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RESEARCH ARTICLE

EVALUATION OF MICROLEAKAGE AND FRACTURE RESISTANCE OF CLASS II CAVITIES IN MAXILLARY PREMOLARS RESTORED WITH CENTION N - WITH AND WITHOUT AN ADHESIVE, SILVER AMALGAM AND BULK FILL COMPOSITE RESIN- AN IN VITRO STUDY

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ABSTRACT

Aim: The aim of this study was to evaluate the fracture resistance and microleakage of class II cavities in maxillary premolars restored with Cention-N, with and without an adhesive, silver amalgam and bulk fill composite resin. **Settings and Design**: This was an in vitro study. **Materials and Method:** A total 120 maxillary premolars were selected and divided into four groups (30 each) according to the filling material used - Group 1- Class II cavities restored with silver amalgam, Group 2- Class II cavities restored with bulk fill composite resin, Group 3- Class II cavities restored with Cention N without an adhesive, Group 4- Class II cavities restored with Cention N with an adhesive. Half of Samples were subjected tothermocycling and immersed in methylene blue dye. Samples were then sectioned longitudinally and evaluated for dye leakage under stereomicroscope. Remaining half were tested for fracture resistance under universal testing machine. Recorded results were subjected to statistical analysis. **Results:** The results of this study showed that Cention Nwith an adhesive showed the highest fracture resistance and lowest microleakage score followed by Cention N without an adhesive and bulk fill composite resin (Tetric N Ceram). While the specimen restored with silver amalgam showed least resistance to fracture and highest micro leakage. Statistical analysis of fracture resistance showed a highly significant difference between the groups and statistical analysis of microleakage showed a significant difference amongst the groups. **CONCLUSION:** Therefore, it may be concluded from the present study that Cention N when used with an adhesive provide highest resistance to fracture and lowest micro leakage amongst all the groups and thus it is suitable for posterior teeth restoration in class II cavities as a good alternative to amalgam and posterior composites.

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INTRODUCTION

Numerous direct filling materials are available for the modern dental practitioner for posterior load bearing restorations – from silver amalgam through to modern day bulk fill composites. Physical characteristics are of critical importance when deciding on suitable materials, because they strongly influence the clinical durability of restorations (Mazumdar et al., 2018). Currently, the main concerns regarding the performance of these materials refer to their ability to bear stress and resist fracture, durability, integrity of marginal sealing and aesthetics (Velagapudi et al., 2015).

Silver amalgam has been used as dental restorative material for more than 100 years for the restoration of posterior teeth (Pradeep et al. 2016). However the amalgam debate surrounding the safety of mercury and any causal link with a variety of diseases is one of the oldest ongoing controversies in medicine. Even though its safety in patients has been proven in countless studies and international reports (Patki 2013 &Ucar& Brantley 2011), the use of amalgam has been decreasing over the years. Clinically, micro leakage is not a significant problem with silver amalgam because the corrosion products from such alloys may eventually seal the interfacial gap between the tooth surface and the restoration (Patki 2013). The major disadvantage of amalgam, however, is its inability to bond to dental hard tissues which necessitates the use of macro mechanical retentive features which cause further weakening of the remaining tooth structure (Chowdhuri, Guha & Desai 2018).

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A quantum leap in the direct restorative was made with the introduction of light cure composites. Composites were introduced in 1960s and have been available for nearly fifty years (Bavaria et al. 2017). Despite having good physical properties, the main shortcomings of composite resin materials are - polymerization shrinkage which causes volumetric shrinkage and stress in the restoration and its subsequent debonding, leading to bacterial microleakage (Yarmohamadi, Jahromi & Akbarzadeh 2018), postoperative sensitivity and secondary caries (Swapna et al. 2017). Some newer developed resin composites like bulk fill composites are superior to the earlier versions, with regard to wear resistance, low polymerization shrinkage and improved depth of cure (Harbi et al. 2015). However the main concern is

