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Comparative Evaluation of Shear Bond Strength of Nanohybrid Composite after Placement of Uncured Liners: An In-Vitro Study

Dr. Arohan Singh[1], Dr. Sakshi Agarwal[2], Dr. Saraswati Sachan[3], Dr. Preeti Rastogi[4], Dr. Pragyan Paliwal[5], Dr. Arfat Ahmad[6]

[1]Professor, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, UP, India

[2]Post Graduate Student, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, UP, India (Corresponding Author)

[3]Assistant Professor, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, UP, India

[4]Assistant Professor, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, UP, India

[5]Reader, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, UP, India

[6]Assistant Professor, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, UP, India

Corresponding Author: Dr. Sakshi Agarwal

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KEYWORDS

Flowable Compomer; Giomer; Nanohybrid composite; Flowable composite; Shear bond strength; Universal testing machine

ABSTRACT:

Background: To evaluate the clinical performance of nanohybrid composite after placement of uncured liners.

Methodology: Forty-eight premolars were collected and sectioned at the level of 2.5 mm from the coronal cusp and 2.5 mm apically from the level of cement-enamel junction using diamond disc with water coolant. Sectioned teeth were embedded in methacrylate base and the prepared surfaces were dried and treated with Universal bonding agent and cured for 20 seconds. A plastic tube was placed on each sample and according to uncured liner material that were used consisting of 12 samples, they were randomly divided into four groups: Group A- Control group (No liner), Group B- Flowable composite (Spectra ST Flow), Group C- Giomer (Beautifil II) and Group D- Flowablecompomer (Dyract).Plastic tubes were filled with uncured lining material according to groups beneath a layer of packable composite. All the samples were then cured with LED curing unit for 20 seconds. A Universal Testing machine was employed to assess the shear bond strength at 1 mm/min of crosshead speed. Results were statistically evaluated using ANOVA and Tukey's post hoc test.

Result and Observation: Group D (Flowablecompomer) showed the highest shear bond strength which was 26.10 ± 5.33 MPa followed by Group B (Flowable composite) with a shear bond strength of 17.46 ± 1.14MPa,Group C (Giomer) had a shear bond strength of 13.71 ± 2.58 MPa and Group A (No liner) showed the least shear bond strength of 5.72 ± 1.94MPa.

Conclusion: Utilizing different uncured liners can increase the shear bond strength of nanohybrid composite.

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Introduction

Dental caries continues to be a ubiquitous disease prevailing among the global population and thereby, a continuous demand for better restorative materials and techniques is still underway. Placement and replacement of restorations are the most frequent dental procedure amounting to a major part of the dentists' working time. The pioneering of composite restorative materials has gained popularity mainly because of their superior aesthetic properties and minimalistic removal of sound tissue. The development of practical adhesive dentistry can be traced to Dr. Michael Buonocore who, in 1955, discovered he could increase the retention of acrylic-based restoratives by first treating the enamel with phosphoric acid. The trend in recent years has been toward not just the simplification of adhesive systems, but making them universal as well.[1] At present, composite resin has made its benchmark in the field of dentistry and is considered to be indispensable and the material of choice for the restoration of anterior and posterior teeth. Dental composites have been in use in dentistry for over 50 years consisting of a polymeric matrix like dimethacrylate, reinforced fillers, silane coupling agents for better adhesion and various additives. However, despite advancements that have improved their physical and mechanical properties they still have certain limitations.[2] These include suboptimal mechanical properties, polymerization shrinkage, low fracture strength, susceptibility to secondary caries due to fractures and high wear rates. To further reduce chances of marginal leakage, flowable composites were introduced. They were produced with either a lesser amount of the typical glass reinforcing particles to make the paste more fluid but also less strong or by specifically formulating resins with reduced viscosity to allow for relatively high filler loading to produce better physical properties.[3] Other newer aesthetic materials were also developed. Polyacid-modified composites also known as compomers were introduced into clinical use in about 1992. The compomers are formed from composites and GICs hence these materials possess many properties of both the materials.[4]A new class of hybrid composites named "Giomer" has been introduced, which are also known as "pre-activated glass ionomers". In fact, they refer to glass ionomers in which glass fillers are inserted into a resin matrix.[5] Various new restorative techniques have also been introduced to further enhance the bonding between the restoration and the tooth surface. One of them involves placement of an uncured liner and then packable composite is placed on this layer of uncured flowable material and both are cured simultaneously.[6] There needs to be more reasearch assessing the efficacy of these materials and techniques in terms of marginal adaptation and bond strength. Therefore, this study aimed to comparatively evaluate the shear bond strength of nanohybrid composite after placement of uncured liners.

