Evaluation of compressive strength, shear bond strength, and microhardness values of glass-ionomer cement Type IX and Cention N

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Abstract

Aim: This study aimed to compare the compressive strength, shear bond strength, and microhardness of glass-ionomer cement (GIC) Type IX and Cention N.

Materials and Methods: Five samples each of GIC Type IX and Cention N were prepared for testing the shear bond strength, tensile strength, and microhardness. Cylinders of the samples measuring 1 cm diameter and 6 mm height were prepared for compressive strength and shear bond strength. For shear bond strength, these samples were embedded into acrylic blocks of dimensions 2 cm × 2 cm. Testing of shear bond strength and compressive strength was done by mounting the samples in a universal testing machine with a crosshead speed of 1 mm/min. The samples for microhardness were 1 cm diameter and 5 mm height. The samples were mounted on Vickers microhardness testing machine to test the microhardness.

Results: The values for shear bond strength of Cention N were statistically highly significant (\( P < 0.01 \)) as compared to GIC Type IX, whereas the compressive strength and microhardness values of Cention N were statistically significant (\( P < 0.5 \)) as compared to GIC Type IX.

Conclusion: The results suggest significantly higher values for mechanical properties of Cention N as compared to GIC Type IX.

Keywords: Cention N; compressive strength; glass-ionomer cement Type IX; microhardness; restorative dentistry; shear bond strength

INTRODUCTION

The initial signs of dental caries include surface softening, however, when the lesion progresses to the point of breaks in the continuity of the enamel surface, microcavitations occur. Once cavitations occur, it is a critical stage in caries process as bacteria can easily invade into the dentin.[1]

Historically, the management of dental caries was based on the belief that caries was a progressive disease that eventually destroyed the tooth unless there was a surgical and restorative intervention.[2] Consequently, the present-day management of dental caries includes identification of an individual’s risk for caries progression, and to assess disease progression alongside management with appropriate preventive services, accompanied by restorative therapy when indicated. Conversely, some carious lesions may not progress and, therefore, may not need restoration.[3]

The benefits of restorative therapy include: removing cavitations or defects to eliminate areas that are susceptible to caries, stopping the progression of tooth demineralization, restoring the integrity of tooth structure, preventing the spread of infection into the dental pulp, and preventing the shifting of teeth due to loss of tooth structure.[4]

Among the dental restorative materials, silver amalgam has been used for >100 years for the restoration of posterior teeth owing to its good mechanical properties.

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However, the controversy regarding amalgam due to the safety of mercury and any causal link with a variety of diseases is one of the oldest ongoing arguments in medicine.[5]

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. The prime concern of a restorative material for pediatric patients takes account of factors such as their ability to bear stress, durability, integrity of marginal sealing, esthetics, and time taken for the restoration. In posterior tooth restorations, mechanical and physical properties play a vital role as it is subjected to heavy occlusal load.[6] A leap in the direct restorative was made with the introduction of light-cured composites. Composites were introduced in the 1960s and have been available for nearly 50 years.[7] Although composite resin materials have good physical properties, the main limitations are polymerization shrinkage resulting in marginal microleakage, postoperative sensitivity, and secondary caries.[8]

Glass-ionomer cement (GIC) can be viewed as basic filling materials; they are long established, economical, and simple to use. They are usually applied in bulk without an adhesive, are self-curing, and do not require complicated dental equipment.[5]

Recently, a tooth-colored, basic filling material for direct restorations, Cention N, has gained importance in restorative dentistry. It is self-curing with optional additional light-curing. The alka site Cention N thus redefines the basic filling, combining bulk placement, ion release, and durability in a dual-curing, esthetic product – satisfying the demands of both dentists and patients. Cention N has been suggested to have strength comparable to amalgam and the esthetics of GIC.[9]

In the quest to further study the properties of Cention N and to compare the compressive strength, shear bond strength, and microhardness of GIC Type IX and Cention N, the following study was conducted to establish Cention N as a material for the restoration of primary teeth.

**MATERIALS AND METHODS**

The present study was conducted in the Department of Pedodontics and Preventive Dentistry and Centre for Advanced Research of the institute.

The materials used in the study were Fuji IX GIC (GC Gold Label) and Cention N (Ivoclar Vivadent). The composition of GIC Type IX with powder consisting of alumina, silica and calcium fluoride and liquid consists of mainly polyacrylic acid and tartaric acid. Unlike the composition of GIC type IX  Cention N consist of liquid made of monomer which is a combination of UDMA, DCP, an aromatic aliphatic UDMA, and PEG400 DMA and the powder consists of ytterbium trifluoride and barium aluminum silicate glass along with photoinitiator Ivocerin.

Five samples each of GIC Type IX (Group 1) and Cention N (Group 2) were prepared for testing the shear bond strength, tensile strength, and microhardness.

**Sample preparation for shear bond strength and compressive strength**

Cylinders of the samples measuring 1 cm diameter and 6 mm height were prepared [Figure 1]. Initially, molds using modeling wax were prepared with the measured dimensions. After this, the molds were filled with the restorative material by mixing the powder and liquid according to the manufacturer’s instructions. The molds were filled up to the height of the cylindrical mold, and the sample was covered with mylar strip, followed by covering with glass slab. The samples were then de-molded, and finishing was done using finishing burs.

