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A comparative evaluation of compressive strength of Cention N with glass Ionomer cement: An *in-vitro* study

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Abstract
Aim: The aim of the present study was to evaluate and compare the compressive strength of Cention N with Glass Ionomer cement as a restorative material.
Materials and Methods: Customised cylindrical moulds of dimension 6±1mm (height) × 4±1mm (diameter) were used to fabricate 10 samples each of Cention N (Ivoclar Vivadent) and Glass Ionomer Cement (GC IX High strength Posterior restoration). Then, samples were tested for evaluation of compressive strength using Universal Testing Machine (UTM). This was connected to a load measuring cell, which continuously recorded the load applied to the samples at a crosshead speed of 0.75 ± 0.25 mm per 1 minute till the samples fractured.
Results: The values were recorded and subjected to statistical analysis for comparison of compressive strength (MPa) between the two materials using SPSS software. In order to compare the means of two materials, Independent T-Test was used. The results of the study showed that Cention N had high compressive strength than GIC Type IX.
Conclusion: Within the limitation of this study, it can be concluded that Cention N can be used as a superior alternative to GIC Type IX for restoration of posterior teeth since its compressive strength was found to be significantly higher. However, long term clinical studies are required to draw any substantial conclusion.

Keywords: Cention N, compressive strength, GIC Type IX, posterior restoration

1. Introduction

Good compressive strength is one of the major properties which a direct posterior restorative material must possess in order to ensure the longevity of the restoration. Dental Amalgam has been used since ages for this purpose, but, its possible toxicity due to mercury release and poor esthetics are its major drawbacks. Glass Ionomer Cement (GIC) has wide range of applications in dentistry. But, its relatively high solubility, low abrasion resistance and questionable compressive strength are the major concerns. The restorative material for posterior teeth should have adequate compressive strength to resist intraoral forces [1]. It is said that compressive strength is the most important mechanical property of restorative materials [2]. A material with very low compressive strength than tooth, tends to fracture under occlusal loads and ends with periodontal problems or even extraction of the tooth [3-5].

An ideal material used for restoration should be adhesive, tooth colored, resistant to wear, nontoxic, biocompatible to the tissue [6,7]. The dental literature provides studies on the mechanical properties of Glass Ionomer cements, such as diametral tensile strength[8], flexure strength [9] and compressive strength.[10-12] However, most of these studies evaluated conventional or resin-modified glass ionomer cements [12-14] with little emphasis on type IX GIC (i.e. High strength, Posterior restorative material). Recently, Cention N has been introduced in dentistry which the manufacturers claim to possess best of the properties of Amalgam and GIC.

Although clinical trials would provide the ultimate evidence of clinical performance of dental restorations but preliminary and safety studies on dental materials should be conducted *in vitro* [15,16]

Therefore, the objective of this *in vitro* study was to evaluate and compare the compressive strength of Cention N with Type IX Glass Ionomer cement as a restorative material.

2. Materials and Methods

Two commercially available brands of restorative materials were used i.e. Cention N (Ivoclar Vivadent) and Glass Ionomer cement (GC IX High strength Posterior restoration) [Fig. 1, 2]. Customised cylindrical moulds of dimension 6±1mm (height) × 4±1mm (diameter) [17, 18] were used to fabricate 10 samples each of Cention N (Ivoclar Vivadent) and Glass Ionomer cement (GC IX High strength Posterior restoration) [Fig. 3,4]. Then, samples were tested for evaluation of compressive strength using Universal Testing Machine (UTM) [Fig. 5]. This was connected to a load measuring cell, which continuously recorded the load applied to the samples at a crosshead speed of 0.75 ± 0.25 mm per 1 minute till the samples fractured [Fig 6].

3. Results

The values were recorded and subjected to statistical analysis for comparison of compressive strength (MPa) between the two materials using SPSS software [Tables 1, 2]. The Null Hypothesis 1 was that there is no significant difference in the mean compressive strength (MPa) of the 2 materials. The Alternate Hypothesis was that there is a significant difference in the mean compressive strength (MPa) of the 2 materials. In order to compare the means of two materials, Independent T-Test was used. The P value was compared with the level of significance. If $P<0.05$, the alternate hypothesis was accepted and concluded that there is a significant difference in the mean compressive strength of the materials. The difference in mean compressive strength between the two materials was found to be statistically significant ($P< 0.001$) [Fig. 7].