Methodology

48 premolars were collected from the Department of Oral and Maxillofacial Surgery, SPPGIDMS, Lucknow after ethical approval. To minimize procedural and environmental bias, the same operator sectioned all the teeth with a diamond disc and straight handpiece.

Sample Preparation

The teeth were sectioned at the level of 2.5 mm from the coronal cusp as well as 2.5 mm apical to the CEJ using a diamond disc with water coolant in order to attain a uniform surface area. Each sectioned tooth was embedded in a methacrylate base of size 17mm x 20 mm x 20 mm. After 20 minutes, samples were carefully removed from the mould die. Later, grinding of samples using a 600 grit SiC sandpaper was done to expose maximum dentinal surface followed by finishing.

Bonding Procedure

After drying the prepared surfaces, Universal Bonding Agent (Prime & Bond Universal adhesive, Dentsply Sirona) was applied on the dentin surface and cured for 20 seconds.A plastic tube of 3 mm × 2 mm (internal diameter × height) was placed on each sample and then they were randomly divided into four groups according to uncured liner materials used.

Group A: Control group (only packable composite) (Spectra ST HV) (n=12)

Group B: Flowable composite (Spectra ST Flow) (n=12)

Group C: Giomer (Beautifil II) (n=12)

Group D: Flowablecompomer (Dyract) (n=12)

The plastic tubes were filled with uncured lining materials according to the groups followed by

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placement of packable nanohybrid composite over the lining material. (Fig.1) Both were then cured using LED curing unit for 20 seconds.

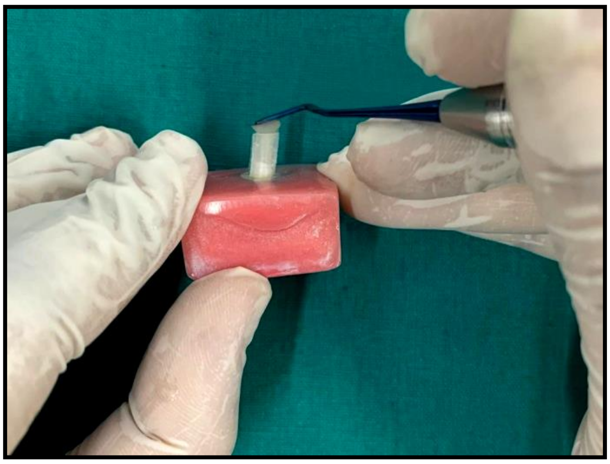

Fig.1. Placement of lining material and overlying packable composite

Shear Bond Testing

A shear bond strength test for each specimen was carried out using Universal Testing Machine at a crosshead speed of 1 mm/min. Load at which failure occurred was then recorded in MegaPascals (MPa). (Fig.2)

