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Comparative Evaluation of Shear Bond Strength of Two Posterior Restorative Materials in Primary Teeth: An in Vitro Study

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Abstract

Introduction: Dental caries remains to be one of the most common diseases encountered in the field of dentistry. Several restorative materials have been introduced with different properties are most widely used nowadays because of their superior aesthetic and physical properties. Shear bond strength of a restorative material plays a key role in deciding the restoration's longevity. Hence, for a better selection of the restorative material, shear bond strength needs to be evaluated.

Aim: Study aim was to evaluate and compare shear bond strength of two posterior restorative materials in primary teeth.

Material & Methods: Twenty extracted deciduous molars were selected for a study to compare the shear bond strength of two restorative materials. The teeth were mounted in acrylic blocks and a uniform dentinal surface was exposed by sectioning with a diamond disk. The specimens were randomly divided into two groups based on the restorative material used: Group 1, restored with Tetric N-Ceram (a nanohybrid composite) and

Group 2, restored with Wizdent WONDER BULKFILL (a bulk-fill composite). The restorative materials were applied to the dentinal surfaces using plastic moulds to ensure uniformity and the specimens were stored in distilled water to simulate oral conditions until testing. Shear bond strength was then measured for all specimens using a universal testing machine, providing data on the adhesive performance of the two materials on deciduous dentin.

Results: The study results indicated that the shear bond strength values for Tetric N-Ceram (19.8460 MPa) and Wizdent WONDER BULKFILL (20.0200 MPa) were comparable. This finding suggests that the bulk-fill composite restorative material demonstrated shear bond strength on par with the nanohybrid composite restorative material when bonded to deciduous dentin.

Conclusion: From this study it can be concluded that bulk-fill composite restorative material has comparable shear bond strength to nanohybrid composite restorative material.

Keywords: Aesthetic, Composite, Restoration, Shear bond strength, Tetric N-Ceram, Wizdent WONDER BULKFILL.

Introduction

Dental caries continues to be a widespread disease prevailing among the overall population and thereby, a continuous demand for better restorative materials and techniques is still underway.[1] The human tooth is marvel of nature. However, it has a limited capacity for regeneration. This necessitates the replacement of tooth structure lost as a result of caries, trauma or other reasons, with a suitable restorative material.[2] Placement and replacement of restorations are the most common dental procedure involving a major part of the dentists' working time.[3]

The physical properties of composites are important because they affect the material's performance in real-world situations. The clinical success of restorative materials depends upon a good adhesion with dentinal surface to resist various dislodging forces acting within the oral cavity. These forces are measured in terms of compressive strength, tensile strength and shear strength. Importance of shear bond strength is that, it's a critical measure in material science that is used to evaluate the bond strength of material. Shear bond strength is the resistance to forces that slides restorative material past tooth structure. It assumes much importance to the restorative material clinically because of the fact that the major dislodging forces at the tooth restoration interface have shearing effect. Therefore, higher shear bond strength implies better bonding of the material to tooth.[4-5]

Composite resin is the most widely used modern dental restorative material. The use of composite restorative materials has gained popularity mainly because of their superior aesthetic properties and minimalistic removal of sound tissue.[1] This material is versatile in dental applications due to the combined properties exerted by the synergistic action of the polymeric base embedding filler particles.[6-7] The polymeric matrix type plays an important role in the filler embedding, assuring an optimal wetting of the particles and generating a proper lamination of these structures and facilitates their further modelling into the desired shape prior to the photo-polymerization process. Thus, resins are widely used in dentistry because of their high binding ability and good mechanical properties[8-9]. However, it is also characterized by the risk of complications due to insufficient polymerization of the material and the occurrence of polymerization shrinkage. Since photo-polymerized resin composites were introduced, the

degree of conversion was acknowledged as vital to the clinical success of these materials. Photo-cured resin composites polymerize only to a certain depth. This depends on the penetration of visible light through the bulk of the material[10-11].

