavities were cleaned, rinsed thoroughly with water and dried gently. Tofflemire retainer with matrix band and wedge were adapted to the preparation to prevent gingival overhang of the restoration. Etching was done with 37% orthophosphoric acid for 15 seconds, rinsed and dried. Tetric N bond was then applied, air dried and light curing was done. The samples were further subdivided based on the restorative material used. All MO box cavities were restored with Cention N and cured for 40 s. All DO box cavities were restored with Tetric N Ceram Bulkfill and cured for 20s. Additional increments were placed till the occlusal cavosurface margin and cured. Another 10 sec curing buccally and lingually was carried out after removing the matrix band. Restorations were polished with Soflex discs.

Specimen preparation for microleakage testing

All prepared samples were stored at 100% relative humidity and a temperature of 37 °C for 24 hours and then subjected to thermal cycling (1000 thermal cycles at 5 °C and 55 °C, 1 minute dwell time at each temperature).

Two layers of nail varnish were applied on to the teeth samples excluding the restoration and 1 mm area around it, immersed in 0.5% aqueous rhodamine B dye for 24 hrs, rinsed and mesiodistally sectioned. Microleakage was measured using a confocal laser scanning microscope at 10x magnification using the following scores on the occlusal/ cervical wall:

0 - No evident dye penetration.
1 - Dye penetrates into half extension of occlusal / cervical wall.
2 - Dye penetrates into more than half of the occlusal / cervical wall
3 - Dye penetrates into the pulpal wall.

Statistical analysis

Statistical analysis was done using Mann Whitney test and Wilcoxon Signed Rank test to compare between the two composite groups and to compare between occlusal and cervical levels respectively. The level of significance was set at $p< 0.05$. Null hypothesis was there is no difference in microleakage at occlusal and cervical margin of class II restoration with alkasite restorative material and bulk fill composite resin with the gingival margin 1mm above and below the CEJ.

RESULTS

Table 1: Comparison of mean microleakage between Group 1 & 2 restored with Cention N at cervical and occlusal margins

Region	Groups	N	Mean	SD	Mean Diff	Z	P-Value
Cervical	Group 1	20	1.25	0.72	-0.60	-2.275	0.02*
	Group 2	20	1.85	0.88			
Occlusal	Group 1	20	0.70	0.73	-0.35	-1.465	0.14
	Group 2	20	1.05	0.76			

*Indicates statistical significance

Table 2: Comparison of mean microleakage between Group 1 & 2 restored with Tetric N Ceram at cervical and occlusal margins

Region	Groups	N	Mean	SD	Mean Diff	Z	P-Value
Cervical	Group 1	20	1.25	0.72	-0.60	-2.275	0.02*
	Group 2	20	1.85	0.88			
Occlusal	Group 1	20	0.70	0.73	-0.35	-1.465	0.14
	Group 2	20	1.05	0.76			

*Indicates statistical significance

Table 3: Comparison of mean microleakage between Cention N & Tetric N Ceram restorations in Group 1 at cervical & occlusal margins

Region	Material	N	Mean	SD	Mean Diff	Z	P-Value
Cervical	Cention N	20	1.30	0.73	0.05	-0.190	0.85
	Tetric N	20	1.25	0.72			
Occlusal	Cention N	20	0.90	0.79	0.20	-0.855	0.39
	Tetric N	20	0.70	0.73			

Table 4: Comparison of mean microleakage between Cention N & Tetric N Ceram restorations in Group 2 at cervical & occlusal margins

Region	Material	N	Mean	SD	Mean Diff	Z	P-Value
Cervical	Cention N	20	1.90	0.91	0.05	-0.324	0.75
	Tetric N	20	1.85	0.88			
Occlusal	Cention N	20	1.35	0.88	0.30	-1.017	0.31
	Tetric N	20	1.05	0.76			

Table 5: Comparison of mean microleakage between cervical & occlusal margins in Group 1 restored with Cention N and Tetric N Ceram

Region	Region	N	Mean	SD	Mean Diff	Z	P-Value
Cention N	Cervical	20	1.30	0.73	0.40	-2.094	0.04*
	Occlusal	20	0.90	0.79			
Tetric N Ceram	Cervical	20	1.25	0.72	0.55	-2.840	0.005*
	Occlusal	20	0.70	0.73			

*Indicates statistical significance

Table 6: Comparison of mean microleakage between cervical & occlusal margins in Group 2 restored with Cention N and Tetric N Ceram

Region	Region	N	Mean	SD	Mean Diff	Z	P-Value
Cention N	Cervical	20	1.90	0.91	0.55	-2.075	0.04*
	Occlusal	20	1.35	0.88			
Tetric N Ceram	Cervical	20	1.85	0.88	0.70	-2.914	0.004*
	Occlusal	20	1.15	0.75			

*Indicates statistical significance

The results of the mean microleakage for Cention N and Tetric N Ceram at both occlusal and cervical level are tabulated in the Tables 1-6. Figures 1-3 show the confocal laser images at different levels for Cention N and Tetric N Ceram.

