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An *in vitro* Evaluation of Mechanical Properties of GIC, Cention-N and Composite Restorative Materials

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ABSTRACT

Introduction: Dental caries is irreversible microbial disease-causing cavitation. It is necessary to restore the cavitated carious lesion with suitable restorative materials. Choice of restorative materials is depending on mechanical properties and biocompatibility.

Objectives: This study was done to compare the mechanical properties (compressive strength (CS) and diametral tensile strength (DTS)) of GIC, Cention-N and nanohybrid composite restorative materials.

Methods: Thirty specimens with 10 in each group were prepared from Glass Ionomer Cement (GIC), Cention-N and nanohybrid composite restorative materials for testing compressive strength and DTS. Results obtained were statistically evaluated by one-way ANOVA and Tukey's *post hoc* test at significance ($p < 0.001$).

Results: We observed highest mean compressive strength for Cention-N 248.52 ± 4.28 MPa, followed by 203.11 ± 1.35 MPa in Nano hybrid composite and least for GIC i.e 157.32 ± 1.58 MPa, which is statistically significant ($P < 0.001$). Highest mean diametral tensile strength was observed with Cention-N ($108.63.76 \pm 1.73$ MPa) followed by Nanohybrid composite (92.54 ± 1.21 MPa) and least with GIC (54.28 ± 1.12 MPa) which is statistically significant ($P < 0.001$). Intergroup comparison of compressive and diametral tensile strength was highly significant 0.001.

Conclusion: This study indicates the highest compressive and tensile strength with Cention N followed by hybrid composite, and GIC restorative materials.

Key Words: Compressive strength, Tensile strength, Restorative materials

INTRODUCTION

Dental caries is one of the most widespread diseases in the population due to high ingestion of carbohydrates and due to improper oral hygiene measures. It is necessary to restore the cavitated carious lesion with suitable restorative materials. Hence, the choice of restorative materials depends on properties such as; load-bearing strength of the materials, adhesion to the tooth structure, biocompatibility, retention, and ease of application.¹ For posterior restorations, the materials have to withstand forces of compression and tension. There is the evolution of restorative materials forms silver amalgam to newer advances like composites. Each material used to restore posterior teeth has specific advantages and disadvantages and these should be suspiciously considered before selection.²

Glass ionomer cement (GIC) was introduced in 1972 by Wilson and Kent for restorative and preventive applications. Its unique properties such as anticarcinogenic character due to fluoride release, satisfactory biocompatibility, adhesion to dentin, and coefficient of thermal expansion similar to that of tooth make it an important material for dental restorations. Nevertheless, one of the major disadvantages of GIC is its weak mechanical properties such as brittleness, toughness, and low compressive strength, because of which alternative filling materials have been researched.³⁻⁵

In the last four decades, there have been tremendous improvements and innovations in the development of more constant composite materials. The dental composite resins have led to a wide range of composite material selections based on clinical situation.⁶ Nanotechnology has a great impact on restorative

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dentistry by offering refinements to the already available resin-based composite system. These materials were introduced in 2002 which were formulated with nanomer and nanocluster filler particles, which were expected to be useful for all restorative applications. But they have the limitation that they cannot be used as posterior restoration materials where isolation is poor and wear is high.⁷

Cention N (Ivoclar Vivadent) is a recently introduced tooth-coloured, restorative filling material for bulk placement in retentive preparations with or without the application of an adhesive. It is an “alkasite” restorative which is a new category of filling material, like compomer, and is essentially a subgroup of the composite resin. Cention N is a urethane dimethacrylate (UDMA)-based, self-curing powder/liquid restorative with optional additional light curing. The liquid comprises dimethacrylates and initiators, while the powder contains various glass fillers, initiators, and pigments. It is radio-opaque and comprises alkaline glass fillers able to release fluoride, calcium, and hydroxide ions. Due to the only use of cross-linking methacrylate monomers in combination with a constant, efficient self-cure initiator, Cention N, displays a high polymer network density and degree of polymerization over the complete depth of the restoration.^{8,9} The success of dental treatment depends not only on biological, physical, chemical, and pathophysiological principles but also on the adequate and significant knowledge of the mechanical properties of dental tissues and materials.^{10,11}

This study was done to compare the mechanical properties (compressive strength (CS) and diametral tensile strength (DTS)) of GIC, Cention-N and nanohybride composite restorative materials.

MATERIALS AND METHOD

The study was done in the department of conservative dentistry and endodontics. Thirty specimens with 10 in each group were prepared from GIC, Cention-N and nanohybrids composite restorative materials for testing compressive strength and DTS. The specimens were made in the cylindrical moulds with standard dimensions of the American Dental Association (ADA) specification.¹² All the materials were mixed and prepared according to the instruction from the manufacturer. The specimens were made at room temperature $23 \pm 2^\circ\text{C}$, with a relative air humidity of $50 \pm 10\%$. The mixed material was slowly inserted into the moulds and plates were placed above it followed by a slight application of pressure for 20 seconds. The excess material was extruded from the top. The test specimens were subjected to a water bath at $37 \pm 1^\circ\text{C}$ for 1 hour before testing.

