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Restoration of Teeth with Cention-N and Tetric N Ceram Bulkfill Materials on Tooth Surface: An In-Vitro Comparative Evaluation of Physico-Mechanical Properties

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ABSTRACT

Objective: The study aimed to evaluate and compare the shear bond strength, degree of conversion, microleakage, sorption, and solubility between Cention N and Tetric N Ceram Bulk Fill restorative materials. **Study Design:** Quasi-experimental study. **Settings:** de' Montmorency College of Dentistry, University College of Dentistry, and Institute of Dentistry, CMH Lahore Medical College, Lahore Pakistan. **Duration:** From January 2022 to December 2024. **Methods:** The study was conducted after the approval of IRB on a sample of 111 extracted molars and premolars, which were divided into four groups, each treated with different combinations of adhesives and restoration: Group A (Cention N with total-etch), Group B (Cention N with self-etch), Group C (Tetric N Ceram with total-etch), and Group D (Tetric N Ceram with self-etch). The samples were subjected to micro shear bond strength testing, FTIR spectroscopy, microleakage using dye penetration, and water sorption and solubility tests. Statistical analyses were performed using ANOVA and post-hoc Tukey tests. **Results:** Cention N demonstrated significantly higher micro shear bond strength ($p<0.001$) compared to Tetric N Ceram. The degree of conversion was highest in Tetric N Ceram ($p=0.008$). Microleakage analysis revealed that Cention N with adhesive showed the least leakage ($p=0.218$), while water sorption and solubility were lowest in Cention N ($p<0.001$ for both). **Conclusion:** Cention N outperformed Tetric N Ceram in terms of micro shear bond strength, microleakage, sorption, and solubility, making it a more reliable and durable restorative material. However, factors such as ease of use, cost, and patient comfort should also be considered.

Keywords: *Microleakage, Polymerization, Resin composites, Shear strength.*

INTRODUCTION

Dental resin composites are popular restorative materials with tooth-like color and mechanical properties similar to enamel or dentine. They require less tooth reduction and bond micromechanically to the tooth structure.[1] However, they have limitations like insufficient cure depth and polymerization shrinkage that may compromise the bond between tooth and restorative material, affecting marginal integrity and leading to microleakage and pulp sensitivity.[2]

Dental restoration longevity relies on the interface between the restorative material and tooth structure, with a strong resin-dentin bond essential for good marginal integrity and reduced microleakage.[3] Dental composites have been modified to improve their properties, including using filler particles of different sizes, pre-polymerized filler particles, and monomers with lower shrinkage. Strategies include using bicyclic monomers like spiro orthocarbonates, opening two cyclic rings to offset shrinkage, and reducing covalent bond generation.[4] Other than changes to filler systems and resin monomers.

The limitation of polymerization shrinkage has been addressed by using different light sources, their modes, adjustment of C-factor, and the direction of shrinkage, as well as application of incremental techniques.[5]

Tetric N Ceram bulk fill is a hybrid bulk-fill composite that hardens with light and contains Bis-GMA, UDMA, Bis-EMA, Barium aluminium silicate glass, and ytterbium trifluoride prepolymer fillers. It can be applied in 4mm increments without affecting mechanical properties.[6]

Centurion N is a dual-cure alkaline that can re-mineralize carious defects using fluoride, calcium, and hydroxide ions.[7-9] It requires acid etching and is self-cure, theoretically unlimited in depth, and has low polymerization shrinkage.[9] It is incorporated with hydroperoxide and thiocarbamide instead of benzoyl peroxide and tertiary amines, making it more temperature-resistant and improving color stability. It comes in a powder-liquid packing.[10]

The study compares micro shear bond strength and degree of conversion of Cention N and Tetric N Ceram Bulk fill restorative materials using FTIR spectroscopy, despite existing data on their physical and mechanical properties. The purpose of this research is to evaluate how well the tooth and the restorative material bond together and how much the two bulk-fill materials change after curing.