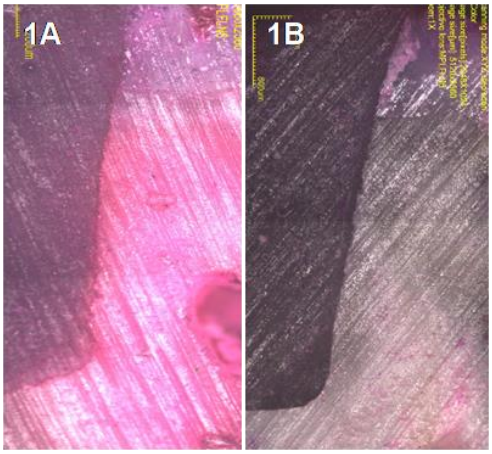

Figure 1: Confocal microscope image at occlusal level with Cention N (1A) and Tetric N Ceram (1B)

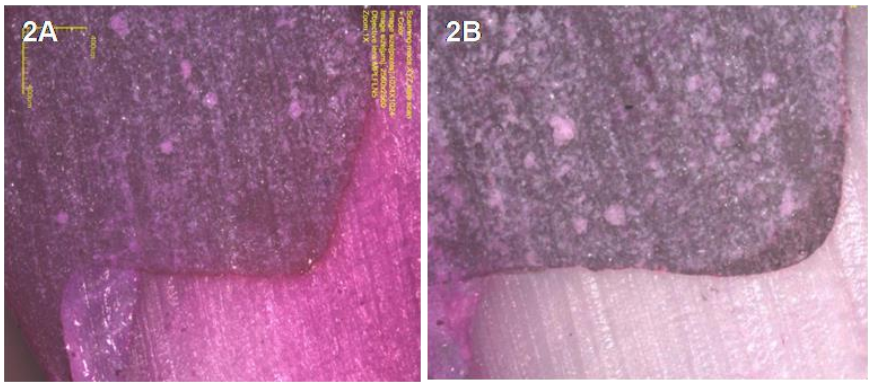

Figure 2: Confocal microscope image at gingival level in Group 1 with Cention N (2A) and Tetric N Ceram (2B)

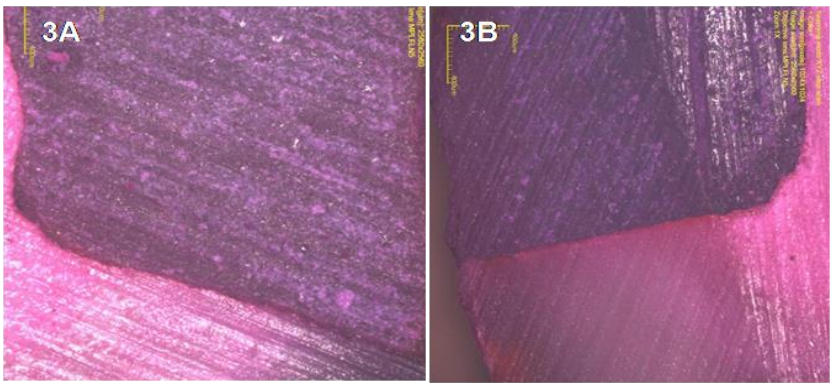

Figure 3: Confocal microscope image at gingival level in Group 2 with Cention N (3A) and Tetric N Ceram (3B)

DISCUSSION

Class II composite resin restoration is often a concern for the clinician due to limited access, difficulty in isolation, difficult and unpredictable bonding to deeper dentin/cementum along with material limitations of polymerization shrinkage and subsequent microleakage [13]. One of the most fundamental factors affecting the long-term success and durability of dental restorations is microleakage [14-18]. It may result in the colonisation of bacteria, which may cause secondary caries, pulpal pathosis, restorative failure and sensitivity [19,20].

Polymerization shrinkage is influenced by various factors including those under the manufacturer's control and those under clinician's control [21]. One of the most important factors in the reduction in shrinkage stresses is the restoration placement techniques. Owing to the demand for a faster, simpler and predictable filling technique that allows reduction of layers, effort and time, 'bulk fill composites' were introduced [22-25].

Bulk fill composites like Tetric NCeram Bulk Fill used in this study can be placed in increments of up to 4 mm [7]. According to manufacturer, it achieves this via following advances in technology [26]. Ivocerin- this polymerisation booster is much more reactive compared with conventional light initiators. Hence, polymerization is initiated even in very deep cavities and the material is fully cured. Isofiller – a specially conditioned shrinkage stress reliever with a low elastic modulus attenuates the forces generated during shrinkage and thereby keeps shrinkage and stress during polymerization to a minimum. [27].