composite gets cured enough in the deeper portion is area of concern as it can lead to decrease in marginal integrity and fracture resistance. Cention N (Ivoclar Vivadent; Schaan, Liechtenstein) is a recently introduced tooth-coloured, basic filling material for bulk placement in retentive preparations with or without the application of an adhesive (Van-Ende et al. 2017). It is an "alkasite" restorative which is a new category of filling material, like compomer or ormocer and is essentially a subgroup of the composite resin (Samanta, Das & Mitra 2017). Cention N is a UDMA-based (Van-Ende et al. 2017), self-curing powder/liquid restorative with optional additional light-curing. Organic monomer comprises of urethane dimethacrylates (UDMA), tricylodecan-dimethanol dimethacrylates (DCP), tetramethyl-xylelene-diurethane dimethacrylates (aromatic aliphatic-UDMA) and polyethylene glycol 400 dimethacrylates (PEG-400 DMA) which form part of the liquid (Sadananda et al. 2018). Fillers containing barium aluminium silicate glass, ytterbium trifluoride, Isofiller, calcium barium aluminium fluorosilicate glass, calcium fluoro silicate glass are found in the powder (Sadananda et al. 2018). Due to the sole use of cross-linking methacrylate monomers in combination with a stable, efficient self-cure initiator, Cention N exhibits a high polymer network density and degree of polymerization over the complete depth of the restoration (Samanta, Das & Mitra 2017). Due to its low elastic modulus this shrinkage stress reliever within Cention N reduces polymerization shrinkage and microleakage (Samanta, Das & Mitra 2017). . As there is demand in tooth colored restorations, this material of choice can be a cost- effective way to deliver a high-quality, predictable restoration and in less time (Deepak & Nivedhitha 2017). Hence the purpose of this in-vitro study was to evaluate and compare the marginal microleakage and fracture resistance of class II cavities restored with Cention N - with and without an adhesive, silver amalgam and bulk fill composite resin in maxillary premolar teeth.

MATERIALS AND METHOD

One twenty (120) human non carious, non-restored, permanent maxillary premolars extracted for orthodontic or periodontal reasons free of caries or fractures were selected for this study. All external debris was removed with ultrasonic scaler and teeth were stored in normal saline until use. Class II cavities were prepared on each of the one hundred and twenty maxillary premolars. A new bur was used for every five teeth. The shape and size of the cavity on the occlusal surface was ideal as advocated by Dr. G.V. Black that was 0.8 to 1mm wide and 1.5 to 2mm deep. The gingival step was 0.8 to 1mm wide that is the diameter of No. 245 bur. The axial wall was 1.5mm deeper thanthe occlusal cavity. The cavity was extended to 0.5mm buccally and palatally to the contact area. Buccal and palatal walls of the cavity were parallel to each other. No additional retentive features were cut. Cavity dimensions were verified using a periodontal probe, straight fissure bur and air rotorbur. These prepared tooth samples were divided into four equal groups with 30 samples in each of the following groups.

Group 1 – Class II cavities restored with silver amalgam ,Group 2 – Class II cavities restored with bulk fill composite resin , Group 3 – Class II cavities restored with Cention N without an adhesive, Group 4 – Class II cavities restored with Cention N with an adhesive

Procedure for testing fracture resistance: For evaluation of fracture resistance the fifteen teeth samples in each of the four groups were mounted in an acrylic block up to 1 mm apical to the CEJ, with long axis of the tooth perpendicular to the base of the block and subjected to compressive force under universal testing machine. Force was applied at a cross head speed of 2mm/min until fracture occurs. The readings of these forces required for fracture of the samples were noted and analysed using one way ANOVA and post hoc test.

Procedure for evaluating microleakage: For evaluation of microleakage remaining fifteen filled teeth samples from each of these four groups were taken and coated with one application of nail varnish except for an area 1 mm surrounding the restored cavities. These samples were then subjected to thermo cycling and were immersed in 2% methylene blue for 24 hours. After removal from the dye, teeth were rinsed in running tap water. Then the teeth samples were sectioned longitudinally in a buccolingual direction by diamond disc using a slow speed hand piece under water spray. Level of dye leakage was measured under a Stereomicroscope with 10x magnification. Dye penetration was scored in 5-scale classification system as follows:

0 = no dye penetration, 1 = dye penetration reaching the enamel, 2 = dye penetration reaching the enamel dentin junction, 3 = dye penetration reaching the dentin, 4= dye penetration reaching the cavityfloor. The data obtained from evaluation of microleakage and fracture resistance studies were subjected to statistical analysis.

