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Research Article

COMPARATIVE EVALUATION OF MECHANICAL PROPERTIES OF CENTION-N AND TYPE IX GIC - AN IN VITRO STUDY

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A B S T R A C T

Aim: To evaluate and compare the mechanical properties such as Compressive strength, Flexural strength and Knoop Microhardness of Cention-N and Type IX GIC using Universal Testing Machine and Micro Hardness Tester.
Methodology: Test specimens were made using custom made plexi glass moulds with different dimensions according to ISO Standard specification, ISO 9917 and were grouped as Group-I and Group-II. Group-I consisted of Cention-N specimens and Group-II consisted of Type IX GIC specimens with specific dimensions. After the test specimen fabrication, they were stored in distilled water for 24 hours prior to the respective mechanical testing using Universal Testing Machine and Micro Hardness Tester.
Results: Cention-N (Group-I) exhibited superior mechanical properties when compared to Type IX GIC (Group-II).

INTRODUCTION

Dental caries is the primary cause of oral pain and tooth loss, which can be arrested and potentially reversed in its early stages. The treatment should focus on the management of the caries process over time with a minimally invasive, tissue-preserving approach. [1]

Conventional glass ionomer cements were introduced to the dental professional by Wilson and Kent in 1972. [2] They possess certain unique properties, which include the adhesion to moist tooth structure and base metals, anticariogenic properties, thermal compatibility, biocompatibility and low cytotoxicity. [3] On the contrary, their use as a restorative material in stress-bearing areas were limited due to poor mechanical properties, such as low fracture strength, toughness, and wears resistance.[4] To overcome the poor mechanical properties of conventional GICs, a newer generation of glass ionomer, Fuji IX, was developed especially for pediatric patients and was introduced to the clinical practice in late 1990's. It possess high strength, wear resistance, chemical adhesion to tooth structure, fluoride release, radiopacity, and less technique sensitive to saliva.[5]

Filling a cavity in bulk will reduces the restorative procedural time, minimizes the air entrapment and improves the quality of the final restoration.[6]

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Recently manufacturers have introduced Cention-N, a newer basic filling material for bulk placement in retentive preparations with or without the application of an adhesive.[7] It is self-curing with optional additional light curing. It consists of alkaline filler which releases acid neutralizing ions. It reduces the polymerization shrinkage and microleakage and also fulfils the requirement for an esthetic bulk fill material in the stress bearing areas.[8]

The present study was undertaken to evaluate and compare the mechanical properties of Cention-N and Type IX GIC.

MATERIALS AND METHODS

Preparation of test specimen: A total of 72 Specimens were fabricated for the study. The test specimens were made using Type IX GIC and Cention-N in a custom made plexi glass moulds of specific dimensions according to ISO Standard 9917. Among 72 Specimens, 36 specimens of different dimensions made by using Cention-N were considered as Group-I. Remaining 36 specimens were considered as Group-II. In both the groups, 12 cylindrical specimens of dimensions 4mm diameter and 6mm height were used for compressive strength testing, 12 bar shaped specimens of dimensions 25x2x2mm were used for flexural strength testing and remaining 12 rectangular specimens of dimensions 8mm diameter and 4mm height were used for knoop microhardness testing. The mixed cements of Cention-N and Type IX GIC were placed into the custom made plexi glass moulds by placing a matrix strip above and below to the moulds to achieve a finished surface. After setting, the specimens were removed from the mould and the excess was trimmed using a Bard Parker blade #11 and polished with 1200 grit paper and then the test specimens were stored in distilled water for 24 hours prior to the respective mechanical testing.

Assessment of compressive strength: 12 cylindrical test specimens from each group were used to assess the compressive strength. Each specimen was placed between the plates of Universal Testing machine (Model PC-2000, Electronic Tensometer). A compressive load was applied at a crosshead speed of 5mm/min until the test specimens were fractured. The maximum load applied to fracture the specimens was recorded.

Assessment of flexural strength: 12 bar shaped test specimens from each group were used to assess the flexural strength. Each specimen was subjected to a 3-point bending test on a Universal Testing machine (Model PC-2000, Electronic Tensometer) at a crosshead speed of 5mm/min. The maximum load applied to fracture the specimens was recorded.