In present study the two composite restorative materials used are nanohybrid composite restorative material i.e. Tetric N-Ceram and bulk-fill composite restorative material i.e. Wizdent WONDER BULKFILL. Tetric N-Ceram is a light-curing, radiopaque, nano-hybrid dental restorative material that can be used to restore teeth in both the anterior and posterior regions. It incorporates advanced technology, providing outstanding mechanical properties, minimal shrinkage and exceptional radiopacity for effective secondary caries detection.[12] Wizdent WONDER BULKFILL has innovative advanced filler technology and its superior filler load allow for steady light transmission resulting in a greater depth of cure, better shade match and high resistance to wear. These along with low polymerisation shrinkage make Wonder Bulk Fill an ideal choice for posterior teeth.[13]

Thus, considering the importance of reliable bond strength values for restorative materials, the aim of the study undertaken is to compare and evaluate the shear bond strength of two composite restorative materials to dentinal surface of primary teeth.[2]

Material and Methodology

The current in vitro study was conducted in the Department of Paediatric and Preventive Dentistry from December 2024 to January 2025. The study design was approved by the International Ethical Review Board Committee.

Table 1: Composite materials used in the study

Composite materials used in the study			
Materials	Type	Composition	Manufacturer
Tetric N-Ceram	Nano hybrid composite	Dimethacrylates (19-20 wt.%). The fillers contain barium glass, ytterbium trifluoride, mixed oxide and copolymers (80-81 wt.%). Additives, initiators, stabilizers and pigments are additional contents (< 1 wt.%).	Ivoclar Vivadent AG, Liechtenstein
Wizdent Wonder Bulkfill	Bulk-fill composite	Barium glass, ytterbium trifluoride, mixed oxide, proacrylate, and zirconium or silica particles.	Pidilite Industries Limited, United Kingdom

A total of 20 primary human molar teeth were selected. Sample size was calculated by considering Mean and SD values of a previous study by Preethy NA et al (2020), using G* power software (version 3.1.9.7). They were randomly assigned to 2 groups of 10 teeth each. The materials used in this study were group 1: Tetric N-Ceram (Nanohybrid composite) and group 2: Wizdent WONDER BULKFILL (Bulk-fill composite). Primary molars which are caries-free and extracted due to various reasons such as dentoalveolar abscess, root resorption was included in the study. Primary teeth with occlusal or proximal caries, attrition and any restoration were excluded from the study. Pulpotomy and pulpectomy treated teeth were excluded from study. Tooth with any

abnormal defect was excluded from study. Teeth were stored in distilled water at room temperature till further use as it has the least interference with the bond strength.[14]

The selected teeth were mounted in hand – made cylindrical acrylic moulds of 12 cm diameter and 15 cm height for standardization. These dimensions were taken according to set-up of the universal testing machine, also the tooth structure embedded in acrylic moulds got proper stability because of acrylic mould base. The teeth were placed in such a way that their occlusal surface was parallel to the acrylic block surface. The teeth were then sectioned horizontally between the middle and occlusal third of the tooth. Uniform dentinal surface was exposed by cutting with a double – faced diamond disk beneath the dentino-enamel junction, so that the corono-dentinal surface is exposed. Wet silicon carbide paper of 180, 320, and 600 grit was used to polish the dentinal surface, so making it uniformly flat. Thermocycling was not done to simulate oral conditions in the present study as variations in the temperature do not have a significant effect on the restorative materials, rather it may lead to spontaneous debonding of the specimens.[15] The cavity was prepared on that exposed surface with 4 mm internal diameter and 1 mm height. This 1 mm height was measured with the help of Williams probe. The specimens were transferred for storage in distilled water at 37°C for 24 hours after which they were randomly divided into 2 groups of 10 teeth under each group. The materials to be tested under each group were as follows:

Figure 1: The two composite materials used for the study for which shear bond strength is to be compared