RESULTS

Fracture resistance results: Following analysis, the mean fracture resistance of teeth in Group 1 restored with silver amalgam was 158.57±26.30 Kgf. The mean fracture resistance of the teeth in Group 2 restored with Tetric N Ceram was 190.78±32.35 Kgf. The mean fracture resistance of the teeth in Group 3 restored with Cention N without an adhesive was 193.89±32.28 Kgf. The mean fracture resistance of the teeth in Group 4 restored with Cention N with an adhesive was 209.51±42.76 Kgf. Results showed a highly significant difference between the groups. When mean difference between Group 1 (silver amalgam) was compared to Group 2 (Tetric N Ceram) the result was non-significant ($p \geq .05$). The mean difference between Group 1 (silver amalgam) and Group 3 (Cention N without an adhesive) was statistically significant ($p=.03$). The mean difference between Group 1 and Group 4 was statistically highly significant ($p \leq .001$). When mean difference between Group 2 and 3 were compared, they were found to be insignificant (p value $\geq .05$).

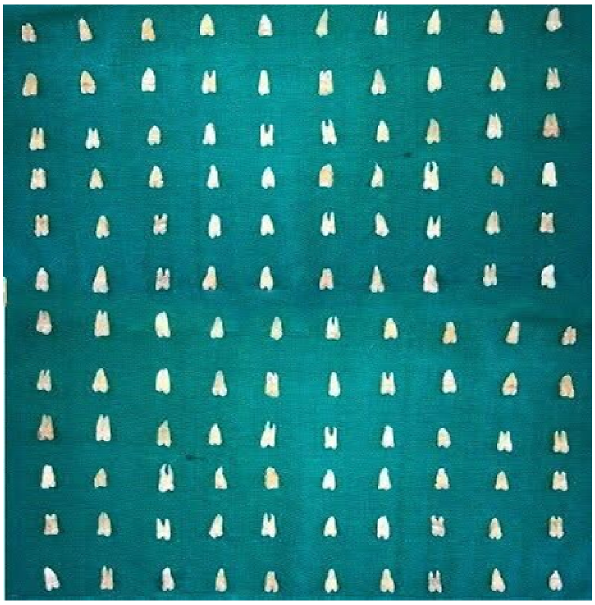


Fig. 1. Selected teeth for study

Fig.2. Samples restored with Amalgam and Tetric N Ceram

Fig. 3. Samples restored with Cention N with and without an adhesive Procedure for testing fracture resistance:

The mean difference between Group 2 and 4 was insignificant (p≥.05). The mean difference between Group 3 and 4 was also insignificant (p≥.05).

MICROLEAKAGE RESULTS

The mean microleakage score of teeth in Group 1 restored with silver amalgam was 1.400±1.1254.

The mean microleakage score of the teeth in Group 2 restored with Tetric N Ceram was 0.733±0.883. The mean microleakage score of the teeth in Group 3 restored with Cention N without an adhesive was 0.666±0.816. The mean microleakage of the teeth in Group 4 restored with Cention N with an adhesive was 0.400±0.6324. Kruskal Wallis test was applied to calculate the microleakage of the groups. Results showed a significant difference between the groups. For intergroup comparison, Mann Whitney test was used (Table 12A, 12B, 12C, 12D, 12E, 12F). When mean difference between Group 1 (silver amalgam) was compared to Group 2 (Tetric N Ceram) the result was non-significant (p≥.05). The mean difference between Group 1 (silver amalgam) and Group 3 (Cention N without an adhesive) was statistically significant (p=.03). The mean difference between Group 1 and Group 4 was statistically highly significant (p≤.001). When mean difference between Group 2 and 3 were compared, they were found to be insignificant (p value ≥.05). The mean difference between Group 2 and 4 was insignificant (p≥.05).the mean difference between Group 3 and 4 were also insignificant (p≥.05).