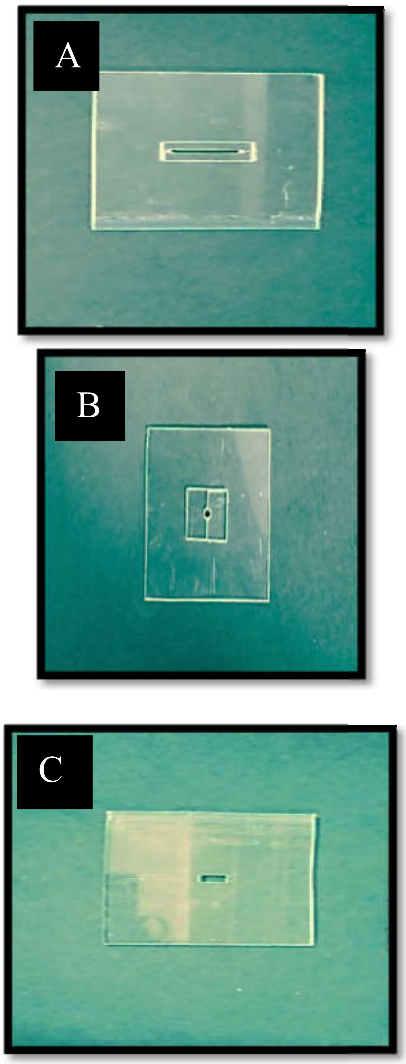

Figure 1 A) Custom made split plexi glass mould of dimension 25mm x 2mm x 2mm, B) Custom made split plexi glass mould of dimension 4mm x 6mm, C) Custom made plexi glass mould of dimension 8mm x 4mm.

Assessment of knoop microhardness: 12 rectangular test specimens from each group were used to assess the knoop microhardness. Each specimen was subjected to Microindentation Hardness Test in a Micro Hardness Tester (Matsuzawa, Japan/MMT-X7A). The hardness was measured using a diamond intender under a load of 100g, applied for 10s as dwell time. Each microhardness determination consisted of five evenly-spaced indentation measurements over the polished surface of each specimen. From these, an average Knoop Hardness Number (KHN) was determined.

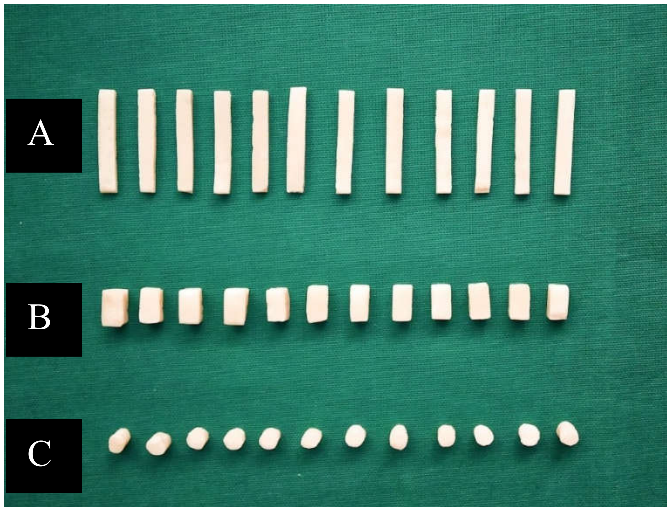

Figure 2 Test specimens for: A) Flexural strength, B) Knoop microhardness and C) Compressive strength testing

Statistical Analysis: The Data obtained from each group was collected, tabulated, coded and fed in SPSS (SPSS version 23) for statistical analysis. Depending upon the nature of the data, the statistical test used for analysis was Student T test. A p-value < 0.05 was considered as statistically significant. The result was presented as mean and standard deviation values.

RESULTS

The mean compressive strength of Cention-N was found to be 140.3574 MPa whereas for Type IX GIC, it was 101.5079 MPa. The mean flexural strength of Cention-N was found to be 90.5502 MPa whereas Type IX GIC showed 31.7092 MPa. The mean knoop hardness of Cention-N was found to be 81.725 MPa whereas for Type IX GIC, it was 67.7333 MPa. Cention-N exhibited statistically significant higher compressive strength, flexural strength and knoop microhardness values with a p value < 0.05 when compared to Type IX GIC (Table 1). The mean compressive strength, flexural strength and knoop microhardness values of Cention-N and Type IX GIC was summarized in (Figure 3).

Table 1 Comparison of compressive strength, flexural strength and knoop microhardness of Cention-N and Type IX GIC in terms of {Mean (Standard deviation)} using Student T test.

Parameters Tested	Materials	N	Mean	Standard deviation	T	Significant
Compressive strength	Cention-N	12	140.3574	1.17737	13.380	0.001 (H.S)
	Type IX GIC	12	101.5079	9.98895		
Flexural strength	Cention-N	12	90.5502	1.38263	112.012	0.001 (H.S)
	Type IX GIC	12	31.7092	1.18312		
Knoop microhardness	Cention-N	12	81.7250	0.79444	42.173	0.002 (H.S)
	Type IX GIC	12	67.7333	0.83048		

p value ≤ 0.05 is significant, HS – Highly significant, NS – Not significant, N – Number of specimens tested, T - Student T test.

