



Evaluation of Compressive Strength of Three Resin Based Composites – An In Vitro Study

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ABSTRACT: Numerous direct filling materials are available to the modern dental practice from amalgams to modern bulk fill composites. For the longevity of a restorative material, many factors play an important role. Strength is one of the important criteria. It should provide enough tensile and compressive strength to resist multidirectional masticatory forces for many years. The aim of the present study is to evaluate the compressive strength of three different restorative materials i.e., Filtek Z350 XT (3M) (nanohybrid composite), Beautifil – Bulk fill (SHOFU) (Giommer) and Cention – N (Ivoclar) (alkasite resin-based composite). 30 specimens were prepared from Filtek Z350 XT (3M), Beautifil – Bulk fill (SHOFU) and Cention – N (Ivoclar) for testing compressive strength and the data obtained was analysed with one way ANOVA and unpaired t-test. ($p < 0.05$). The Filtek 350(3M) had the highest strength compared to another two Beautifil – Bulk fill (SHOFU) and Cention – N (Ivoclar) but this difference is statistically not significant ($p > 0.05$). Compressive strength is one of the major criteria in selecting a restorative material for posterior restorations. Cention – N can give promising results in posterior restorations.

KEYWORDS: Compressive strength, composite resin, Cention – N, Filtek Z350 XT, Beautifil – Bulk fill

I. INTRODUCTION

With the availability and high consumption of finely refined carbohydrates, the occurrence of dental caries has been widespread amongst the population. Also, lack of oral hygiene as well as poor oral hygiene methods leads to

dental caries. A carious tooth has an impaired structure, shape and function and has an undesirable effect on its fracture strength and increases the risk of cusp cracks and fracture. Hence, it becomes essential to restore the carious lesion and also restore the integrity of the tooth structure in order to withstand masticatory forces.

A restorative material is one which re-establishes the esthetic, functional, and biological properties of the tooth structure.^[1] Numerous direct filling materials are available to the modern dental practice from amalgams to modern bulk fill composites. For the longevity of a restorative material, many factors play an important role. Strength is one of the important criteria. A restorative material should provide enough tensile and compressive strength to resist multidirectional masticatory forces for many years.^[2]

In last 4 decades, there has been extensive improvements in the mechanical properties of composites.^[3] The modifications in the filler particles and polymer technology of dental composite resins have led to a wide range of composite material selections based on clinical situation.^[4] Nanotechnology has a great impact on restorative dentistry by offering refinements to the already available resin-based composite system.^[3] Nanohybrid composites contain the least amount of organic matrix and greater percentage of fillers and demonstrate lesser polymerisation shrinkage.^[5]

Resin-based composite (RBC) materials are increasingly being used for the restoration of posterior teeth. The increasing demand for aesthetic, tooth-coloured and mercury-free restorations has driven a surge in the use of RBC dental materials. These bulk fill composites allow increment depths between 4-10 mm. The placement



of these larger increments of RBC may reduce the time needed when placing posterior restorations and thereby reduce technique sensitivity.^[6]

In Filtek Z350 XT (3M), The resin contains bis-GMA, UDMA, TEGDMA, and bis-EMA resins. The fillers are a combination of non-agglomerated/non-aggregated 20 nm silica filler, non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, and aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm zirconia particles).^[7]

Beautiful bulk-fill restorative (Shofu, Japan) is classified as multifunctional giomer composites and produced with a complex balance by combination of fillers with dissimilar types of monomers to reduce shrinkage and stress associated with the polymerization process. The surface pre reacted glass fillers of Beautiful bulk-fill restorative have exceptional surface treatment to enhance the wettability and integration to the matrix.^[8]

Ivoclar Vivadent has introduced a toothcolored filling material, named Cention N, for the bulk application in retentive preparations with or without the application of an adhesive system. Cention N is an “alkasite” restorative material reflecting a new category of filling material as a subgroup of the composite resins. Cention N is a UDMA-based, self-cure material with optional additional light-curing which consists of a powder and a liquid component. The liquid is composed of dimethacrylates and initiators and the powder consists of glass fillers, initiators, and pigments. Cention N entails a high-density polymer network and degree of polymerization over the complete depth of the restoration because of its cross-linking methacrylate monomers combined with a stable self-cure initiator.^[9]

The aim of the present study is to evaluate and compare the compressive strength of three different restorative materials i.e., Filtek Z350 XT (3M) (nanohybrid composite), Beautiful – Bulk fill (SHOFU) (Giomer) and Cention – N (Ivoclar) (alkasite resin-based composite).

