Journal of Advanced Medical and Dental Sciences Research
@Society of Scientific Research and Studies NLM ID: 101716117
Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100
(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Comparative Analysis of Mechanical Properties of Glass Ionomer Cement Type IX and Cention N: An In-Vitro Study

Satyanarayana Naidu S

Senior Lecturer, Department of Conservative Dentistry and Endodontics, Asian Institute of Advanced Dentistry, Hyderabad, Telangana, India

ABSTRACT:
Aim: This study focused on comparing the compressive strength, shear bond strength, and microhardness of Type IX glass-ionomer cement (GIC) and Cention N. **Materials and Methods:**Ten samples each of Type IX GIC and Cention N were prepared to evaluate their shear bond strength, tensile strength, and microhardness. For compressive and shear bond strength testing, cylindrical samples measuring 1 cm in diameter and 6 mm in height were created. These were embedded in acrylic blocks that measured 2 cm x 2 cm for the shear bond strength assessment. The tests for shear bond and compressive strength were conducted using a universal testing machine, set to a crosshead speed of 1 mm/min. Additionally, samples for microhardness testing were created with a diameter of 1 cm and a height of 5 mm, and these were mounted on a Vickers microhardness testing machine. **Results:** The shear bond strength of Cention N showed a statistically significant difference ($P < 0.05$) when compared to GIC Type IX. Additionally, the compressive strength and microhardness of Cention N were also statistically significant ($P < 0.05$) relative to GIC Type IX. **Conclusion:** These findings indicate that Cention N exhibits notably superior mechanical properties compared to GIC Type IX.
Keywords: GIC, Centtion N, Shear bond strength]

Received: 29 July, 2025 Accepted: 28 August, 2025 Published: 10 September, 2025

Corresponding author: Satyanarayana Naidu S, Senior Lecturer, Department of Conservative Dentistry and Endodontics, Asian Institute of Advanced Dentistry, Hyderabad, Telangana, India

This article may be cited as: S Satyanarayana N. Comparative Analysis of Mechanical Properties of Glass Ionomer Cement Type IX and Cention N: An In-Vitro Study. J Adv Med Dent Scie Res 2025; 13(9):68-71.

INTRODUCTION

The mechanical properties of dental materials play a vital role in evaluating their performance and suitability for various clinical applications in dentistry.[1] Among these properties, compressive strength, shear bond strength, and microhardness are critical indicators that influence the longevity and effectiveness of restorative treatments.[2,3] Compressive strength refers to a material's ability to withstand axial loads without failure, while shear bond strength measures the adhesion between the material and tooth structure under lateral forces.[4] Microhardness, on the other hand, reflects a material's resistance to indentation and wear, serving as an important factor in determining its durability and performance in the oral environment.[5]

Glass-ionomer cement (GIC) Type IX has long been regarded as a reliable material within restorative dentistry.[6] Its unique properties, such as chemical adhesion to dental tissues, biocompatibility, and the ability to release fluoride, have made it a popular choice for various applications, including cavity fillings and luting agents. However, despite its advantages, GIC Type IX has limitations, particularly regarding mechanical strength and wear resistance, which may affect its clinical longevity under functional loading conditions.[7,8]

In recent years, new materials have been developed to address these limitations. One such alternative is Cention N, which is classified as a universal restorative material. Cention N claims to offer enhanced mechanical properties compared to traditional glass-ionomer cements. With its composition designed to improve compressive strength and bond stability, Cention N aims to provide better performance in challenging clinical situations where higher stress resistance is required.[9]

Given the advancements in restorative materials, it is essential to conduct a thorough evaluation of the mechanical properties of both GIC Type IX and

Cention N. This study aims to systematically assess and compare the compressive strength, shear bond strength, and microhardness values of these two materials. By analyzing these parameters, we seek to gain a deeper understanding of how these materials behave under realistic loading conditions, thereby informing clinicians about their relative strengths and weaknesses.

Through this comparative evaluation, we hope to provide valuable insights that will aid dental professionals in making informed decisions regarding material selection for various restorative procedures. Ultimately, our findings could contribute to improved patient outcomes by enhancing the longevity and effectiveness of dental restorations in everyday clinical practice.

MATERIAL AND METHODS

To evaluate the mechanical properties of Type IX glass-ionomer cement (GIC) and Cention N samples were prepared, consisting of 10 samples from each material**(Table 1)**. The following steps outline the detailed methodology employed in the study:

Table 1: Material Details

Cention N (Ivoclar vivadent, Liectenstein)	Powder: Consists of filler particles and other initiator components (Barium aluminium silicate glass, Ytterbium trifluoride, Calcium barium aluminium fluorosilicate glass, Calcium fluoro silicate glass). Liquid: Consists of four different dimethacrylates monomers and initiators. (Urethane dimethacrylate (UDMA), Tricyclodecan-dimethanol dimethacrylate (DCP), Tetramethyl-xylylen-diurethane dimethacrylate (Aromatic aliphatic-UDMA), Polyethylene glycol 400 dimethacrylate (PEG-400 DMA)
Fuji IX GP (GC Corporation, Tokyo, Japan)	Powder: Fluro alumino silicate glass, Polyacrylic acid powder. Liquid: Polyacrylic acid Polybasic carboxylic acid

Sample Preparation

For the shear bond strength and compressive strength tests, cylindrical samples with a diameter of 1 cm and a height of 6 mm were fabricated using Type IX GIC and Cention N. Each sample was mixed according to the manufacturer's instructions to ensure consistent results.Materials samples were then placed in specially designed molds and allowed to set for the time recommended by the manufacturers before being removed for further testing.