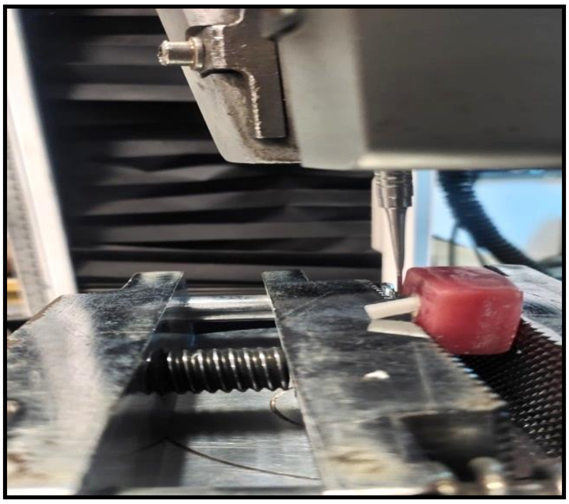

Fig.2. Load at which failure occurred

Statistical Analysis

Data were summarised in Mean±SD (standard deviation). Groups were compared by one factor analysis of variance (ANOVA) and the significance of mean difference between (inter) the groups was done by Tukey's HSD (honestly significant difference) post hoc test after ascertaining normality by Shapiro-Wilk's test and homogeneity of variance between groups by Levene's test. A two-tailed (α=2) $P < 0.05$ was considered statistically significant. Analysis was performed on SPSS software (Windows version 22.0).

Results

Table 1: Shear bond strength (MPa) of four groups

Group	n	Shear bond strength (MPa) (Mean ± SD)	F value	*P* value
Group A	12	5.72 ± 1.94	85.71	< 0.001
Group B	12	17.46 ± 1.14		
Group C	12	13.71 ± 2.58		
Group D	12	26.10 ± 5.33		

Shear bond strength of four groups were summarised in Mean ± SD and compared by ANOVA (F value).

Table 2: Comparison (*P* value) of difference in mean shear bond strength (MPa) between groups by Tukey test

Comparison	Mean diff.	q value	*P* value	95% CI of diff.
Group A vs. Group B	11.74	12.84	P < 0.001	8.28 to 15.19
Group A vs. Group C	7.99	8.74	P < 0.001	4.53 to 11.44

Group A vs. Group D	20.38	22.30	P < 0.001	16.93 to 23.84
Group B vs. Group C	3.75	4.10	P < 0.05	0.29 to 7.20
Group B vs. Group D	8.65	9.46	P < 0.001	5.19 to 12.10
Group C vs. Group D	12.39	13.56	P < 0.001	8.94 to 15.85

diff: difference, **q value:** Tukey test value, **CI:** confidence interval.

