Section A-Research paper
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A CRITICAL EVALUATION OF THE INFLUENCE OF ACID CHALLENGES ON THE FLEXURAL RESISTANCE OF CENTION N AND NANOHYBRID COMPOSITE – AN *IN VITRO* STUDY.

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ABSTRACT

Aim: To evaluate and compare the impact of acidic beverages on the flexural resistance of the Cention N and Nanohybrid composite.

Methodology: 24 samples were prepared and equally distributed into 2 groups, Filtek Z250 XT (n=12) and Cention N (n=12). Samples were maintained at 37°C in a shaking incubator and further subdivided into 4 groups based on their acidic medium. Subgroup 1: Artificial saliva; Subgroup 2: Coco cola; Subgroup 3: Pulpy orange; Subgroup 4: Limca. The prepared samples were exposed to these acidic beverages for 3 cycles of 5-minute immersion in a day and tested for flexural resistance after the time interval of 24 hours, one week, and four weeks using Universal Testing Machine.

Results: Mann-Whitney U test or independent sample t-test for normal data. After applying the test for skewed data, the outcomes showed a statistically significant difference between the two groups at 24 hours. At the end of the 1-week and 4-week time periods, no appreciable difference was seen.

Conclusion: Cention N is a novel material with equivalent flexural resistance that can replace composite materials.

Keywords: Cention N, Nanohybrid composite, Flexural resistance

INTRODUCTION

Improvements in restorative cement have been made as a result of the significant advancements in restorative dentistry. Longevity in the oral cavity is a sign of a material's potential success.[1]

For posterior load-bearing restorations, the modern dental practitioner has access to a wide range of direct filling materials, from silver amalgam to contemporary bulk fill composites. Due to its excellent mechanical qualities, silver amalgam has been utilized as a dental restorative material for the restoration of posterior teeth for more than 100 years. Utilization has declined over time for two reasons: mercury toxicity and a surge in demand for tooth-colored restorations.[2]

The development of novel resin-based restorative materials, like composites, which were launched in the 1960s and are now widely used, was prompted by the declining acceptance of amalgam.[3] Although composite resin materials have strong physical qualities, their principal downsides are minor microleakage, postoperative sensitivity, and secondary caries.[4]

Due to their morphology, thin enamel walls, higher prevalence of proximal and cervical cavities, as well as other issues such as the lack of the child's cooperation, primary teeth restoration is difficult. Because of its advantages of easy handling, chemical bonding to teeth, fluoride release, and cost-effectiveness, glass ionomer cement is frequently used to restore primary teeth. However, the application of this material in moist locations, proximal lesions, and anterior cervical lesions has been demonstrated to have the potential for microleakage.[5]

One of the most often used dental techniques is the use of nanomaterials to restore tooth structure. [6] Consequently, nanotechnology-based nano-filled composites were introduced to reduce polymerization shrinkage. [5] They have benefits in terms of smoothness, polishability, precise shade characterization, flexural strength, and micro-hardness, among other things.[6] Numerous research claimed that adding nanoparticles to dental materials made of resin enhanced their flexibility, fracture toughness, and tissue adherence. Studies revealed that using inorganic nano-filler instead of empty resins improved several mechanical qualities.[7]

With or without the use of an adhesive, the tooth-colored filling material Cention N is intended for bulk restorations in retentive preparations.[8] It is a dual-curing powder/liquid restorative material that is UDMA-based [9]. In addition to providing a more affordable alternative to amalgam, Cention N due to its properties of decreased microleakage and polymerization shrinkage also meets the demand for an aesthetic bulk fill material in the posterior area. [2] It can be used with or without adhesive in baby teeth, depending on how retentive the cavity preparation is. [5]

Erosion is a problem that frequently affects kids. Chemical, biological, behavioral, and interplaying factors in children and adolescents are potential causes of this disorder.[10] Consumption of acidic foods, alcoholic beverages, soft drinks, and energy drinks are extrinsic causes of erosion. GI diseases including anorexia and bulimia, which produce frequent regurgitation and lower the pH of the oral environment, are examples of intrinsic causes. Mechanical, thermal, or passive hydrolysis may be to blame for the polymer deterioration linked to the erosion of the composite material. These elements cause the material to soften and the surface imperfections to increase, which causes them to wear out faster. [11]

The greatest stress that a material can withstand before failing when subjected to a bending load is known as flexural strength. Fracture resistance is inversely correlated with flexural strength. Restorations that are subjected to considerable masticatory forces should have high flexural strength. [12]

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The modification in flexural resistance of Cention N following exposure to commercially available soft aerated acidic beverages, however, has not yet been the subject of studies. This study compares and evaluates the impact of acidic beverages on the flexural resistance of the Cention N and Nanohybrid composite in order to fill in the gaps in the literature.