Embedding Samples

Once set, the cylindrical samples were carefully embedded in acrylic blocks measuring 2 cm x 2 cm to facilitate easy handling during testing. The embedding process was performed to ensure stability and prevent movement during strength assessments.

Shear Bond Strength Assessment

The shear bond strength was evaluated by adhering the embedded samples to flat surfaces. A universal testing machine was utilized for this purpose, where the samples were subjected to shear forces at a controlled crosshead speed of 1 mm/min. The maximum load sustained before failure was recorded and used to calculate the shear bond strength.

Compressive Strength Testing

Compressive strength was measured using the same universal testing machine. The cylindrical samples were placed vertically in the testing apparatus. A compressive load was then applied until the samples fractured, with the maximum load at failure noted for further analysis.

Microhardness Testing

For microhardness evaluation, additional samples were prepared with a diameter of 1 cm and a height of 5 mm. These samples were tested using a Vickers microhardness testing machine, which applies a specific load for a set duration to determine the hardness value. The indenter's diagonal lengths from the resulting indentations were measured, and the microhardness values were calculated according to standard Vickers hardness equations.

Statistical Analysis

All acquired data for shear bond strength, compressive strength, and microhardness values were analyzed statistically. Differences between the mechanical properties of Cention N and Type IX GIC were assessed for significance using appropriate statistical tests, with a p-value of less than 0.05 indicating statistical significance.

RESULT

Table 2 displays the shear bond strength, compressive strength, and microhardness of GIC Type IX and Cention N. The results indicate that the shear bond strength of Cention N is statistically significantly higher compared to GIC Type IX. Additionally, the compressive strength and microhardness of Cention N also show statistically significant values ($P < 0.05$).

Table 2: Intergroup Comparison of different mechanical properties of Type IX GIC and Cention N			
Group	**Shear Bond Strength**	**Compressive Strength**	**Microhardness**
GIC Type IX	3.77±0.85	83.11±4.46	89.56±4.45
Cention N	8.01±0.45	127±6.51	99.76± 1.31
p value	< 0.05*	< 0.05*	< 0.05*

*Significant

DISCUSSION

The results of this study underscore the differences in mechanical properties between Type IX glass-ionomer cement (GIC) and Cention N, particularly in the context of their shear bond strength, compressive strength, and microhardness. These properties are critical for their performance in dental applications where they are often used as restorative materials.

Shear Bond Strength

The shear bond strength results indicated that Cention N exhibited a statistically significant advantage over Type IX GIC (P < 0.01). This enhanced bond strength could be attributed to Cention N's chemical composition and setting mechanism, which may allow for better adhesion to dental substrates. The superior bonding characteristics of Cention N might enhance its use in various clinical scenarios, particularly where strong bonding is essential for the longevity and durability of restorations.

In contrast, Type IX GIC, while known for its favorable biocompatibility and fluoride release, may have limitations regarding bond strength relative to more modern materials like Cention N. This highlights the importance of choosing materials based on the specific clinical needs and the required mechanical performance.[10]

Compressive Strength

The compressive strength of both materials is another crucial aspect of their performance. Although specific numerical data from this study isn't presented, it is generally acknowledged that restorative materials need to withstand significant occlusal forces in the oral environment. The performance of Cention N in this regard is particularly interesting, as its formulation is designed to provide improved mechanical properties when compared to traditional materials like GIC.

In practice, the implications of compressive strength are far-reaching, influencing not only the longevity of a restoration but also the prevention of failure due to excessive loading. It is essential to consider that materials with higher compressive strength may be more suited for posterior restorations due to the increased occlusal forces present in those areas.Kaur et al. compared the compressive strength of Cention N and Glass Ionomer Cement Type IX as restorative materials. Researcher concluded that Cention N is a superior alternative for posterior tooth restorations due to its significantly higher compressive strengthwhich is similar to current study.[11]

Microhardness

Microhardness testing serves as an indirect measure of the durability and wear resistance of dental materials. Higher microhardness values generally correlate with increased wear resistance and durability, which are vital for the longevity of restorative materials.

Cention N's formulation is specifically designed for improved hardness and wear resistance, potentially making it a preferable choice for areas subjected to higher wear, such as posterior teeth. The findings from the microhardness tests underscore the need for materials that can withstand daily wear from mastication and other functional activities in the oral cavity.

Comparatively, while Type IX GIC offers advantages in terms of release of fluoride and biocompatibility, its microhardness may not be sufficient for specific high-stress clinical situations. Understanding these nuances can guide clinicians in material selection based on mechanical performance and specific patient needs.Narjes Amrollahi's systematic review and meta-analysis indicate that Cention-N offers superior shear bond strength and lower micro-leakage than glass-ionomer cement, making it a better option for restoring primary teeth, especially in stress-bearing areas.[10]

Clinical Implications

The findings of this study have significant clinical implications. Given the superior mechanical properties observed in Cention N, it might be advantageous to utilize this material in cases where enhanced bond strength and wear resistance are required. This would particularly apply in posterior restorations, where mechanical demands are higher.

Additionally, the discussion of the merits of GIC and Cention N suggests that while traditional materials are valuable for certain applications, advances in material science have yielded options that may offer greater performance in critical aspects. As clinicians, understanding these differences can lead to more informed decision-making, ultimately improving patient outcomes.[11-13]

CONCLUSION

This study emphasizes the importance of evaluating and comparing the mechanical properties of dental materials. The significant differences in shear bond strength, compressive strength, and microhardness between Type IX GIC and Cention N provide valuable insights for material selection in restorative dentistry. As advancements in dental materials continue, it is crucial for practitioners to remain informed about the latest research findings to enhance the quality and longevity of dental restorations in clinical practice.

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