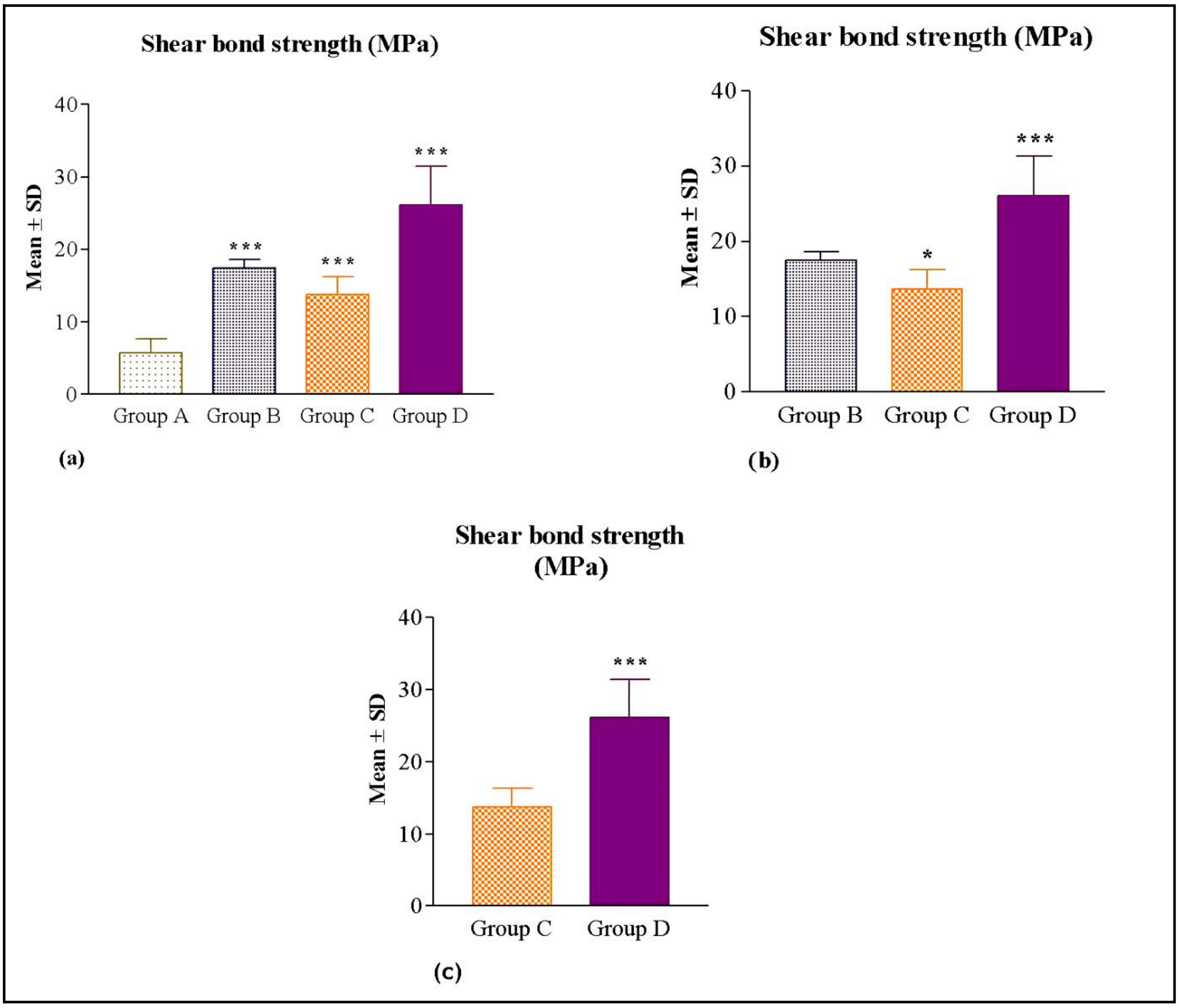

Fig. 1. Comparisons of difference in mean shear bond strength of Group B, Group C and Group D with Group A (a), Group C and Group D with Group B (b) and Group D with Group C.*- just significant (*P*< 0.05) and ***- highly significant (*P*< 0.001)

Discussion

Over the past few years, there has been a significant rise in the clinical utilization of resin-based restorative materials, primarily because of their improved properties, ease of handling, and excellent aesthetic and bonding properties.The newer generations of composites are superior to amalgam in terms of aesthetics, physical properties, ability to bond to tooth structure thereby warranting their use as a posterior restorative material. However they have certain drawbacks like polymerization shrinkage, microleakage and poor adaptation to the cavity walls. One of the primary objectives of adhesion is to create a strong,

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durable, and predictable bonding between the restorative material and the tooth structure. This strengthens their relationship, which accounts for the increased shear bond strength and fewer voids at the resin-dentinal wall junction.[7] Without significantly removing healthy tooth structure, bonding helps a restoration stay in place and stabilise. By avoiding the formation of marginal gaps caused by polymerisation shrinkage stress, a strong link between the restorative material and the tooth minimises discolouration and marginal leakage. According to Patras M. et al., composite resin must be shaped to fit every area of the prepared cavity rather than just condensing into it. This impacts how well the material adapts to the preparation.[8] Polymerisation shrinkage, which persists and causes tension at the interface between the restoration and dentinal wall, is another significant issue with composite restorations. This causes the restoration to debond from the cavity wall. Another study by Jacob G. et al. came to the conclusion that insufficient cavity adaptation can lead to microleakage and unsatisfactory marginal sealing.[9] To overcome these drawbacks, many techniques have been suggested such as incremental, injection moulding and snowplow technique. Among these techniques, Snowplow technique has been recently introduced in which an uncured liner is placed in the prepared cavity prior to placement of restorative composite. Many newer restorative materials with lower viscosity have also been developed to lessen the occurrence of void formation and insufficient marginal sealing. However, studies have proven that these materials were not giving satisfactory results. To achieve close adaptation of restorative material to the dentin surface, it was suggested to combine the use of these restorative materials with various lining techniques. A significant shift in composition over time, from macrofilled to nanofilled and/or nanohybrid composites, has enhanced the overall mechanical and physical properties of composites. The enhanced clinical efficacy, extended lifespan, and growing popularity of composite resin restorations can also be attributed in part to advancements in adhesive technology and minimally invasive surgical techniques.[10]