4. Discussion

Glass Ionomer cements bond chemically to tooth achieved via initial cross linking of Ca ions with polyacrylic acid forming calcium polyacrylate chains. Final setting involves cross linking of trivalent Al ions with polyacrylic acid forming aluminium polyacrylate chains. The Ca and Al polyacrylate cross linked chains become hydrated over time with water being present in the liquid. This process is known as maturation. Thus, the microstructure of set cement consists of agglomerates of unreacted glass particles (glass cores which serves as filler in cement matrix) surrounded by silica gel embedded in an amorphous matrix of hydrated Ca and Al polysalts. Water plays an important role in setting reaction of GIC by serving initially as reaction medium and then slowly hydrates the matrix. During initial setting, water is loosely bonded to Ca polyacrylate chains and at this stage, any loss of water from exposure to ambient air or uptake of water from moisture contamination results in chalky, cracked surface and leaching of ions from matrix respectively. Both uptake and loss of water results in weak and more soluble cement with reduced translucency. Hence, this is prevented by coating of varnish immediately after placing the restoration [19, 20]

Glass ionomer cements are very technique and methodology sensitive, and are even subjected to failures during manipulation - a very important aspect when materials that require manual mixing are tested. For these reasons, it has been suggested to use smaller specimen dimensions (6 mm x 4 mm) to investigate mechanical properties of glass ionomer cements, according to ISO 7489:1986 specification [21, 22].

Cention N is an “alkasite” restorative. Alkasite refers to a new category of filling material which utilizes an alkaline filler, capable of releasing acid-neutralizing ions. Cention N is a tooth-coloured, resin based, self-curing, basic (alkaline) filling material for direct restorations with optional additional light-curing property. Cention N is available in the tooth shade A2.

Composition of Cention N: available as powder and liquid.

POWDER **–** consists of filler particles and other initiator components.

Filler	Function
Barium aluminium silicate glass	Strength
Ytterbium trifluoride	Radiopacity
Isofiller (Tetric N-Ceram technology)	Shrinkage stress relief
Calcium barium aluminium fluorosilicate glass	Strength, fluoride release
Calcium fluoro silicate glass	Ion release F^-, OH^-, Ca^{2+}

LIQUID **–** consists of four different dimethacrylates monomers and initiators.

- Urethane dimethacrylate (UDMA) - main component of monomer matrix and has no hydroxyl side groups i.e. its hydrophobic and exhibits low water absorption.
- Tricyclodecan-dimethanol dimethacrylate (DCP) - low viscosity, difunctional monomer which initiates hand mixing of Cention N.
- Tetramethyl-xylylen-diurethane dimethacrylate (Aromatic aliphatic-UDMA) - partially aromatic urethane dimethacrylate is a hydrophobic, high-viscosity cross-linker which combines the favourable properties of aliphatic (low tendency to discolour) and aromatic (stiffness) diisocyanates.
- Polyethylene glycol 400 dimethacrylate (PEG-400 DMA) - enhances the flowability of Cention N [23].

Polymerization technology in Cention N

Self-cure mechanism – liquid part of Cention N has hydroperoxide and the standard filler in the powder is coated with the other initiator components. Hydroperoxide rather than conventional benzoyl peroxide imparts greater temperature-resistance i.e. it is less sensitive to heat, which is an important factor regarding storage stability. Thiocarbamide rather than amine also improves the colour stability of the product.as colour stability of a material decreases with increasing amine content.

Light-cure (dual-cure) mechanism – it has photoinitiator Ivocerin and an acyl phosphine oxide initiator for optional light-curing. Ivocerin, a dibenzoyl germanium derivative [24] is an amine free initiator.

This *in vitro* study was done to evaluate the compressive strength of Type IX GIC and a newer material i.e. Cention N. Both the materials are esthetically appealing in nature with Cention N manufacturers claimimg it to have high compressive strength, so can be used as a posterior restorative material. This is the reason that Type IX GIC indicated for posterior restorations was used in comparison to Cention N in this study.

The results of this *in vitro* study revealed that compressive strength of Cention N was higher than Type IX GIC. The reason can be 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. This is a good basis for long lasting restorations. Another reason for higher compressive strength of Cention N can be attributed to a special patented isofiller (partially functionalized by silanes) which is also used in Tetric N-Ceram Bulk Fill. This acts as a shrinkage stress reliever which minimizes shrinkage force, whereas the organic/inorganic ratio as well as the monomer composition of the material, is responsible for the low volumetric shrinkage [25].