MATERIALS AND METHODS

This study was done at the Amrita School of Dentistry in Kochi, India in collaboration with the Department of Nanosciences, Amrita Institute of Medical Sciences, and Department of Mechanical Engineering, Amrita Vishwa Vidyapeetham, India. Prior to the execution of this in vitro experiment, clearance was obtained from the Institutional Ethical Committee.

Study Samples

A custom-made silicone mould with the measurement of 25 mm x 2 mm x 2 mm was used to create 24 rectangular-shaped bar specimens that adhered to ISO standards.
Test Group – Cention N
Control Group – Nanohybrid composite

Sample Preparation

The manufacturer's instructions are followed when manipulating samples and transferring them to the mould. To establish a smooth surface and prevent oxygen from interfering with the polymerization of the composite material, a mylar matrix strip was placed over each filled mould. The prepared samples were then removed from the mould using a probe after polymerization for 40 seconds. All samples were smoothed using 600 grit silicone carbide sandpaper, to ensure an even finish of all surfaces. Later they were transferred to beakers containing artificial saliva [UniBiosys Biotech Research Lab], where the pH was maintained at 6.75. The samples were kept at 37°C in a shaker incubator until the time of testing. Based on the exposure medium, the samples were separated into 4 groups.

Subgroup 1: Medium artificial saliva (pH 6.7)
Subgroup 2: Medium Coco cola (pH 2.6)
Subgroup 3: Medium pulpy orange (pH 3.7)
Subgroup 4: Medium Limca (pH 3.3)

The processed samples were returned to the artificial saliva after three rounds of 5-minute immersion in the test aerated acidic liquids. Every 24 hours, each storage medium was refreshed to keep the pH steady. Utilizing a three-point bending test (I = 20 mm) with a cross-head speed of one millimeter per minute, flexural strength was assessed using a Universal Testing Machine (UTM) until the specimen fractured under a load of one kilogram at the end of 24 hours, one week and four weeks.
Flexural strength was calculated using the formula

$$\sigma = \frac{\sigma 3FL}{2BH^2}$$

where, F = sample load (Newtons), L = sample arm spacing (mm), B = sample width (mm), and H = sample height (mm).

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Fig. 1 Stepwise study intervention

RESULTS:

Statistical analysis was performed using IBM® SPSS® Statistics Software version 20.0 software. To test the statistical significance of the difference in the mean values, an Independent sample t-test for normal data and Mann Whitney U test for skewed data was applied. The significance level was considered at $p \leq 0.05$ for all tests. Table 1 and Figure 2 shows descriptive data of flexural resistance for both groups.

The mean and standard deviation of 66.7026 ± 4.57954 for group I Cention N and 43.1613± 15.04358 for group II Nanohybrid composite at 24 hours interval; 65.9376 ± 5.60775 for group I Cention N and 61.2503± 0.76247 for group II at 1 week of the interval; 61.1607 ± 15.26687 for group I Cention N and 57.2653 ± 19.93658 for group II at a 4-week interval (Table 1). After 24 hours of acidic challenges, Group I (Cention N) differed statistically from Group II (Nanohybrid composite). No statistically significant difference was observed between Group I (Cention N) and Group II after 1 week and 4 weeks of acidic challenges (Nanohybrid composite).

GROUP			N	Mean	Standard. Deviation	P value
24 HRS	GROUP I	Cention	4	66.7026	4.57954	0.024
	GROUP II	Nanohybrid composite	4	43.1613	15.04358	0.047
1 WEEK	GROUP I	Cention	4	65.9376	5.60775	0.149
	GROUP II	Nanohybrid composite	4	61.2503	0.76247	0.193
	GROUP I	Cention	4	61.1607	15.26687	0.767

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4 WEEK	GROUP II	Nanohybrid composite	4	57.2653	19.93658	0.768

Table 1. Descriptive statistics of the flexural resistance of Cention N and Filtek Z350