The universal adhesive was used to every group in our examination in order to standardise the study process. According to Perdiago J. et al., it overcomes the surface tension of water and spreads across dentin and into dentinal tubules to form an even, homogenous layer. A consistent layer of adhesive is left on the entire surface to ensure a strong bond when the solvent and water evaporate at the same time.[11] Shear bond strength is important for restorative materials in clinical settings because shear stresses are the main source of dislodging forces at the tooth restoration interface. Therefore, higher shear bond strength implies better bonding between the material and the tooth. We also used premolars to prepare the samples for our study because they are easily accessible and usually extracted for orthodontic procedures. They also provide a big surface area for testing. This was done in accordance with an investigation by Dugaret al.[12] As previous research by Jain G. et al. has also demonstrated a decrease in bond strength when resin composite is bonded to deep dentin, the coronal dentin surface of the tooth was used to analyse the shear bond strength in this study.[13] This can be attributed to the complexities in the structure of deep dentin, such as an increase in the number of tubules and their diameters with much less intertubular dentin matrix when compared to superficial dentin. Shear bond strength testing was performed on the samples. The resin must have a strong enough bond to endure the internal tensions caused by polymerisation shrinkage. Furthermore, shear stress is quite simple to perform and is thought to replicate many clinical situations. In the present study, Group D (Flowablecompomer) showed the highest shear bond strength which was 26.10 ± 5.33 MPa followed by Group B (Flowable composite) with a shear bond strength of 17.46 ±1.14MPa,Group C (Giomer) had a shear bond strength of 13.71 ± 2.58 MPa and Group A (No liner) showed the least shear bond strength of 5.72 ± 1.94MPa. Group D (Compomer) showed the highest shear bond strength among all the experimental groups. The findings of this investigation were found to be comparable to those of the study carried out by Jayasree S. et al. This might be because Compomer and the dentine surface make hermetic contact, which creates a resin inter-diffusion zone called the Type I interface.[14] In order to improve strength by lowering stress concentrations and avoiding weak spots, Habib E. et al. recommended a uniform distribution of inorganic fillers in the resin matrix. This provides mechanical reinforcement, which in turn strengthens the bond.[15] Furthermore, Chuang et al. reported that ionic cross-links are formed as a result of an ion exchange interaction between the carboxyl groups of the compound and calcium ions present in enamel and dentin. This process enhances adhesion and reduces the likelihood of microleakage at the contact.[16] Group B (Flowable composite) showed a lower bond strength as compared to Group D (Compomer). Newer flowable composites have a higher filler content of 76-80% by weight which provides strength to the material and also helps in reducing polymerisation shrinkage at the resin-dentin interface thus improving adaptation. Moreover, the incorporation of an "elastic" basal layer may act as a "shock" absorber against functional loading and internal tensions triggered by polymerization.[17] Furthermore, materials with a lower modulus of elasticity are said to be more flowable and undergo plastic deformation. This inherent flow, which allows the molecules to slip into new positions and orientations, compensates for any stresses caused by polymerization shrinkage, thereby allowing for the maintenance of the adhesive bond. The recently introduced flowable composite with high filler content used in this study is incorporated with a novel SphereTEC filler technology. This technology utilizes granulated spherical fillers in combination with an optimised resin matrix system to enhance easy handling by the clinician, aesthetics and longevity of the restoration.[18] Whereas, the shear bond strength of Group C (Giomer) was found to be lower than Group B (Flowable composite). Giomer's thicker consistency reduces its wettability and adaptability, which in turn reduces its penetration into dentinal tubules or in the spaces between collagen fibres, resulting in reduced resin microtag production, according to Sunico M.C. et al.[19] Group A (Control) showed the least shear bond strength among all the tested groups. This result may be explained by the fact that packable composite, which is comparatively more viscous, exhibits poor adaptation to dentinal walls because, when used alone, it can result in high polymerisation shrinkage stress at the adhesive interface, which may cause secondary caries, adhesive failure, or microgaps. This outcome was consistent with the research by Attar N. et al., which found that the largest gingival microleakage was shown by packable composites alone, without the use of intermediary materials.[20] In this in-vitro study, use of a low viscosity lining material, Snowplow technique has shown an increase in shear bond strength as compared to when composite was used alone. The snowplow approach improved bonding to dentine and increased the shear bond strength. Tabatabaei SH. et al. state that by applying a higher viscosity composite on top of uncured flowable material, the hydraulic pressure of the heavier viscosity composite would improve the material's penetration into dentinal tubules. This would reduce voids, improve the restorative material's adaptation, and encourage sealing at the borders. Concurrent curing of the flowable liner and the underlying packable composite layer would reduce the space between the tooth-restoration interface.[21] Furthermore, Shinde M.M. et al. came to the conclusion in their investigation that the uncured lining material also serves as a flexible intermediate layer that aids in stress relief during the restorative resin's polymerisation shrinkage. By better adapting to the dentinal wall, the snowplough approach lowers the risk of subsequent caries.[22]