Fig 1: Cention N (Ivoclar Vivadent)

Fig 2: Glass Ionomer cement (GC IX High strength Posterior restoration)

Fig 3: Ten samples each of Cention N (Ivoclar Vivadent

Fig 4: Ten samples each of Glass Ionomer cement (GC IX High strength Posterior restoration)

Fig 5: Universal Testing Machine (UTM)

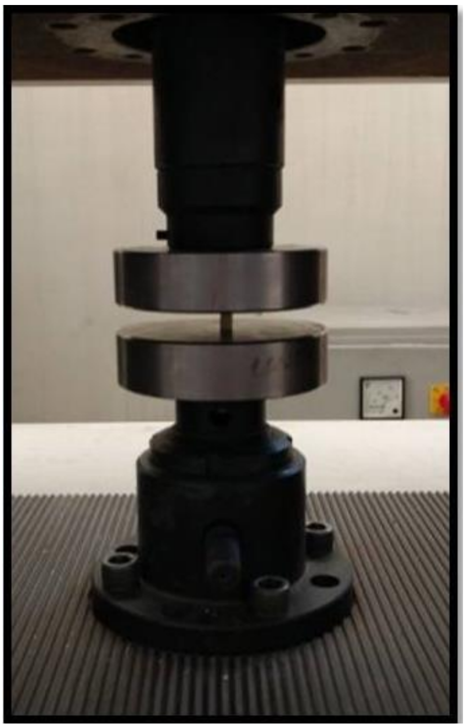

Fig 6: Samples subjected to load in UTM

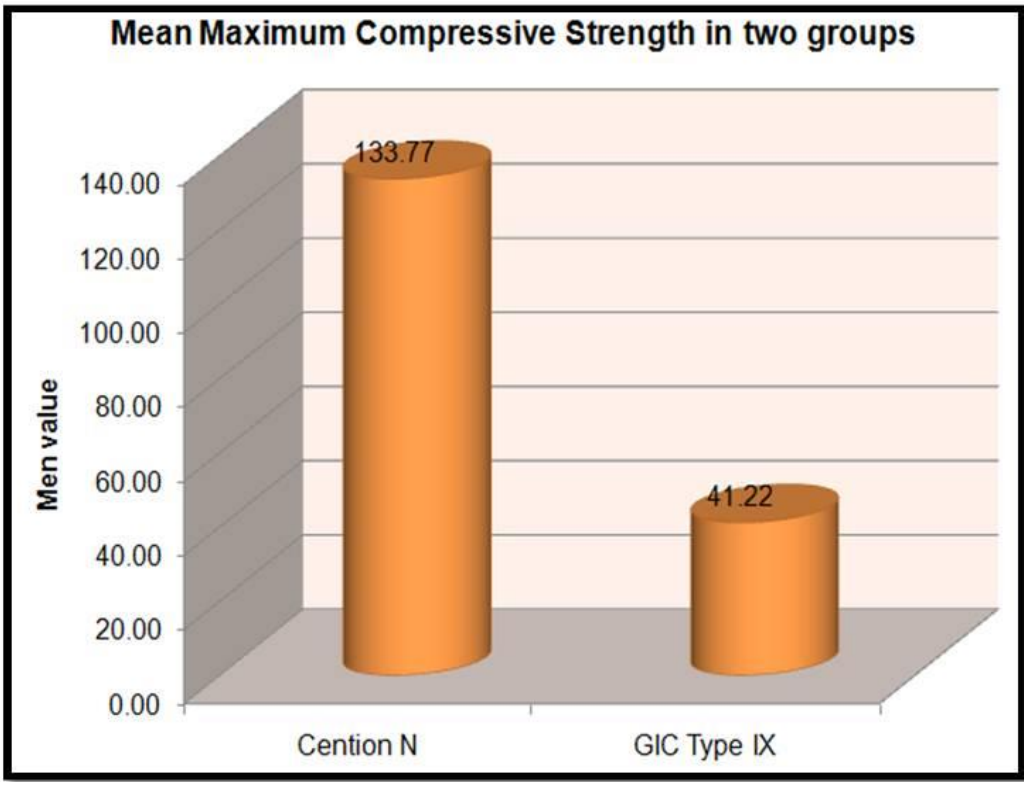

Fig 7: Comparison of compressive strength (MPa) between the two material

Table 1: Mean compressive strength of two materials

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	10	133.7747	26.40147	8.34888	114.8882	152.6612	101.44	183.67
2	10	41.2194	5.88244	1.86019	37.0114	45.4274	35.64	55.51
Total	20	87.4971	50.99906	11.40374	63.6288	111.3653	35.64	183.67

Table 2: Difference in mean compressive strength between two materials

Group	N	Range	Mean ± SD	SEM	't' value	P value
Cention N	10	101.44 – 183.67	133.77 ± 26.40	8.348	10.821	<0.001**
GIC Type IX	10	35.64 – 55.51	41.22 ± 5.88	1.860		
**p<0.001; Highly significant						

6. Conclusion

Within the limitation of this study, it can be concluded that Cention N can be used as a superior alternative to GIC Type IX for restoration of posterior teeth since its compressive strength was found to be significantly higher. However, long term clinical studies are required to draw any substantial conclusion.

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