Group 1: Tetric N-Ceram

Group 2: Wizdent WONDER BULKFILL

The teeth were etched with silica free 37% ortho-phosphoric acid (PRIME) for about 20 seconds and rinsed with water for 10 seconds. They were then blotted dry using cotton pellets. A bonding agent (SDI Stae Single component total etch adhesive) was then applied in two coats using a fully saturated disposable tip. Light curing was done for 10 seconds. Readymade plastic moulds of 5 mm internal diameter and 5 mm height were taken and the inner surface of the moulds was coated with petroleum jelly. These moulds were used to bond the restorative material to the tooth surface. The moulds were placed on the tooth surface and were then subsequently filled and condensed with the respective restorative composite materials in 2.5 mm increments at room temperature and were light-cured (Unicorn LED curing light) for 20 seconds each. This cured restorative material was then pushed out of the plastic mould with a ball burnisher (Fig. 2) as done in a similar study by Nujella et al.[16-17]

Figure 2: Twenty prepared specimens involving 10 of each group

All the 20 specimens were placed in distilled water for 24 hours at 37°C after which they were subjected to shear bond strength testing using Universal Testing Machine. Total load applied was 0.2% of total capacity (1000kN) at a crosshead speed of 0.5 mm/minute following the 2003 ISO technical specification and shear bond strength was calculated.[18]

The following equation was used to calculate the shear bond strength (SBS):

P = F/S

P = Shear bond strength in megapascals (MPa)

F = Maximum load at fracture in Newtons (N)

S = Shear specimen interface cross-sectional area in square millimetres (mm2)

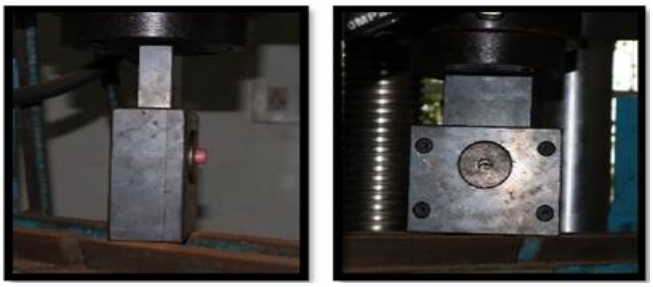

Figure 3 and 4: Shear bond strength calculated using Universal testing machine Model No: RKI UTE 100T FLG

Statistical Analysis

Data analysis was conducted using IBM SPSS statistical software version 25. The data obtained were tabulated and analyzed using independent t-test and probability value of ≤ 0.05 was considered as significant

Results

The mean and standard deviation values of the shear bond strength of the two restorative materials are depicted in Table. The shear bond strength of Wizdent WONDER BULKFILL was found to be comparable with Tetric N-Ceram. Shear bond strength revealed that there was no significant difference in Wizdent WONDER BULKFILL and Tetric N-Ceram composite restorative materials.

Table 2: Analysis for shear bond strength of two different restorative materials

Analysis for shear bond strength of two different restorative materials				
Groups	N	Mean	Standard deviation	*P* value
Group 1	10	19.8460	0.2633	0.334
Group 2	10	20.0200	0.4879	

Independent t-test (p value ≥ 0.05)

Result was insignificant.

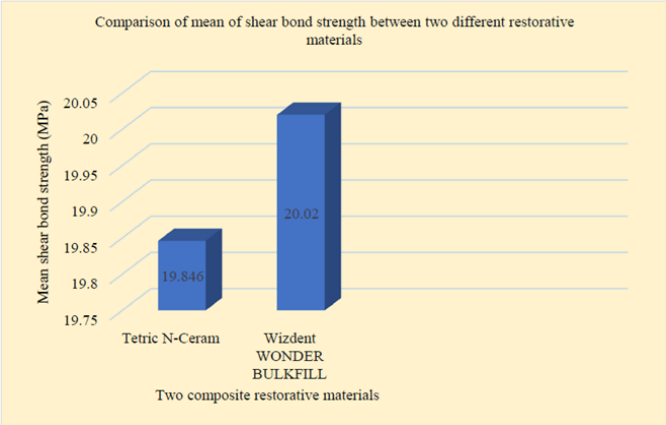

Figure 5: Comparison of mean of shear bond strength between two different restorative materials

Discussion

The present study compared the shear bond strength of commercially available two different posterior restorative composite materials i.e. Nanohybrid composite restoration and Bulk-fill composite restoration.