II. MATERIAL AND METHOD

A total of 30 specimens (n = 30) were prepared with the three materials used for the study i.e., Filtek Z350 XT (3M) (nanohybrid composite) (n=10), Beautiful – Bulk fill (SHOFU) (Giomer) (n=10) and Cention – N (Ivoclar) (alkasite resin-based composite) (n=10) (Fig 1).

The specimens were prepared in the cylindrical molds with standard dimensions of the American Dental Association (ADA) specification i.e., cylindrical specimens were prepared in molds

with dimensions of 6 mm in diameter and 12 mm in height. All the materials were manipulated according to the instruction from the manufacturer.



Fig 1. Samples of all the three groups

The 4mm increments of Filtek Z350 XT and Beautiful – Bulk fill were cured with LED light for 20 seconds. Cention – N was mixed with the powder liquid ratio of 1:1 and condensed in the molds.

Compressive strength testing was carried out using the Autograph Universal Testing Machine with crosshead speed of 1.0 mm/minute (Fig 2). Each sample was placed with the flat ends between the plates of the specimens. The maximum load applied to fracture the specimens was recorded and the compressive strength was calculated using the following formula: $CS = 4P/\pi D^2$, where P is the maximum applied load (N) and D is the measured diameter of the sample (mm).

Data was noted in a tabular form and was statistically analysed in SPSS software. The mean value with its standard deviation was calculated for each restorative material. Results were subjected to one-way ANOVA for comparison between groups and unpaired t-test to compare the materials among groups. (p<0.05).



Fig 2. Universal Testing Machine



III. RESULTS

The compressive strength of Filtek z350 xt (3M), Beautifil bulk fill (SHOFU), and Cention – N (Ivoclar) was 97.133 ± 29.33 , 95.978 ± 19.79 & 94.907 ± 24.05 respectively. The Filtek z350 xt (3M) had the highest strength compared to another two Beautifil bulk fill (SHOFU) and Cention – N (Ivoclar) but this difference is statistically not significant ($F= 0.61$ & $p>0.05$).

When we compared between two groups

- 1) The compressive strength of Filtek z350 xt (3M) was more i.e. 97.133 ± 29.33 compared to Beautifil bulk fill (SHOFU) i.e. 95.978 ± 19.79 but this difference is statistically not significant ($t=0.10$ & $p>0.05$)
- 2) The compressive strength of Filtek z350 xt (3M) was more i.e. 97.133 ± 29.33 compared to Cention – N (Ivoclar) i.e. 94.907 ± 24.05 but this difference is statistically not significant ($t=0.18$ & $p>0.05$)
- 3) The compressive strength of Beautifil bulk fill (SHOFU) was more i.e. 95.978 ± 19.79 compared to Cention – N (Ivoclar) i.e. 94.907 ± 24.05 but this difference is statistically not significant ($t=0.11$ & $p>0.05$).

GROUP	COMPRESSIVE STRENGTH	
	Mean	SD
A- Filtek 350(3M)	97.133	29.33
B- Beautifil(SHOFU)	95.978	19.79
C- Cention (Ivoclar)	94.907	24.05

IV. DISCUSSION

Several dental restorative materials have been used for restoration procedures like GIC, amalgam, composite since many years. During the last decade, due to high esthetic demands from patients, resin composites have gained popularity. However, like superior esthetics, strength is also one of the important criteria, as it greatly influences the selection of a restorative material according to the clinical scenario. Stronger materials resist deformation and fracture in a better way, provide more equitable stress distribution, greater stability, and greater probability of clinical success.