The study aimed to evaluate and compare the interfacial strength, degree of conversion, microleakage, sorption, and solubility between Cention N and Tetric N Ceram Bulk Fill restorative materials.

METHODS

The quasi-experimental study was conducted at de' Montmorency College of Dentistry, the University College of Dentistry and the Institute of Dentistry, CMH Lahore Medical College after the approval of Institutional Review Board of University College of Dentistry, University of Lahore (vide letter No. UCD/ERCA/21/10ac). The testing of the samples was carried out at the Department of Microbiology and PITMAEM, PCSIR, Laboratory.

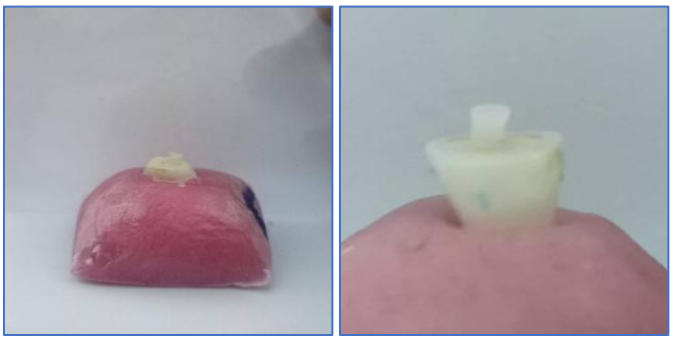
The sample size for each group was determined using the formula by Abo Al-Hana *et al*. Based on a 95% power of the study, 95% confidence, and a 5% significance level, a total sample size of 133 was calculated with 7 samples in each group.[11]

The prepared specimens were randomly divided into four groups for analysis of micro shear bond strength. The groups were defined as follows: Group A, with a total-etch adhesive system and Cention N; Group B, with a self-etch adhesive system and Cention N; Group C, with a total-etch adhesive system and Tetric N Ceram Bulk fill; and Group D, with a self-etch adhesive system and Tetric N Ceram Bulk fill.

For sample preparation, 133 extracted human molars and premolars were cleaned and disinfected before being stored in an isotonic solution. The coronal portion of each tooth was removed using a lathe disc, exposing a flat dentine surface, which was then prepared using a 600-grit wet silicon carbide paper. The teeth were subsequently mounted in acrylic resin, and the specimens were randomly allocated into the four experimental groups.

Figure 1: Removal of the coronal portion to expose the dentine

Figure 2: Tooth mounted in acrylic resin and build-up of restorative material on prepared tooth



In Group A, etchant (Eco-Etch gel Ivoclar Vivadent) was applied to the exposed dentine surface, followed by drying and application of the Adhese Universal bonding agent, which was light-cured for 10 seconds before restoration with Cention N. In Group B, the adhesive primer was applied, air-thinned, and coated with the Adhese bond before restoring the tooth with Cention N. Group C followed a similar procedure to Group A but used Tetric N Ceram Bulk fill as the restorative material. Group D used the self-etch adhesive system and restored the tooth with Tetric N Ceram Bulk fill.

Restoration of the teeth was done using a wax mould, ensuring that the restorative material was condensed within the mould. The samples were light-cured using an LED unit for 20 seconds, after which the wax mould was removed without disrupting the micro-cylinder formed

for micro shear bond strength testing. The prepared specimens were then placed in an ionized solution for 10 days before testing for shear forces using a universal testing machine.

For microleakage analysis, three study groups were prepared: Group A (Cention N with adhesive), Group B (Cention N without adhesive), and Group C (Tetric N Ceram Bulk fill). Microleakage was scored based on dye penetration. The results for water sorption and solubility were also analyzed, with four groups developed to test the materials under different conditions (Cention N and Tetric N Ceram in both artificial saliva and distilled water).

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) (IBM, Inc.). ANOVA was performed to compare the differences across the study groups for micro shear bond strength, microleakage, water sorption, and solubility. A post hoc Tukey test was performed for the pairwise comparison. A p-value less than or equal to 0.05 was taken as significant.