Compressive Strength Testing

According to the ADA specification, cylindrical specimens were prepared in moulds with dimensions of 6 mm

in diameter and 12 mm in height. This test was carried out using the Instron universal testing machine that has a crosshead speed of 1.0 mm/minute. Each sample was placed with the flat ends between the platens of the specimens. The maximum load applied to fracture the specimens was recorded and the compressive strength was calculated using the following formula: $CS = 4P/\pi D^2$, where P is the maximum applied load (N) and D is the measured diameter of the sample (mm).

Diametral tensile strength (DTS)

For the DTS test, the dimension of specimens was 6.0 mm in diameter and 3.0 mm in height. The sample was placed with the flat ends perpendicular to the platens in the Instron universal testing machine so that the load will be applied to the diameter of the specimens. When the maximum load was applied to the fracture, the specimens were recorded at a crosshead speed of 0.1 mm/minute and the DTS was calculated using the following formula: $T = 2P/\pi DL$, where P is the maximum applied load (N), D is the measured diameter of the sample (mm), and L is the measured length of the sample (mm).

The obtained data were statistically evaluated using SPSS, IBM software version 20.0 with one-way ANOVA for comparison between groups and Tukey's *post hoc* test to compare the materials among groups at a p value of less than 0.05.

RESULTS

Table 1 shows that highest mean compressive strength for Cention-N $248.52 \pm 4.28\text{MPa}$, followed by $203.11 \pm 1.35\text{MPa}$ in Nanohybrid composite and least for GIC i.e $157.32 \pm 1.58\text{MPa}$, which is statistically significant ($P < 0.001$).

Table 2 shows the highest mean diametral tensile strength for Cention-N ($108.63.76 \pm 1.73\text{MPa}$) followed by Nanohybrid composite ($92.54 \pm 1.21\text{MPa}$) and least with GIC ($54.28 \pm 1.12\text{MPa}$) which is statistically significant ($P < 0.001$).

Tables 3 shows the intergroup comparison of compressive and flexural strength which is highly significant 0.001. This study indicates the highest compressive and diametral tensile strength with Cention N followed by hybrid composite, and GIC restorative materials.

DISCUSSION

The restorative materials used in the oral environment are subjected to various occlusal The success of restorative treatment depends on careful selection of material and physical and mechanical properties of selected restorative material. Kumar et al.¹¹ done a comparative study on mechanical properties of direct core build-up materials. They concluded

that the composite had high mechanical properties and GICs showed the weakest; this is in agreement with our study.¹¹⁻¹³

Al-Tae et al. evaluated the physical properties of eight commercial restorative GICs; Ketac™ Fill Plus Applicap (C&H), Fuji IX GP Extra (C&H), Fuji IILC (C&H), Glass Carbomer Cement and Equia® Forte Fil, capsulated versus manually mixed. They found improved mechanical properties with GIC/RMGICs compared to other tested groups.¹³ Hotwani et al. evaluated the colour stability of hybrid esthetic restorative materials against various beverages and concluded that giomer specimens exhibited less colour change as compared to RMGIC specimens.¹⁴ Li et al. assessed the flexural strength and compressive strength of four resin-modified luting glass ionomer cements (RL, NR, GCP, and GCC). They concluded that compressive strengths of the NR and GCP groups are higher than those of the GCC and RL groups, there are no significant differences ($P > 0.05$) between NR and GCP.¹⁵

Jayanthi and Vinod assessed the Compressive Strength and Flexural Strength of Conventional Core Materials with Nanohybrid Composite Resin Core Material. They found the highest compressive strength and flexural strength with Fluorocore followed by Filtek Z350 [nanocomposite] Amalgam had the least flexural strength and Vitremer GIC had the least compressive strength.¹⁶ Kaur et al. evaluated the compressive strength of Cention N with glass Ionomer cement and found high compressive strength with Cention N compared to GIC Type IX.¹⁷

The limitation of our study is the smaller samples size. Further studies are needed with larger samples size including other restorative material for evaluation of other mechanical properties of restorative materials.

CONCLUSION

This study indicates the highest compressive and tensile strength with Cention N followed by hybrid *composite* and GIC restorative materials.

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Author contribution

1. UP- Manuscript writing
2. ASS- Investigation
3. VDR- Data collection
4. KR- Data collection
5. AG- Evaluation
6. AMN- Editing
7. SM- Analysis

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Table 1: Mean value of Compressive strength (MPa)

Group	Material	N	Mean±SD	P
A	Nano hybride composite	10	203.11±1.35	0.001*
B	Cention-N	10	248.52±4.28	0.001*
C	GIC	10	157.32±1.58	0.001*

*One-way ANOVA (F value – 4235.34), SD- standard deviation

Table 2: Mean value of diametral tensile strength (MPa)

Group	Material	N	Mean±SD	P
A	Nano hybride composite	10	92.54±1.21	0.001*
B	Cention-N	10	108.63.76±1.73	0.001*
C	GIC	10	54.28±1.12	0.001*

*One-way ANOVA (F value – 1028.42), SD- standard deviation

Table 3: Intergroup comparison of the compressive and diametral tensile strength (MPa)

Test	Group comparison	Mean difference	P
Compressive strength	Group A with Group B	-43.48	<0.001*
	Group A with Group C	35.57	<0.001*
	Group B with Group C	78.53	<0.001*
Flexural strength	Group A with Group B	-15.12	<0.001*
	Group A with Group C	76.18	<0.001*
	Group B with Group C	92.29	<0.001*

MPa- Mega pascal