For shear bond strength, these samples were embedded into acrylic blocks of dimensions 2 cm × 2 cm. The samples were embedded to a height so that 2 mm of the sample was above the acrylic block. Following this, the samples were stored in distilled water for 24 h.

Testing of shear bond strength and compressive strength was done by mounting the samples in a universal testing machine with a crosshead speed of 1 mm/min.

**Sample preparation for microhardness [Figure 1]**

The samples for testing the microhardness were prepared similarly to the samples for compressive strength. The dimensions for the samples were 1 cm diameter and 5 mm height.

![Figure 1: Samples for testing compressive strength, shear bond strength, and microhardness](image)
The samples were mounted on Vickers microhardness testing machine, and three indents were taken at three different points for each sample, followed by measurement of the Vickers hardness number at these points.

**Statistical analysis**

The data collected were tabulated accordingly and were subjected to statistical analysis using Statistical Package for the Social Sciences (version-20-IBM SPSS Statistics.) Mean and standard deviations were calculated for each group and analyzed using Student's t-test used for the equality of means and Levene's test for the equality of variances.

**RESULTS**

The shear bond strength, compressive strength, and microhardness of GIC Type IX and Cention N are shown in Table 1. The results suggest that the values for shear bond strength of Cention N are statistically highly significant \( (P < 0.01) \) as compared to GIC Type IX. Furthermore, the compressive strength and microhardness of Cention N have values which are statistically significant \( (P < 0.5) \).

**DISCUSSION**

The long used economic, basic filling materials, i.e. amalgam and glass ionomers both remain popular under particular dental circumstance. Numerous direct filling materials are available to the modern dental practice from amalgams through modern bulk-fill composites.[9]

Amalgam materials were first introduced to Western dentistry in the 19th century. Amalgams offer unparalleled longevity and strength but are coupled with poor esthetics and controversial ingredients.[3] However, the longevity of the restoration is no longer the primary factor in selecting a restorative material. Esthetics also play an integral part in selecting a restorative material. Along with this, the tooth preparation has now shifted from conventional to minimal intervention. Coupled with the increasing rate of avoidance of dental amalgam because of its mercury content and the excessive replacement of serviceable amalgam restorations, amalgam has lost popularity as a restorative material.[10]

GIC systems have become important dental restorative materials for use in children as they are easy and practical to use, leach fluoride, adhere to tooth structure, require conservative preparation, and undoubtedly offer better esthetics as compared to amalgam.

Thus, the quest for a real alternative to amalgam or GIC has always been explored which is cost-effective, fluoridereleasing, is quick and easy to use without complicated equipment, and that offers both strength and good esthetics.

Cention N, a tooth-colored, basic filling material for direct restorations, is self-curing with optional additional light-curing. It is available in the tooth shade A2, is radiopaque, and releases fluoride, calcium, and hydroxide ions.[9]

The clinical success of restorative material depends on a good adhesion with dentinal surface so as to resist various dislodging forces acting within the oral cavity. Shear bond strength is important to the restorative material clinically because of the fact that the major dislodging forces at the tooth restoration interface have a shearing effect.[11] Therefore, higher shear bond strength implies better bonding of the material to tooth. The results of the present study suggest that the shear bond strength of Cention N was comparatively higher as than that of GIC Type IX. Manuja et al. suggested that GIC Type IX has the lowest shear bond strength values when comparing it with giomer, ormocer-based composite, and nanoceramic restorative material.[11]

The compressive strength is an important property in restorative materials, particularly in the process of mastication. The results of the present study advocate that Cention N has compressive strength values significantly higher than GIC Type IX. Sadananda et al. in their study reported high compressive strength and flexural strength values on comparing Cention N and GIC.[12]

The higher values for Cention N could be attributed to the fact that monomers together with initiators, catalysts, and other additives form the reactive part of a resin-based restorative. The strong mechanical properties and good long-term stability can be attributed to the combination of UDMA, DCP, an aromatic aliphatic-UDMA and PEG-400 DMA, which interconnects (cross-links) during polymerization. UDMA is the main component of the monomer matrix. It exhibits moderate viscosity and yields strong mechanical properties. The highly cross-linked polymer structure is responsible for the high flexural strength.[9]

Hardness is the resistance of a material to indentation or penetration. It has been used to predict the wear resistance of a material and its ability to abrade or be abraded by opposing tooth structures. In the present study, it was also seen that the Vickers hardness number
Leaves were also significantly higher for Cention N as compared to GIC Type IX. Mazumdar et al. suggested that Cention N showed better microhardness properties becoming a more clinically suitable option for minimal invasive treatments. The increased microhardness of Cention N is probably related to the nanoparticle size of inorganic filling. It includes a special patented filler (partially functionalized by silanes) which keeps shrinkage stress to a minimum. This isofiller 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.\[13\]

Along with the high strength, other properties such as the dual-cured mechanism, fluoride ion release, calcium and hydroxide ion release, low polymerization shrinkage, and the capacity to remineralize make Cention N as a preferred restorative material in pediatric dentistry.

**CONCLUSION**

The results of the present study indicate significantly higher values for mechanical properties of Cention N as compared to GIC Type IX, thus recommending its use as a restorative material for pediatric dental patients. Further, in vivo studies are, however, required to authenticate it as an ideal restorative material.

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**Conflicts of interest**

There are no conflicts of interest.

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