Conclusion

Within the limitations of this in-vitro study, Group D (Compomer) showed highest bond strength followed by Group B (Flowable composite), Group C (Giomer) whereas, Group A (Control) showed the least shear bond strength. A statistically significant difference was seen when liners made of various restorative materials were utilised. Additionally, the nanohybrid composite's attachment to dentine was strengthened by the snowplough procedure. Therefore, the shear binding strength of the nanohybrid composite to dentine can be increased by using various lining materials and restoration procedures. To support the results of the current in-vitro investigation, more research is necessary.

Ethical Approval

Ethical approval for the study was obtained from the institutional ethics committee.

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Nil.

Conflicts of Interest

There are no conflicts of interest.

References

1. Alex G. Universal adhesives: the next evolution in adhesive dentistry? CompendContinEduc Dent. 2015 Jan;36(1):15-26; quiz 28, 40. PMID: 25822403.

2. Al-Ibrahim I, Shono N, Al-Saud L, Al-Nahedh H. Five years of restorative resin-based composite advancements: a narrative review. BMC Oral Health. 2025 Jul 2;25(1):1061. doi: 10.1186/s12903-025-05816-7.
3. Lokhande NA, Padmai AS, Rathore VP, Shingane S, Jayashankar DN, Sharma U. Effectiveness of flowable resin composite in reducing microleakage - an in vitro study. J Int Oral Health. 2014 Jun;6(3):111-4. Epub 2014 Jun 26. PMID: 25083045
4. Neelam Mittal and Supriya Gupta. “Compomers: A Review of Literature". Acta Scientific Dental Sciences 5.6 (2021): 53-56.
5. D. Zavare et al. Comparison of the shear bond strength in Giomer and resin-modified glass ionomerin class V lesions. Heliyon 9 (2023) e14105.https://doi.org/10.1016/j.heliyon.2023.e14105.
6. Haddad M, Lugassy D, Barhum M, Brosh T, Matalon S. The Influence of Posterior Class II Composite Restoration Location and Techniques on Marginal Sealing. Dent J (Basel). 2025 Jan 17;13(1):39. doi: 10.3390/dj13010039.
7. Can-Karabulut DC, Oz FT, Karabulut B, Batmaz I, Ilk O. Adhesion to primary and permanent dentin and a simple model approach. Eur J Dent. 2009 Jan;3(1):32-41. PMID: 19262729.
8. Leinfelder KF. Using composite resin as a posterior restorative material. J Am Dent Assoc. 1991 Apr;122(4):65-70. doi: 10.14219/jada.archive.1991.0142. PMID: 2022790.
9. Neppelenbroek KH. The clinical challenge of achieving marginal adaptation in direct and indirect restorations. J Appl Oral Sci. 2015 Oct;23(5):448-9. doi: 10.1590/1678-77572015ed005.
10. Păstrav M, Păstrav O, Chisnoiu AM, Chisnoiu RM, Cuc S, Petean I, Saroși C, Feștilă D. Properties of Nanohybrid Dental Composites-A Comparative In Vitro Study. Biomedicines. 2024 Jan 22;12(1):243. doi: 10.3390/biomedicines12010243.
11. Jayaprakash T, Srinivasan MR, Indira R. Evaluation of the effect of surface moisture on dentinal tensile bond strength to dentine adhesive: An in vitro study. J Conserv Dent. 2010 Jul;13(3):116-8. doi: 10.4103/0972-0707.71640.