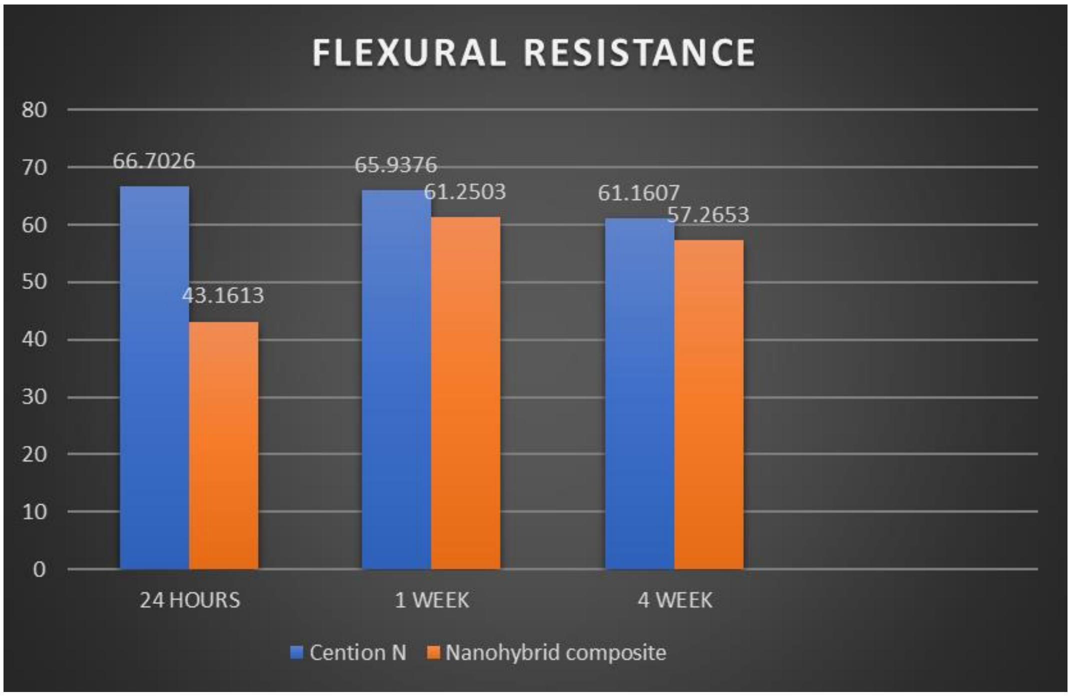

Fig.2 Cention N & Nanohybrid composite's flexural resistance is depicted in a 3D column diagram.

DISCUSSION

While Glass Ionomer Cement is more commonly utilized in pediatric dentistry, a newly introduced alkasite, self-adhesive bulk fill material called Cention N is employed in restorative dentistry. It is composed of dimethacrylates, initiators, glass fillers, and pigments. It is a radio-opaque restorative material that has the ability to release calcium, fluoride, and hydroxide ions. Additionally, it contains a specialized, patented filler called isofiller that relieves shrinkage stress and decreases microleakage and polymerization shrinkage because of its low elastic modulus.[9] Although it was first marketed as being able to be restored without an adhesive system because of the claimed ability to close marginal gaps via hydroxyapatite precipitation, an additional adhesive system has lately been advised. In light of this, it can be said that the clinical use of this novel "alkasite" material type is comparable to other bulk-fill composites, with the added advantage of having a protective effect on the dental hard tissues through ion release and alkalization. [13]

Based on earlier research, the light curing option was selected for the current experiment because it increases the material's strength. According to Bahari et al., the microhardness of Cention N was higher in the light cure mode than it was in the self-curing mode.[14] Additionally Francois et al. also discovered that posterior restorations with light curing mode had greater flexural strength in HV- GIC and Cention N.[15]

However, in the current research, there was no discernible variation in the flexural resistance of Filtek Z350 resin composite after 24 hours, one week, and four weeks of storage. It might also be the result of chemical deterioration brought on by hydrolysis. Through the creation of pores, progressive polymer degradation changed the microstructure of the composite bulk.[16]

The Cention N group showed lower amounts of phosphate ions released after 24-hours when compared to Filtek Z350 resin composite. This may be due to the formation of calcium fluoride and calcium phosphate layer on the surface of Cention N during the initial setting reactions and resisted dissolution for some time.[17]

In our investigation, after 1 week and 4 weeks of exposure to an acidic medium, Cention N did not exhibit any appreciable difference in the flexural resistance when compared to the Filtek Z350 resin composite. Similar findings were observed by Chowdhury et al., who investigated two modern restorative materials, Filtek Z350 resin composite, and Cention-N, and their fracture resistance was assessed in a amalgam-restored class II cavity. It was observed that, following the preparation and filing of Class II cavities, the Cention-N and Filtek Z350 resin composite materials effectively strengthened the teeth. [18]