DISCUSSION

There is a continual scrutiny for the restorative materials that ensure adhesion to the tooth structure to curtail the leakage potential and the materials which can withstand the masticatory forces (Mali, Deshpande & Singh 2006 & Walia et al. 2019). The microleakage and fracture resistance test are used as a measure by which clinicians and researchers can predict the performance of a restorative material (Walia et al. 2019). Removal of tooth structure *via* cavity preparation has been shown to weaken the teeth and increase their susceptibility to fracture. Another major factor influencing the longevity of any dental restoration is microleakage. Amalgams offer unparalleled longevity and strength but are coupled with poor esthetics and controversial ingredients. Maintaining the integrity at the margins of the amalgam restoration is a primary goal and breakdown in this area can lead to fracture and microleakage.

During last decade there is an increasing demand for esthetic restorations in mesio-occlusal-distal (MOD) cavities in posterior dentition (Ragauska et al. 2008). Therefore, the restorative material should not only replace the missing dental structure, but it should also increase fracture resistance and improve marginal seal and provide esthetics. Due to high esthetic demands from patients, resin composites have gained popularity, the concept of bulk-fill composites has been introduced by which cavity can be restored using single increments of 4 mm. Bulk application technique has the advantages of being simpler as it makes the treatment quicker by reducing the number of clinical steps thus making it minimally technique sensitive (Roggendorf et al. 2011). Tetric N-Ceram (Ivoclar Vivadent) is one of the materials introduced as bulk-fill restorative composite. Tetric N- Ceram which contains better composite filler technology, a pre polymer shrinkage stress reliever, a light sensitivity filter to provide required physical and mechanical properties. It is a posterior composite of the nano-optimized Tetric N Collection (Patel & Desai 2016) However, the main concern is whether composite gets cured enough in the deeper portion is area of concern as it can lead to decrease in marginal integrity and fracture resistance. Cention N is a new basic filling material offering these characteristics of bulk fill composites plus other advantages over both amalgams and GIC.

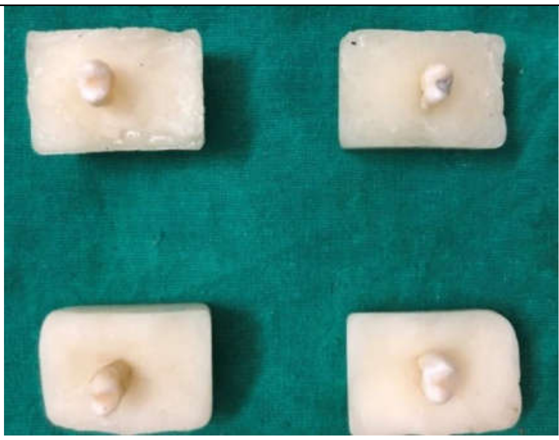


Fig.4. Restoredsamplesmounted onacrylicblocks

Fig.5.Universal testing machine used in the study

Fig. 6. Stereomicroscope

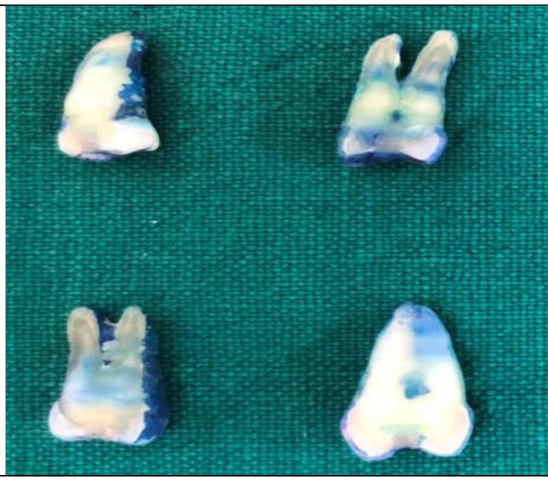
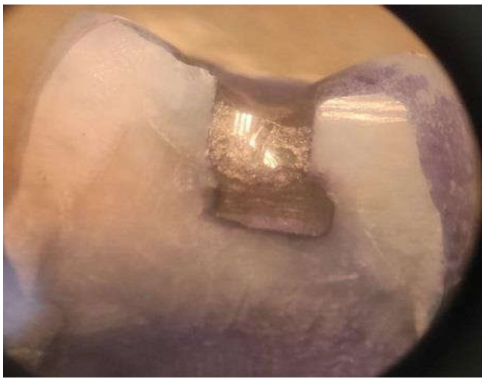