Cention N is a dual cured, bulkfill alkasite restorative material, that is available in powder and liquid form [2]. Due to the usage of cross-linking methacrylate monomers as well as a stable, effective self-cure initiator, it displays a high degree of polymerization. It contains a special patented filler (partially functionalized by silanes), an Isofiller, which reduces shrinking force and functions as a stress reliever. It also has low volumetric shrinkage owing to its organic/inorganic ratio and the monomer composition.

The alkaline glass of Cention N is claimed to release fluoride, calcium and acid-neutralizing hydroxide ions [28]. These properties of Cention N as claimed by the manufacturer may be of great advantage in restoring cervically placed class II restorations.

In this study, permanent molars were selected as Class II lesions are most commonly encountered. Microleakage is frequently encountered while restoring class II lesions, with little or no enamel on the proximal gingival margins [29]. In this study, class II box cavities were prepared in both mesial and distal aspect and all the cavities had similar dimensions to standardize the preparation. The cervical margin of the cavity was placed 1 mm above the CEJ (group 1) and 1 mm below the CEJ (group 2). This was done to assess the effect of cervical margin levels on microleakage in class II restorations. To simulate oral conditions, the specimens were subjected to thermocycling.

Microleakage can be evaluated using several techniques. Dye penetration is one of the oldest and most commonly followed methods for identifying microleakage as it is not toxic or expensive and is simple to carry out. It can provide a very accurate description of restoration failure [30-32]. A non-destructive technique like Confocal laser scanning microscopy (CLSM) helps visualizing the subsurface tissue properties. [33-35]. In this study, microleakage was measured using CLSM at10x magnification [36].

In this study, both materials Cention N and Tetric N Ceram bulk fill showed some microleakage. With Cention N, at the occlusal margins, mean microleakage value was 0.9 and 1.35 for groups 1 & 2 respectively. With Tetric N Ceram bulk fill, mean microleakage value at occlusal margin was 0.7 and 1.05 for groups 1 & 2 respectively. Microleakage at the occlusal margin was less than the cervical margin at both levels (1mm above CEJ and 1mm below CEJ) with both material (Cention N and Tetric N Ceram bulk fill) and this difference was statistically significant. This can be attributed to the fact that the enamel usually exhibits a higher bond strength than dentin [37, 38].

Gingivally, mean microleakage was higher with the margin 1mm below CEJ with Cention N (1.9) and TetricNCeram (1.85) compared to the margin 1mm above CEJ with CentionN (1.3) and TetricNCeram (1.25). And this difference was statistically significant. The gingival seat close to the CEJ has less enamel and more dentin/cementum in a Class II cavity. Bonding to dentin is proven to be lower compared to enamel because of the difference in composition and histology [38]. Also, the cavities were restored using etch and rinse technique and studies have proven that bonding is better to enamel with etch and rinse technique [37]. This could well contribute to the results of the present study. Margins located below the CEJ are cervically limited by the hypomineralised and hyperorganic cementum layer which does not provide microretention for the adhesive materials even after acid etching [39-41].

Though Cention N has showed marginally more microleakage than Tetric N Ceram bulk fill at all tested levels, this difference was not significant statistically and thus the null hypothesis was partially accepted. This can be attributed to the similar composition in Cention N and Tetric N Ceram bulk fill. The presence of specially patented Isofiller and photoinitiator, Ivocerin in common in both the materials can corroborate with the results of this study. An in vitro study done by Sahadev et al compared microleakage between Cention N and bulk fill SDR and showed least microleakage in bulk fill SDR followed by Cention N [42].

From the results of our study, Cention N showed microleakage values similar to Tetric N Ceram bulk fill suggesting that Cention N, being a dual cure material, curing by self-cure mode in those areas where light does not penetrate along with the advantage of fluoride, calcium and hydroxide ion release in the critical area below the contact can be a material of choice in cervically placed class II cavities and can be an alternative to Tetric N Ceram bulk fill especially in clinical situations where salivary buffering is compromised and in caries prone conditions like rampant caries, pediatric patients, root caries in geriatric patients and those with salivary disorders.

CONCLUSION

Within this invitro study's limits, it can be concluded that both Tetric N Ceram Bulk fill and Cention N showed microleakage along occlusal and cervical margins at both levels (1mm above and below CEJ). Although Cention N has showed marginally higher microleakage than Tetric N Ceram at all tested levels i.e occlusal margin, cervical margins (1mm above & below CEJ), the difference was not significant statistically. Mean microleakage at occlusal margin was lower than that at cervical margin in both these groups and this was statistically significant. Gingivally mean microleakage was higher with the margin 1mm below CEJ with both materials. And this difference was statistically significant. Tetric N Ceram and Cention N performed comparable in terms of microleakage and may be preferred for class II restoration of posterior teeth consideringthe decreased working time and their favorable properties. However, long term studies and clinical trials are required to fully understand the performance of these materials.

Conflict of Interests: Nil

Source of funding: Nil

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