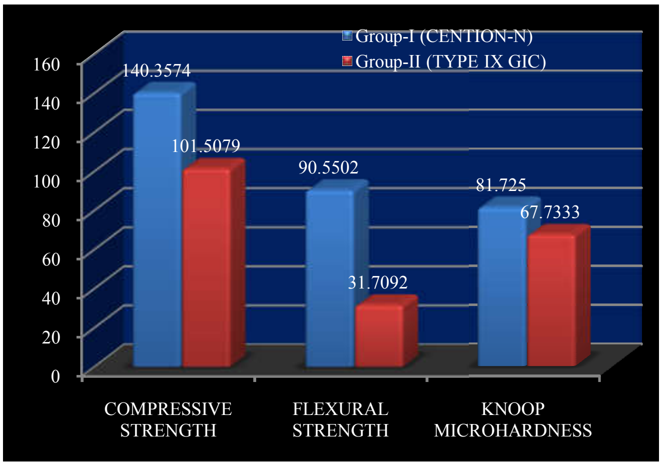

Figure 3 Mean compressive strength, flexural strength and knoop microhardness of Cention-N and Type IX GIC in MPa.

DISCUSSION

The role of restorative materials is to stimulate functional, biological and esthetic harmony of the lost tooth structure. Occlusal forces acting on the restorative materials can ultimately compromise their durability over time. Since many forces are acting in oral cavity, the knowledge and interpretation of how the dental restorative materials behave under such forces are relevant to understand the performance of these materials.[9] Based on the research by Hanan Alzraikat *et al* and Heintze *et al*, amongst the mechanical properties of restorative materials, compressive strength and flexural strength are considered to be a critical indicator in the durability of the restorative materials, as they resist masticatory and parafunctional forces.[10] Another determinant factor which can influence on the polishing ability of the restorative material is its surface characteristics. Hardness of the restorative material can predict the wear resistance of the material and its ability to abrade or to be abraded by the opposing tooth structures.[11] Inorder to determine the microhardness of brittle materials or thin layers, knoop microhardness test is conducted.

The present study evaluated and compared the mechanical properties such as compressive strength, flexural strength and knoop microhardness of Cention-N and Type IX GIC. Mechanical properties were tested according to the International Organization for Standardization (ISO) Standard 9917: 2003 for dental water-based cements.[12, 13] The test was conducted in a method similar to that used by Bonifacio and colleagues.[14] Based on the results obtained, the present study revealed that the maximum mean value of compressive strength, flexural strength and knoop microhardness was found to be higher for Cention-N than that of Type IX GIC.

In the present study Cention-N exhibited a higher flexural strength value of 90.55 Mpa, whereas Type IX GIC exhibited only 31.70 Mpa. Similarly Cention-N exhibited a significantly higher compressive strength value of 140.35 Mpa, whereas Type IX GIC exhibited only 101.50 Mpa, which was statistically significant with a p value < 0.05. The high compressive strength and flexural strength of Cention-N might be due to the presence of four different dimethacrylates combination in the monomer matrix of Cention-N, which includes Urethane dimethacrylate (UDMA), Tricylodecan-dimethanol dimethacrylate (DCP), Tetramethyl-xylen-diurethane dimethacrylate (Aromatic-aliphatic UDMA), Polyethylene glycol 400 dimethacrylate (PEG-400 DMA). UDMA is the major component of the monomer matrix, these exhibits a stronger crosslinking during polymerization reaction. DCP has a cyclic aliphatic structure which facilitates enhancement of strength.[15] Similar results were observed in flexural and compressive strength evaluation study of Cention-N and Type IX GIC, conducted by Vandana and colleagues.[16] Cention-N showed the highest knoop microhardness value of 81.72 Mpa when compared to Type IX GIC which showed 67.73 Mpa, which was statistically significant with a p value $<$ 0.05. The increased microhardness of Cention-N might be related to the nanoparticle size of the fillers in the monomer matrix. The inorganic fillers comprises of barium aluminium silicate glass filler, ytterbium trifluoride, an Isofiller (Tetric N-Ceram technology), a calcium barium aluminium fluorosilicate glass filler and calcium fluorosilicate an alkaline glass filler, with a particle size of between 0.1 µm and 35 µm. These fillers were the soul component behind the improved microhardness of Cention-N.[17,18]

CONCLUSION

The present study concludes that the alkasite restorative material - Cention-N exhibited statistically significant, excellent mechanical properties such as compressive strength, flexural strength, knoop microhardness when compared to that of commonly used Type IX GIC. Within the limitation of the present study, Cention-N can be used as bulk fill restorative material for anterior as well as posterior restorations in pediatric dentistry. However, further in-vivo studies are obligatory to clinically evaluate the success rate of Cention-N as a restorative material.

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