Fig. 7. Sectioned samples after immersion in dye

Cention with adhesive



Amalgam

Tetric n ceram

Cention n without adhesive

Stereomicroscopic study

Table 1. Anova test for Mean fracture resistance of all the four groups.

Groups	N	Mean	S.D	P value	Significance
Group 1	15	158.57	26.306		
Group 2	15	190.78	32.350		
Group 3	15	193.89	32.283		
Group 4	15	209.51	42.761	0.001	HS

Tables showing intergroup comparison between all groups using post hoctest

Table 2a. Showing comparison of mean fracture resistance of Group 1 with Group2

Groups	N	Mean	S.D	P value	Significance
Group 1	15	158.5700	26.30615	0.056	NS
Group 2	15	190.7800	32.35027		

Table 2b showing comparison of mean fracture resistance of Group 1 with Group3

Groups	N	Mean	S.D	P value	Significance
Group 1	15	158.5700	26.30615	0.030	S
Group 3	15	193.8900	32.28385		

Table 2c showing comparison of mean fracture resistance of Group 1 with Group 4

Groups	N	Mean	S.D	P value	Significance
Group 1	15	158.5700	26.30615		
Group 4	15	209.5100	42.76131	0.001	HS

Table 2d showing comparison of mean fracture resistance of Group 2 with Group 3

Groups	N	Mean	S.D	P value	Significance
Group 2	15	190.7800	32.35027	0.994	NS
Group 3	15	193.8900	32.28385		

Table 2f showing comparison of mean fracture resistance of Group 3 with Group 4

Groups	N	Mean	S.D	P value	Significance
Group 3	15	193.8900	32.28385	0.592	NS
Group 4	15	209.5100	42.76131		

Table 3. Mean difference between the microleakage of all the four groups with karuskal Wallis test.

Groups	N	Mean	S.D	P value	Significance
Group 1	15	1.4000	1.1254		
Group 2	15	0.7333	0.8837		
Group 3	15	0.6667	0.8165		
Group 4	15	0.4000	0.6324	0.0120	S

Intergroup comparison of microleakage with Mann-Whitney U test

Table 4a. microleakage score comparison of group 1 with group 2

Groups	N	Mean	S.D	P value	Significance
Group 1	15	1.4000	1.2546	0.089	NS
Group 2	15	0.7333	0.8837		

Table 4b. Microleakage score comparison of group 1 with group 3

Groups	N	Mean	S.D	P value	Significance
Group 1	15	1.4000	1.2546	0.049	S
Group 3	15	0.6667	0.8165		

Table 4c. Microleakage score comparison of group 1 with group 4

Groups	N	Mean	S.D	P value	Significance
Group 1	15	1.4000	1.2546	0.006	HS
Group 4	15	0.4000	0.6324		

Table 4d. Microleakage score comparison of group 2 with group3

Groups	N	Mean	S.D	P value	Significance
Group 2	15	0.7333	0.88372	0.683	NS
Group 3	15	0.6667	0.81650		

Table 4e. Microleakage score comparison of group 2 with group4

Groups	N	Mean	S.D	P value	Significance
Group 2	15	0.7333	0.88372		
Group 4	15	0.4000	0.63246	0.325	NS

Table 4f. Microleakage score comparison of group 3 with group 4

Groups	N	Mean	S.D	P value	Significance
Group 3	15	0.6667	0.81650		
Group 4	15	0.4000	0.63246	0.436	NS

