IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 10 Ver. 8 (October. 2018), PP 79-82
www.iosrjournals.org

"*In Vitro* Comparision of Flexural Strength of Cention-N, Bulk-Fill Composites, Light-Cure Nanocomposites And Resin-Modified Glass Ionomer Cement"

Dr Dayananad Chole[1], Dr Hetal Khushal Shah[2], Dr Shashank Kundoor[3], Dr Srinivas Bakle[4], Dr Neha Gandhi[5], Dr Nikhil Hatte[6]

[1]Professor and Head; Department Of Conservative Dentistry and Endodontics P.D.U Dental College; Solapur
[2]Post Graduate Student; Department Of Conservative Dentistry and Endodontics PDU Dental College Solapur
[3,4]Reader; Department Of Conservative Dentistry and Endodontics PDU Dental College Solapur
[5,6] Senior Lecturer; Department Of Conservative Dentistry and Endodontics PDU Dental College Solapur
Corresponding Author: Dr Dayananad Chole

Abstract: *Cention-N is recently introduced material. So, the aim of this study is to compare the flexural strength of Cention-N, Resin-modified glass ionomer cement, bulk-fill composite & light-cure nanocomposite. In this study, flexural strength of Cention-N,resin-modified glass ionomer cement, bulk-fill composites and light-cure nanaocomposites will be compared and evaluated. For testing flexural strength, 10 samples of each group will be fabricated using bar-shaped customised moulds of size 25×2×2 mm. The specimens will then be polymerized using a blue light emitting diode light source from both sides of the mould. Subsequent to polymerization the samples will be removed from the mould and stored in distilled water at 37˚C for 24 hours to ensure complete polymerization prior to testing. One-way ANOVA will be used to analyse the data and ascertain statistical differences among the groups. Cention—N shows highest flexural strength but further in vivo studies need to be carried out.*

Keywords: *Cention N, flexural strength, Bulk-fill composites, Nanocomposites, Resin-modified glass ionomer cement.*

Date of Submission: 09-10-2018 Date of acceptance: 24-10-2018

I. Introduction

Cention N is a basic, resin-based, alkasite self-curing powder/liquid restorative. Alkasite refers to filling material, which like compomer or ormocer materials is essentially subgroup of composite material class which utilizes alkaline filler capable of releasing acid-neutralizing ions. Cention-N is available as powder and liquid of which liquid has dimethacrylates and initiators and powder is composed of various glass fillers, initiators and pigments.[1] Bulk-fill composite has bisphenol A-diglycidyl dimethacrylate (Bis-GMA), ethoxylated bisphenol A dimethacrylate (Bis-EMA) and urethane dimethacrylate (UDMA). The organic matrix constitutes approximately 1% of mass. Several different types of fillers are also incorporated in the material. Barium, aluminium silicate glass with two different mean particle sizes, an isofiller comprising of cured dimethacrylates, ytterbium fluoride and spherical mixed oxide are included to achieve desired physico-mechanical properties as per manufacturer's instructions. [2] It comprises an overall standard filler content of approximately 75% by weight, 61% by volume and 17% polymer fillers or isofillers.[3]

In order to enhance physical, chemical and mechanical properties of resin composites some changes have been proposed: the incorporation of new monomers, new initiation systems and new technologies like nanotechnology for inorganic filler production. [4] Nanotechnology consists of production of materials and functional structures in an interval between 0.1 and 100 nm using various physical and chemical methods.[5,6] Within certain limit, the smaller the size of the inorganic filler the more fillers can be incorporated into the resin composite. Incorporation of nanometric inorganic fillers promotes an increase in flexural strength.[4]

Resin-modified glass-ionomer is light-cured glass-ionomer. Mathis , Ferracane'and Antonucci et al introduced these materials with the intention of retaining advantages, adhesion and fluoride release of conventional material whilst at the same time increasing wear properties and mechanical strength. To achieve this, part of water in formulation of glass-ionomer is replaced with hydrophilic monomer often hydroxyethyl methacrylate (HEMA). In some instances polymeric acid is also modified by grafting of additional monomer onto polymer backbone in place of some of the acid groups. The resin-modified glass-ionomer has two setting reactions; the acid-base reaction of conventional glass-ionomer and a polymerisation reaction similar to that of composite resin. The set cement will have two matrices, the ionic one of conventional glass-ionomer and a polymerisation one similar to that of composite resin. Since acid-base reaction forms a significant part of cement, the resin-modified glass-ionomer cements increase in strength with time due to their ongoing acid-base reaction. Two different setting reactions have a complementary effect on one another. [7]

The flexural strength is measure of fracture resistance of material which indicates the flaws within the material that may possess potential to bring about failure once subjected to loading. [8,9]This property is used to evaluate the strength of material and amount of distortion expected under bending stresses.[2]

The comparison of flexural strength of Cention-N, resin-modified GIC, bulk-fill composites and nano-composites can help clinician to choose the appropriate and best material for restoration.