A concurrent investigation by Balagopal et al., comparing the flexural resistance of the two novel materials, High strength GIC and Cention N were shown to differ significantly, with Cention N exhibiting stronger flexural resistance. [19] Additionally, a study by Biswas et al. revealed comparable outcomes in comparison to other restorative materials. [20]

According to Firouzmandi et al., who examined and evaluated the strength of Cention N and Z350 restorative materials following class II cavity preparation and repair. Both restorative materials, in his opinion, demonstrated better strength.[21] The same conclusions were drawn from a study of a similar nature conducted by Sadananda et al.[22] However, Panpisut et al. found a different outcome, noting that the flexural resistance of Cention N showed lower strength compared to Filtek Z350. He asserted that due to the use of high glass transition temperature monomers, it was anticipated that they would disperse with significant amounts of nanofiller. The strength and fracture resistance of resin composites may be increased by the addition of these tightly spaced dispersing fillers. In addition, Cention N contains an alkaline filler that might react with water to release ions from the material. Reduced mechanical characteristics of Cention N might result from the fillers dissolution.[23]

A survey report stated that aerated beverages are consumed daily by children in amounts ranging from 56 to 85 percent.[24] Yazkan et al., claimed that aerated beverages significantly worsen the surface roughness of self-adhesive materials and this effect gets worse the longer the material is exposed to it. [25]

In our study, three aerated drinks—Coca-Cola, Pulpy Orange, and Limca—were evaluated; children and teenagers tended to favor Coca-Cola. According to Sribante et al, an in vivo exposure to Coca-Cola for a month is equivalent to a day of immersion in the beverage in terms of the acidic difficulties. On the other hand, this ongoing contact with aerated soft drinks replicates prolonged exposure in the oral cavity.[26] The flexural strength of composites declined from its peak in distilled water after a week in various beverages, according to Szalewski et al.[27] He also claimed that Coca-Cola and orange juice were the most unfavorable conditioning environments, causing the greatest loss in mechanical qualities. However, cola drinks have a higher erosive potential than orange juice within the first minute of exposure, possibly due to their much lower pH values.[28]

The only factor that diminishes the mechanical strength of the restorative material is prolonged exposure; nevertheless, in our investigation, we found no difference in the type of beverages that affected the strength of the materials. This was corroborated by Sribante et al, who found that after a month of storage in Coca-Cola, there was no variation in the flexural strength of various composite materials.[29] According to Xavier et al., prolonged and repeated exposure to acidic beverages may alter the hardness of aesthetic tooth restorative types of cement. Additionally, it was shown that the beverage with phosphoric acid caused more surface hardness loss in the restorative specimens than the beverage with citric acid. [16]

But throughout our investigation, we found that the medium and prolonged exposure both weakened the alkasite material. Both Cention N and Filtek Z350 showed a decrease in flexural strength when compared to the initial exposure after 1 week and 4 weeks of acidic challenges. Risana et al. published a conflicting finding, claiming that long periods of storage do not significantly affect flexural strength. [30]

The current investigation was conducted to fill research gaps regarding the impact of acidic challenges on the flexural resistance of Cention N. However, more in vivo investigations are needed to assess the impact of the acidic challenges in children on larger samples, and additional clinical research may be necessary to verify the outcomes of this in vitro study.

CONCLUSION

Within the constraints of this investigation, it was determined that the newly developed alkasite material Cention N's flexural resistance was affected by longer storage time and exposure to aerated beverages. After being exposed to acid, Cention N initially showed increased flexural resistance, which eventually decreased.

REFERENCE:

1. Velagapudi NJ et al (2016). Comparative evaluation of marginal integrity & microleakage in nano-ionomer and low shrinkage posterior composite restorative materials: An In vitro study. J Int Oral Health, 8(2):261-266.
2. Dr. Jagvinder Singh Mann (2018). CENTION N: A REVIEW. Journal of Current Research, 10 (05): 69111-69112.
3. Setu R et al (2017). Comparative Evaluation of Micro Leakage of 2 Different Bulk Fill Composites with Posterior Composite for Class II restorations by dye extraction method- An in Vitro Study. IOSR Journal of Dental and Medical Sciences, 16(3): PP 72-77
4. Swapna et al (2015). comparing the marginal microleakage of three Bulk Fill composites placed in Class II cavities under a confocal microscope: An in vitro study. J Conserv Dent,18: 409-13.
5. Dr. Nidhi Agarwal et al (2020). International Journal of Dental Science and Innovative Research (IJDSIR), Volume - 2 Issue - 6, Page No. 710 - 715
6. Reddy et al (2020). Nanotechnology and its Application in Restorative Dentistry: A Review of Literature. Indian Journal of Forensic Medicine & Toxicology, Vol. 14: No. 4
7. Pratapa et al (2019). Characteristics and potential uses of resin-based restorative dental materials, W 55: 126–138
8. Van Ende A et al (2017). Bulk-Fill Composites: A Review of the Current Literature. J Adhes Dent; 19(2): 95-109
9. Samanta, S et al (2017). Comparison of glass ionomer cement, flowable composite resin, and Cention N for the restoration of a class V cavity with microleakage. Imp J Interdiscip Res, 8(3): 180-83
10. Lussi et al (2007). Dental erosion – diagnosis and prevention in children and adults. International Dental Journal, 57: 385-398.
11. Phin CH et al (2020). Effect of Alcoholic Beverages on the Surface Microhardness of Three Restorative Materials. Journal of International Dental and Medical Research, 13(4):1268-1275.
12. S. M. Chung et al (2004). Flexural Strength of Dental Composite Restoratives: Comparison of Biaxial and Three-Point Bending Test. J Biomed Mater Res Part B: Appl Biomater 71B: 278 –283.
13. Gubler A et al (2021). Anti-demineralizing protective effects on enamel identified in experimental and commercial restorative materials with functional fillers. Sci Rep, 11(1):11806.
14. Bahari M, Kahnamoui MA (2021). Effect of curing method and thermocycling on flexural strength and microhardness of a new composite resin with alkaline filler. Dent Res J, 18:96
15. François et al (2021). Flexural properties and dentin adhesion in recently developed self-adhesive Bulk-fill Materials. Journal of Oral Science, Vol. 63, No. 2: 139-144.
16. Xavier AM et al (2016). Repeated exposure of acidic beverages on esthetic restorative materials: An in-vitro surface microhardness study. J Clin Exp Dent, 8(3): 312-7.
17. Kasraeri et al (2021). Phosphate Ion Release and Alkalizing Potential of Three Bioactive Dental Materials in Comparison with Composite. International Journal of Dentistry: p8

18. Chowdhury et al (2018). Comparative Evaluation of Fracture Resistance of Dental Amalgam, Z350 Composite Resin and Cention-N Restoration In Class II Cavity, 17 (4): PP 52-56
19. Balagopal S et al (2021). An In Vitro Evaluation of the Mechanical Properties and Fluoride-releasing Ability of a New Self-cure Filling Material. J Contemp Dent Pract, 22(2):134–139.
20. Biswas et al (2018). Comparative Evaluation Of Fracture Resistance Of Dental Amalgam, Dyract-Xp Composite Resin And Cention-N Restoration In Class I Cavity, 3(2): p 384-92.
21. Firouzmandi et al (2021). Fracture Strength and Marginal Adaptation of Conservative and Extended MOD Cavities Restored with Cention N. International Journal of Dentistry : p1- 7
22. Sadananda et al (2018). Alkasite restorative material: flexural and compressive strength evaluation. Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9: 2179.
23. Panpisut and Toneluck (2020). Monomer conversion, dimensional stability, biaxial flexural strength, and fluoride release of resin-based restorative material containing alkaline fillers. Dental Materials Journal, 39(4): 608–615
24. O'Sullivan et al (2000). A comparison of acidic dietary factors in children with and without dental erosion. ASDC J. Dent. Child., 78, 186–192.
25. Yazkan B (2020). Surface degradation evaluation of different self-adhesive restorative materials after prolonged energy drinks exposure. J Esthet Restor Dent, 32(7):707-714.
26. Scribante et al (2020). Exposure of Biomimetic Composite Materials to Acidic Challenges: Influence on Flexural Resistance and Elastic Modulus. Biomimetics, 5; 56;
27. Szalewski, L et al (2021). The Influence of Popular Beverages on Mechanical Properties of Composite Resins. Materials, 14, 3097
28. Zimmer S et al (2015). Influence of Various Acidic Beverages on Tooth Erosion. Evaluation by a New Method. Plos ONE, 10(6): e0129462
29. Scribante et al (2019). Flexural Properties and Elastic Modulus of Different Esthetic Restorative Materials: Evaluation after Exposure to Acidic Drink. Biomed Res Int.
30. Risana et al (2021). Comparative evaluation of flexural strength of glass ionomer cement and cention n in an artificial medium over time intervals - an in-vitro study. J Evolution Med Dent Sci, 10(32):2609-2614