The bond between restorative materials and the tooth should be strong and durable, not only from a mechanical point of view but also from biological and esthetic perspectives.[19] Bond strength value acts as a gross assessing tool to evaluate the bonding efficacy of any restorative material to the tooth.[20] In vitro testing to assess shear bond strength proves to be the least technique sensitive to perform and predicts the possible clinical performance of the material by emphasizing the strength at the bonded interface.

Bulk-fill composite has low shrinkage and it reveals good edge conformity. It also has sufficient radiopacity and shows sufficient resistance against chewing forces in the posterior region.[21] Nanohybrid composite has a high filler loading due to a range of particle sizes, which gives them strength similar to the traditional hybrid composites.[22]

In our study bulk-fill composite restorative material demonstrated comparable shear bond strength compared to nanohybrid composite restorative material due to their larger particle size and potential for better adaptation to the tooth structure. Bulk-fill composite restorative material is easy to use than conventional composite material and can be completed in fewer layers.[23] Posterior teeth are often subjected to shearing during chewing, so restorative materials with better shear bond strength are recommended for these teeth.[24]

In a study by Colak H. et al, bulk-fill composite restorative materials are simpler than conventional composites and can be used more efficiently. However, further studies are required in this area to better understand how the bond strengths of these adhesive systems behave under clinical conditions. The specific shear bond strength of both bulk-fill and nanohybrid composite restorative material can vary significantly depending on the manufacturer and composition of the material.[25] Nanohybrid composite is commonly used for restoring posterior teeth whereas bulk-fill has been commonly used to restore the tooth post endodontic treatment, but after our study's result it's clear that bulk-fill composite restorative material is also good option for restoration of posterior teeth.

Limitations

Shear bond strength was only the parameter calculated in the study.

The strength of the composite restorative material is not only dependent on shear bond strength but also involves other physical properties such as compressive strength, flexural strength, wear resistance, density, coefficient of thermal expansion, etc.

Also, both the groups were stored in distilled water for 24 hours before the testing i.e. medium used in this study was distilled water which was slightly different than saliva. So, partially we were unable to maintain the conditions in the oral environment.

Conclusion

From this study it can be concluded that bulk-fill composite restorative material has comparable shear bond strength to nanohybrid composite restorative material. Hence bulk-fill composite can be a viable option as restorative material in primary teeth.

References

1. Preethy NA, Jeevanandan G, Govindaraju L, Subramanian E. Comparison of Shear Bond Strength of Three Commercially Available Esthetic Restorative Composite Materials: An In Vitro Study. Int J Clin Pediatr Dent. 2020;13(6):635-39.
2. Somani R, Jaidka S, Singh DJ, Sibal GK. Comparative Evaluation of Shear Bond Strength of Various Glass Ionomer Cements to Dentin of Primary Teeth: An in vitro Study. Int J Clin Pediatr Dent. 2016;9(3):192-96.