So, the aim of this study is to compare the flexural strength of Cention-N, bulk-fill composites, light cure nanocomposites and resin-modified glass ionomer cement.

II. Materials & Methods

Ten samples of each material were used in this study.
Samples were divided into 4 groups
Group 1-Cention-N (ivoclar vivadent)
Group2- Bulk-fill composites (ivaclar vivadent)
Group-3-Nanocomposites (ivoclar vivadent)
Group 4- Resin-modified GIC (GC)

Sample Preparation

As per ISO 4049 specifications for flexural strength, ten samples of each test material were fabricated using customised stainless steel split molds with dimensions of 25 × 2 × 2 mm. The test materials were packed into mold until completely filled and excess material was removed. The specimens were polymerized using a blue light emitting diode light source as per manufacturer's instructions from both the sides of mold. Subsequent to polymerization the samples were removed from mold and stored in distilled water at 37˚C for 24 hours to ensure complete polymerization prior to testing.[2]

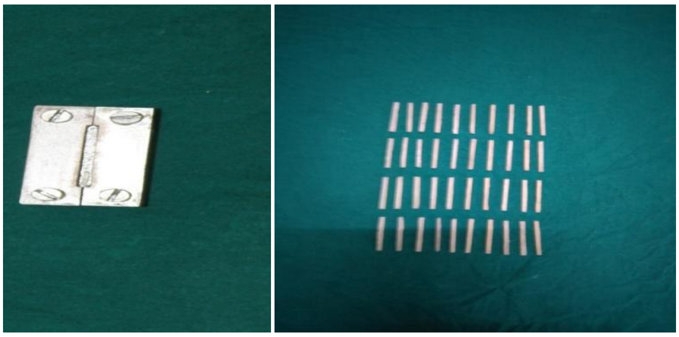

Fig 1: Preparation of samples

Sample Evaluation

Flexural Strength

The fabricated samples were mounted on 3 point bending test device and loaded in Universal Testing Machine at a cross head speed of 1mm/min. The maximum fracture load (F in Newton) of each sample was recorded and flexural strength was calculated based on the formula below.[2]

σ = 3Fl/2bh2
F – Maximum load (Newton)
l – Distance between the supports (millimeter)
b – Width of the specimen (millimeter)
h – Height of the specimen (millimeter)

III. Statistical Methods

The data obtained after testing the materials for flexural strengths were subjected to statistical analysis. One-way ANOVA was applied to verify the existence of statistical significance between group variations. Significance level was set at p- value <0.05

IV. Results

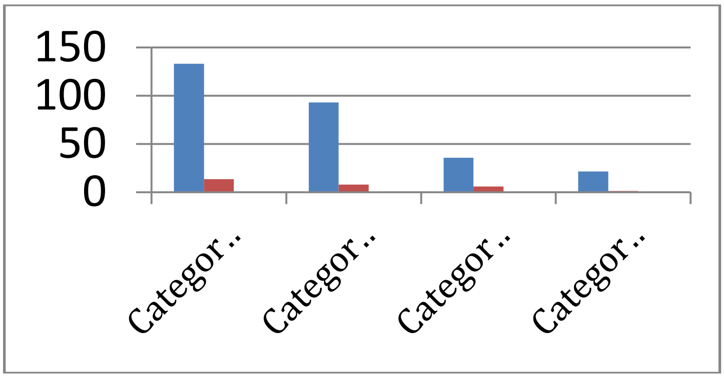

Fig 2: Mean values of flexural strength of study groups.

Table 1-Mean strength values and standard deviation

Groups	Mean	Standard deviation
Group 1	133.2	13.65
Group 2	93	7.87
Group 3	35.6	5.97
Group 4	21.65	1.32

The results of the study exhibited that Group 1 (Cention-N) had the highest mean flexural strength value (MPa) 133.2 followed by Group 2 (Tetric N Ceram bulk-fill composites) 93 followed by Group 3(Tetric N Ceram nanocomposites) and Group 4 exhibited the least mean flexural strength value of 21.65. The results exhibited a statistically significance p-value of <0.05.