RESULTS

The comparison of the micro-shear bond strength between the study groups revealed a significant difference (p=0.001) (Table 1). The results of the post-hoc Tukey test are exhibited in Table 2. When all groups were compared, the maximum shear bond strength was reported in Group A, and the minimum strength was reported in Group D.

There was a significant difference between the study groups regarding the degree of conversion (p=0.008) (Table 1). The maximum degree of conversion was noted in group C, while the minimum degree of conversion was noted in group B. The results of the post-hoc Tukey test are exhibited in Table 2.

The comparison of the mean scores for microleakage using one-way ANOVA is expressed in Table 1. There was no statistically significant difference between the study groups (p=0.218). The highest microleakage was exhibited by group C, and the lowest was reported in group A. The multiple comparisons of microleakage using the post-hoc Tukey test are exhibited in Table 2.

The comparison of water sorption showed a significant difference between the study groups (p=0.001). The highest water sorption was reported in group D, and the lowest water sorption was reported in group A. The pairwise comparison using the post-hoc Tukey test is shown in Table 2. There was a statistically significant difference in solubility of the study groups (p=0.001). The maximum solubility was observed in group C. The multiple comparison using the post-hoc Tukey test is shown in Table 2.

Table 1: Descriptive statistics and comparison of shear bond strength, degree of conversion, microleakage, water sorption and solubility among study groups

Characterization	Study Groups	N	Mean	Std. Deviation	F	p
Shear Bond Strength	Group A	7	12.07	2.88	11.49	<0.001
	Group B	7	10.45	2.97		
	Group C	7	6.35	2.40		
	Group D	7	5.28	1.62		
Degree of Conversion	Group A	7	78.00	3.60	8.174	0.008
	Group B	7	62.33	4.50		
	Group C	7	80.66	9.07		
	Group D	7	64.33	3.51		
Microleakage	Group A	7	0.8	0.836	1.73	0.218
	Group B	7	1.0	0.707		
	Group C	7	1.6	0.547		
Water Sorption	Group A	7	2.50	0.956	65.63	<0.001
	Group B	7	5.54	2.702		
	Group C	7	10.68	1.908		
	Group D	7	16.64	2.128		
Solubility	Group A	7	-0.32	0.705	111.266	<0.001
	Group B	7	-0.45	1.159		
	Group C	7	-6.90	0.334		
	Group D	7	-4.09	1.840		

P-values were obtained using one-way ANOVA

Table 2: Pairwise comparison of Micro Shear Bond Strength, Degree of Conversion, Microleakage, Water Sorption, and Solubility among Study Groups between Study Groups

Characterization	Group	Group	Mean Difference	t	p-value
Micro Shear Bond Strength	A	B	1.617	0.986	0.362
		C	5.715	6.948	**<0.001***
		D	6.787	6.804	**<0.001***
	B	C	4.098	2.888	**0.028**
		D	5.170	3.734	**0.010**
	C	D	1.071	1.066	0.327
Degree of Conversion	A	B	15.66	17.76	**0.003**
		C	2.66	-.369	0.747
		D	13.66	3.33	0.079
	B	C	18.33	-2.33	0.144
		D	2.00	-.433	0.707
	C	D	16.33	4.97	**0.038**
Microleakage	A	B	0.20	-1.0	0.897
		C	0.80	-4.0	0.897
	B	C	0.60	-2.44	0.216
Water Sorption	A	B	3.03	-2.22	0.068
		C	8.18	-14.35	**<0.001***
		D	14.13	-21.97	**<0.001***
	B	C	5.141	-3.19	**0.019**
		D	11.09	-6.79	**<0.001***
	C	D	5.95	-7.91	**<0.001***
Solubility	A	B	0.12	0.20	0.842
		C	7.22	-35.45	**<0.001***
		D	3.76	4.33	**0.005**
	B	C	7.35	-13.18	**<0.001***
		D	3.63	5.99	**0.001**
	C	D	10.99	14.15	**<0.001***

p-values were obtained using a post-hoc Tukey test

DISCUSSION

The study reveals that Cention N has superior micro-shear bond strength compared to Tetric N Ceram Bulk Fill restorative material, possibly due to hydrophilic PEG-400 DMA in the liquid component.[10] Vertically oriented tubules have a thicker hybrid layer. Previous literature suggests that the adhesive strength of restorative materials declines with water aging.[12]