3. Mjor IA, Shen C, Eliasson ST, et al. Placement and replacement of restorations in general dental practice in Iceland. Oper Dent. 2002;27:117-23.
4. Colak H, Ercan E, Hamidi MM. Shear bond strength of bulk-fill and nano-restorative materials to dentin. Eur J Dent. 2016;10(1):40-45.
5. Pradeep K, Ginjupalli K, Kuttappa MA, Kudva A, Butula R. In vitro Comparison of Compressive Strength of Bulk-fill Composites and Nanohybrid Composite. World J Dent 2016;7(3):119-22.
6. Salernitano E., Migliaresi C. Composite Materials for Biomedical Applications: A Review. J. Appl. Biomater. Biomech. 2003;1:3-18.
7. Battistella E, Varoni E, Cochis A, Palazzo B, Rimondini L. Degradable Polymers May Improve Dental Practice. J. Appl. Biomater. Biomech. 2011;9:223–31.
8. Gorkem U, Guzel K., Sonmez I. Assessment of monomer release from 3 different fissure sealants. J. Appl. Biomater. Funct. Mater. 2018;16:90–96.
9. Yao S, Qin L, Ma L, Zhang X, Jiang H, Zhang J, Zhou C, Wu J. Novel antimicrobial and self-healing dental resin to combat secondary caries and restoration fracture. Dent. Mater. 2023;11:1040–50.
10. Yadav R, Meena A, Lee HH, Lee SY, Park SJ. Tribological behavior of dental resin composites: A comprehensive review. Tribol. Intern. 2023;190:109017.
11. Korkut E, Torlak E, Altunsoy M. Antimicrobial and Mechanical Properties of Dental Resin Composite Containing Bioactive Glass. J. Appl. Biomater. Funct. Mater. 2016;14:296–301.
12. Pastrav M, Pastrav O, Chisnoiu AM, Chisnoiu RM, Cuc S, Petean I, et al. Properties of Nanohybrid Dental Composites-A Comparative In Vitro Study. Biomedicines. 2024;12(1):243.
13. Van Ende A, De Munck J, Lise DP, Van Meerbeek B. Bulk-Fill Composites: A Review of the Current Literature. J Adhes Dent. 2017;19(2):95-109.
14. Titley KC, Chernecky R, Rossouw PE, et al. The effect of various storage methods and media on shear- bond strengths of dental composite resin to bovine dentine. Arch Oral Biol. 1998;43(4):305-11.
15. Tezvergil A, Lassila LVJ, Vallittu PK. Composite-composite repair bond strength: Effect of different adhesion primers. J Dent. 2003;31(8):521-25.
16. Nujella BPS, Choudary MT, Reddy SP, et al. Comparison of shear bond strength of aesthetic restorative materials. Contemp Clin Dent. 2012;3(1):22-26.
17. Fleming GJ, Awan M, Cooper PR, Sloan AJ. The potential of a resin-composite to be cured to a 4mm depth. Dent Mater. 2008;24:522–9.
18. International Organization for Standardization. ISO/TR 11405 Dental Materials-guidance on Testing of Adhesion to Tooth Structure. Geneva, Switzerland:: WHO;1994..pp.pp. 1-13.
19. Manuja N, Pandit IK, Srivastava N, et al. Comparative evaluation of shear bond strength of various esthetic restorative materials to dentin: an in vitro study. J Indian SocPedod Prev Dent. 2011;29(1):7-13.
20. Jain G, Narad A, Boruah LC, et al. Comparative evaluation of shear bond strength of three resin based dual-cure core build-up materials: an in-vitro study. J Conserv Dent JCD. 2015;18(4):337-41.
21. Jafarpour D, Ferooz R, Ferooz M, Bagheri R. Physical and Mechanical Properties of Bulk-Fill, Conventional, and Flowable Resin Composites Stored Dry and Wet. Int J Dent. 2022;10:7946239.
22. Ferooz M, Bagheri R, Jafarpour D, Burrow MF. Physical Properties of Nanohybrid and Microhybrid

Resin Composites Subjected to an Acidic Environment: A Laboratory Study. Oper Dent.45(3):105-13.

23. Sunbul H. A., Silikas N., Watts D. C. Surface and bulk properties of dental resin-composites after solvent storage. Dental Materials. 2016;32(8):987-97.
24. Sarrett D. Clinical challenges and the relevance of materials testing for posterior composite restorations. Dental Materials. 2005;21(1):9-20.
25. Saati K, Khansari S, Mahdisiar F, Valizadeh S. Evaluation of Microhardness of Two Bulk-fill Composite Resins Compared to a Conventional Composite Resin on surface and in Different Depths. J Dent (Shiraz). 2022;23(1):58-64.