V. Discussion

Achievement of predictable and efficacious direct posterior restoration is major concern for dental practitioners which may be attributed to technique sensitivity and various steps involved in proper placement of material.[2] Restoring tooth with composite material at one time is advantageous for both patient and dental practitioner.[10,11,12]

Fractures observed within the bulk of restoration and at margins is one of the major problems associated with failure of posterior composites. Flexural strength testing determines a restorative material's fracture related properties, especially useful when the material is utilized for Class I, Class II or IV restorations.[2] Based on research by Heintze et al. flexural strength testing can be used as an indicator for the durability of material under masticatory conditions. Various studies have shown that volume of filler and level of filler weight of composites directly correlate with the strength of material.[13]

In this study, compared to other restorative materials Cention-N showed highest flexural strength with statistically significant difference (p<0.05). Highest flexural strength of Cention-N can be attributed to higher filler loading. Fillers are responsible for imparting restorative materials with adequate strength to withstand stresses and strains of the oral cavity and to achieve acceptable clinical longevity. The filler composition of Cention N is found in Cention N Powder. The fillers of Cention N were chosen not only to achieve strength but also to obtain desired handling characteristics of mixed material. All the fillers therefore (except ytterbium trifluoride) are surface-modified to ensure wettability by liquid and incorporation into polymer matrix. The inorganic fillers comprise a barium aluminium silicate glass filler, ytterbium trifluoride, an Isofiller ,calcium barium aluminium fluorosilicate glass filler and a calcium fluorosilicate (alkaline) glass filler, with particle size of between 0.1 μm and 35 μm.[1]

Studies on influence of monomer composition on the mechanical properties of resin composites have found that flexural strength increases when BisGMA or TEGDMA are substituted by UDMA.[4] The organic, monomer part of Cention N is found in Cention N liquid. It consists of four different dimethacrylates which represent 21.6% wt. of final mixed material. A combination of UDMA, DCP, an aromatic aliphatic-UDMA and PEG-400 DMA, interconnects (cross-links) during polymerization resulting in strong mechanical properties and good long-term stability. Cention N does not contain Bis-GMA, HEMA or TEGDMA. UDMA is the main component of the monomer matrix. Due to 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 also attributes to high flexural strength of Cention-N.[1]

Introduction of bulk-fill resin based composites in the dental material market has initiated research studies investigating various physico-mechanical properties, but the number of available research is limited.

According to the manufacturer's claims the bulk-fill materials can be placed in single incremental layer ranging from 4 to 6 mm.[2] The curing of 4 mm increments represents a paradigm shift in restorative dentistry. Bulk Fill composites achieve this by incorporating advanced composite-filler technology, a pre-polymer shrinkage stress reliever, photo initiator Ivocerin® (polymerisation booster) and light sensitivity filter. A special patented filler which is partially functionalised by silanes acts as unique shrinkage stress reliever. Ivocerin, a dibenzoyl germanium derivative allows the application and curing of posterior restorations in larger increments of up to 4 mm, without compromising optical properties of composite such as translucency or colour.[14] Nanotechnology allows addition of nano-additive like rheological modifier contained This modifier is responsible for material's viscosity and good pliability. Lower flexural strength of light cure nanocomposites can be attributed to higher content of BisGMA & TEGDMA in them.[15] RMGIC showed lowest flexural strength. The organic species of RMGIC interfere with the transport required for acid-base reaction and polymeric matrix hinders formation of the ionic matrix. Structures of set RMGIC contain polyHEMA, which is highly hydrophilic, and water-soluble species such as unpolymerised HEMA. The lowest flexural strength of RMGIC could be attributed to higher water sorption of RMGIC after setting.[7] The use of standardized protocols, such as ISO 4049, allows the results from different studies to be compared. Limitations exist when trying to extrapolate results to clinical performance of materials, since the ISO 4049 standards for flexural strength testing recommend submerging the specimen in distilled water for only 24 hours prior to testing; furthermore, the specimen is submitted to only one mechanical cycle before submitting to fracture. These specifications do not reflect the material's long-term performance.[4] Despite these considerations, the 3-point bending test used according to ISO 4049 is still considered a standard test.[16]

VI. Conclusion

In present study, Cention-N showed highest flexural strength followed by bulk-fill composites, light-cure nanocomposites and least flexural strength is shown by resin-modified glass ionomer cement. According to the present study which assessed the physical properties based on accepted methods, the results obtained show that all the test materials are acceptable and suitable for restorations which involve the occlusal surfaces. It is important to note that the present study was conducted under ideal laboratory environment which may not be the expected scenario in clinical situations. Numerous factors are known to affect the process of polymerization which may be intrinsic or extrinsic.[2] So, some in vivo studies upon usage of Cention-N, bulk-fill composites, light cure nanocomposites and RMGIC s as restorative materials are required.

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