Evaluation of microleakage of each restorative material is of utmost importance as it is directly related to the success or failure of the restoration.[13] The study evaluated microleakage between two restorative materials, finding a statistically significant difference between Cention N with adhesive and Tetric N Cerum bulk fill. In the present study, Cention-N showed minimal color penetration, possibly due to an acid-resistant resin-dentin interdiffusion zone.[8] The findings of this study align with a previous study conducted by John Burgess, which also observed dye penetration into Cention-N with adhesive compared to without adhesive, observing minimal microleakage in Cention-N with adhesive.[8,14] The difference in microleakage could be attributed to the size of filler particles in both materials, as smaller particles allow for better adaptation to the tooth surface.

The degree of conversion plays a crucial role in determining the properties, behavior, and biocompatibility of polymer-based restorative materials.[15]

The study found no significant difference between the two materials, rejecting the alternative hypothesis. Santos *et al*. in 2024 showed degree of conversion (DC%) variation in resin matrix compositions is due to chemistry differences.[16] Bis-GMA's high viscosity limits its potential

for higher DC%, leading manufacturers to use less viscous and flexible monomers.[17]

Photo-curable polymer composites' water diffusion properties are influenced by the polymeric organic matrix, with factors like hydrophilicity, porosity, and crosslink density affecting the adsorption and desorption processes.[18] Tetric N Ceram bulk fill contains Bis-GMA and TEGDMA, which contribute to higher water uptake. Cation N has lower water uptake due to its hydrophobic nature. Solubility is influenced by the monomer used.[19-21]

The study found negative water sorption and solubility values for all groups, except Group C (Tetric N Ceram in Artificial Saliva), suggesting incomplete dehydration or low solubility rather than complete dissolution.[22] Some studies explain this phenomenon as a result of possible hydrolytic chemical reactions that lead to the formation of metal hydroxides on the filler surface.[23,24] Literature suggests that negative values may be due to hydrogen bonds between absorbed water molecules and the polar groups of polymer chains, which cannot be completely removed.[22,24,25]

CONCLUSION

Cention N demonstrated superior performance compared to Tetric N Ceram in several key aspects. It exhibited higher micro shear bond strength, indicating better adhesion between the restorative material and tooth structure. Additionally, Cention N showed lower microleakage, which suggests a more effective seal and reduced risk of bacterial infiltration. Moreover, Cention N had lower sorption and solubility levels, making it a more stable material in the oral environment. These findings collectively suggest that Cention N is a more reliable and durable restorative option, offering enhanced longevity and performance compared to Tetric N Ceram.

LIMITATIONS

A limitation of this study is the in vitro nature as laboratory testing does not fully replicate the complex oral environment where restorative materials are subjected to fluctuations in temperature, pH, salivary enzymes, and masticatory forces. Consequently, the long-term clinical behavior of the tested materials may differ from the laboratory findings. Furthermore, only two resin-based restorative materials were tested, restricting the scope of comparison. Inclusion of additional contemporary materials could have provided a broader understanding of material performance.

SUGGESTIONS / RECOMMENDATIONS

Cention N offers advantages over Tetric N Ceram bulk fill in micro shear bond strength, microleakage, sorption, and solubility, but factors like ease of use, cost-effectiveness, and patient comfort should be considered when choosing restorative materials for dental procedures.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflict of interest.

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None to declare.

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