Compressive strength of restorative material is important because restorative material replace part of tooth structure and they should provide sufficient strength to resist intraoral compressive and tensile forces that are produced in function and parafunction.^[2]

In the present study, Filtek Z350 XT (3M) had the highest strength compared to another two

Beautifil bulk fill (SHOFU) and Cention – N (Ivoclar) but this difference is statistically not significant. These results were similar to a study conducted by Iftikhar et al. (2019), who compared the compressive strengths of conventional glass ionomer (Fuji IX), ClearFil AP-X, Filtek Z350-XT, and Cention N and found that there was no significant difference between the compressive strengths of Filtek Z350-XT and Cention N.^[3]

Also, in a study by Rehab et al. (2021), the compressive strengths of Tetric Evo Ceram Bulk Fill (Ivoclar, Nanohybrid composite) and Cention – N was compared which showed non-significant difference in their compressive strength.^[10]

It contains 78.4% inorganic filler which gives better compressive and flexural strength with lower shrinkage and reduces stress on cavity walls. It has been observed that liquid part of Cention-N has four different dimethacrylates (urethane dimethacrylate, tricyclodecandimethanol dimethacrylate, aliphatic-UDMA, and polyethylene glycol), and an initiator forming a cross link polymer.^[1]

These results may be attributed to the existence of a highly cross-linked monomer network, using a stable, effective self-cure initiator and shrinkage stress reliever in Cention N material, resulting in high degree of polymerization and proper mechanical properties. It should also be noted that the spherical shape of Cention N filler particles allows an increased filler load and increases their compressive strength, as mechanical stresses appear to focus on the angles and protuberances of the filler particles.^[10]

Chowdhury et al. (2018), investigated the fracture resistance of three different restorative materials, Z350 nanofill composite resin, Cention N, and silver amalgam material in a class II cavity, concluded that the use of Cention N and Z350 restorative materials significantly strengthens teeth after class II cavity preparation and restoration.^[11]

Sharma et al. (2019) showed similar fracture resistance readings for Cention N and Z350 composite in endodontically treated teeth. The high filler contents of barium aluminum silicate glass and calcium aluminum silicate glass can be a potential reason for this high and comparable strength of Cention N.^[12]

Zahra et al. (2021) in their study observed that the mean fracture resistance value of the specimens restored by the Beautifil bulk-fill restorative material were significantly different compared to the other two types of bulk-fill composites which might be attributed to higher filler loading in Beautifil composite (87% wt, 74.5% vol.), which resulted in increased composite



stiffness with higher modulus of elasticity and consequently led to a greater fracture resistance.^[13]

Abdulhameed et al. (2018) also found similar results in their study, which reported that a Beautiful bulk-fill restorative had significantly greater value of fracture resistance than nano hybrid (Tertic EvoCeram) and nano-filled (Filtek).^[14]

According to a study conducted by Ilie and Fleming (2015), they stated that high viscosity bulk fill giomer showed increased micromechanical properties compared to conventional composites.^[15]

However, another study disagreed and reported that the values of FR of the high-viscosity bulk-fill giomer are statistically lower than both high-viscosity bulk-fill as well as the incrementally placed nanocomposite. This might be due to high filler loading which impede adequate light penetration and reduce degree of conversion leading to incomplete polymerization.^[16]

Apart from the composition and polymerisation of the material, the strength and other mechanical properties also depends on the oral environment, the thermochemical factors, saliva as well as the intake of other fluids, and the directions and magnitude of forces varying according to the individual, etc.

Thus, further long-term clinical studies are required to assess the longevity of restorative material in different oral environments.

V. CONCLUSION

Compressive strength is one of the major criteria in selecting a restorative material for posterior restorations. Our study showed that Cention – N can give promising results in posterior restorations. However, Within the limitations of the study, further laboratory research and clinical trials are required to assess its long term success.

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