12. Dugar M, Ikhar A, Nikhade P, et al. (September 01, 2022) Comparative Evaluation of Shear Bond Strength of Nanohybrid Composite Restoration After the Placement of FlowableCompomer and Composite Using the Snowplow Technique. Cureus 14(9): e28663. DOI 10.7759/cureus.28663.
13. Jain G, Narad A, Boruah LC, Rajkumar B. Comparative evaluation of shear bond strength of three resin based dual-cure core build-up materials: An In-vitro study. J Conserv Dent. 2015 Jul-Aug;18(4):337-41. doi: 10.4103/0972-0707.159754.
14. Jayasree S. et al. Compomer – Dyract- A Comparison of its Bond Strength And Microleakage with Composite Resin And Glass Ionomer – An in Vitro Study. e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 7 Ver. VII (July. 2017), PP 32-42 www.iosrjournals.org
15. Islam MS, Nassar M, Elsayed MA, Jameel DB, Ahmad TT, Rahman MM. In Vitro Optical and Physical Stability of Resin Composite Materials with Different Filler Characteristics. Polymers (Basel). 2023 Apr 29;15(9):2121. doi: 10.3390/polym15092121.
16. Diez-García S, Sánchez-Martín MJ, Valiente M. The power of weak ion-exchange resins assisted by amelogenin for natural remineralization of dental enamel: an in vitro study. Odontology. 2022 Jul;110(3):545-556. doi: 10.1007/s10266-022-00688-7. Epub 2022 Feb 11.
17. Oral Health Care - An Important Issue of the Modern Society http://dx.doi.org/10.5772/intechopen.95132
18. Baldi A, Rossi T, Comba A, Vergano EA, Montrella R, Pampaloni B, Chiecchio V, Rolando C, Scotti N. The ability of highly-filled flowable composites in preventing marginal gap in class V restorations: an optical coherence tomography study. BMC Oral Health. 2025 Apr 23;25(1):619. doi: 10.1186/s12903-025-05970-y.
19. Shetty S, Rai N, Shetty K, Mayya A, Chatra A, Shetty P. Comparison of Proanthocyanidin and EDTA in Enhancing Shear Bond Strength of Giomer and Cention N to Human Dentin: An *In vitro* Study. J IntSocPrev Community Dent. 2025 Feb 26;15(1):61-68. doi: 10.4103/jispcd.jispcd_178_24.
20. Gernhardt, Christian Ralf, AnhDuc Nguyen, Mary Michaelis, and Natalie Pütz. 2023. "Clinical Outcome of Class I and II Restorations with and

without an Intermediary Layer of a Flowable Composite after 24 Months: A Prospective, Randomized, Split-Mouth-Designed, Controlled and Single-Blinded Clinical Trial" *Applied Sciences* 13, no. 7: 4224. https://doi.org/10.3390/app13074224.

21. França FM, Tenuti JG, Broglio IP, Paiva LE, Basting RT, Turssi CP, do Amaral FL, Reis AF, Vieira-Junior WF. Low- and high-viscosity bulk-fill resin composites: a comparison of microhardness, microtensile bond strength, and fracture strength in restored molars. Acta Odontol Latinoam. 2021 Aug 1;34(2):173-182. doi: 10.54589/aol.34/2/173.
22. Han SH, Sadr A, Shimada Y, Tagami J, Park SH. Internal adaptation of composite restorations with or without an intermediate layer: Effect of polymerization shrinkage parameters of the layer material. J Dent. 2019 Jan;80:41-48. doi: 10.1016/j.jdent.2018.10.013.