It is a resin-based, self-curing powder/liquid restorative, an alkasite group of material; it has been developed as an alternative to amalgam as it is tooth colored, less expensive and has high flexural strength. Alkasite refers to a new category of filling material, which like compomer materials are essentially a subgroup of the composite material class (Desai & Das 2012). It also includes special patented filler (Isofiller) which acts as a shrinkage stress reliever minimizing the shrinkage force whereas the organic/ inorganic ratio, as well as the monomer composition of the material, is responsible for the low volumetric shrinkage. When the material polymerizes, either in self-cure mode or through additional light-curing, the monomer chains located on the fillers together with the silanes begin a cross-linking process and forces between the individual fillers come into play which (if the restorative has been placed adhesively) place stress on the cavity walls. This stress is influenced by both volumetric shrinkage and the modulus of elasticity of the material. The silanes bonded to the filler particles improve the bond between the inorganic filler (glass and quartz particles) and the monomer matrix as they are able to establish a chemical bond between the glass surface and the matrix (Kumar & Ajitha 2019).

Ultimately, the volumetric shrinkage and shrinkage stress in Cention N are reduced during polymerization - allowing bulk increments to be placed and an increase in compressive strength and lesser microleakage. In the current study marginal microleakage and fracture resistance of class II cavities restored with Cention N with and without an adhesive, silver amalgam and bulk fill composite resin in maxillary premolar teeth was evaluated. The results of the fracture resistance study showed that Cention N with an adhesive showed the highest fracture resistance. While the specimen restored with silver amalgam showed least resistance. This could be due to the facts that; Cention N has various multifillers with particle size range between 0.1 m to 35m. These fillers might be responsible for imparting adequate strength. It has UDMA as the main component of the monomer matrix which yields its strong mechanical properties due to its higher viscosity. Also the lack of hydroxyl side groups in it, which are hydrophobic in nature causes lower water resorption and increases strength. The results of the present study are in accordance with the study conducted by Chowdhary, Guha and Desai 2018 which demonstrated that Cention N showed highest fracture resistance when compared to amalgam and composite resin (Z350). Bisvas et al. 2018 compared the fracture resistance of Cention N with amalgam and composite (Dyract XP), and found that Cention N showed greater fracture resistance values. Sadananda et al. 2018 also performed a study to compare and evaluate the flexural and compressive strengths of four restorative materials i.e Cention N, Fuji IX GC, Ketac Molar and zirconomer. They reported that Cention N exhibited greater compressive strength amongst all the tested materials.

The results of the microleakage study showed that Cention N with an adhesive showed the least microleakage score. While the specimen restored with silver amalgam showed highest microleakage. This could be attributed to the facts that Cention N due to its low elastic modulus (10 GPA) the shrinkage stress reliever within Cention N minimizes the shrinkage force which causes less volumetric shrinkage, thus reduces polymerization shrinkage and microleakage. Also the organic/inorganic ratio as well as the monomer composition of the material, is responsible for the low volumetric shrinkage, allowing bulk filling of material and thus least microleakage. (Kaur et al. 2018). Similar results were found in the study conducted by Samanta et al. 2017 who compared microleakage of Cention N, glass ionomer and flowable composite in class v cavity, Where Cention N showed least microleakage. Mazumdar et al 2019 evaluated the microleakage score of Cention N, GIC and silver amalgam in class II cavities and found least microleakage score with Cention N. Mesharm et al. 2018 also compared microleakage score of Cention N with adhesive and a flowable composite, their results showed least microleakage with Cention N at enamel restoration interface, while Tetric N Flow showed least microleakage at dentin restoration junction.

Thus, results of the present study are encouraging and clinically significant as the class II prepared teeth after restoration were able to resist normal occlusal forces. The results of the present study favour Cention N with an adhesive. However these results must be interpreted with caution. Long term clinical observations of the performance of these materials should be studied to arrive at any definitive conclusions.

Conclusion

It may be concluded from the present study that Cention N when used with an adhesive provide highest resistance to fracture and lowest microleakage amongst all the groups and thus it is suitable for posterior teeth restoration in class II cavities as a good alternative to amalgam and posterior composites. However, long term clinical trials as well as in-vitro studies on large number of samples and at a large scale need to be undertaken, before drawing any definitive conclusion.

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