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Evaluation Of Light Transmitting Ability of Various Aesthetic Posts and Its Effect on Push-Out Bond Strength of Dual Cure Resin Cement

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ABSTRACT

Endodontically treated teeth with coronal structure loss often require posts and cores for retention. With rising demand for aesthetic restorations, non-metallic fiber posts have become popular due to their mechanical properties and light transmission ability. However, studies show inadequate polymerization of resin cement, especially in the middle and apical regions of root canals. Dual-cured resin cements help overcome this issue, but their degree of conversion (DC) decreases without sufficient light exposure, leading to reduced push-out bond strength due to the presence of residual monomer. Optimizing polymerization, proper cementation techniques, and ensuring adequate light intensity exposure are essential for the longevity and success of post-retained restorations..

Keywords: *Everstick, push-out bond strength, curing light intensity, dual cure resin.*

1. INTRODUCTION

Endodontically treated teeth with significant coronal structure loss pose a challenge for restorative dentists (Yasa et al., 2015). Posts and cores are often necessary to support the final restoration. In recent years, the demand for aesthetic, tooth-colored restorations has led to the growing popularity of non-metallic posts (Naumann et al., 2015; Ferrari et al., 2000). These aesthetic posts not only enhance the visual appeal of restorations but also offer favorable mechanical properties, making them a reliable clinical choice (Akkayan et al., 2002) [1].

Light curing resins are not recommended for fiber post cementation due to inadequate depth of cure in the apical root portions, even with translucent posts. Thus, dual-cured and self-cured resin cements are advised. Dual-cured cements are widely used and have been investigated in multiple studies. These cements are expected to polymerize even in areas unreachable by light [2].

However, some dual-cured cements may not achieve full conversion without light exposure. Therefore, light curing is recommended to ensure adequate polymerization. To improve curing, translucent fiber posts were introduced, helping transmit light deeper into the root canal. Proper curing is particularly important in apical regions, as studies show that adhesion in these areas is often compromised [2].

As the light transmission at different root canal depths is crucial for optimal polymerization and performance of resin luting cement. Incomplete conversion in deeper radicular sections results in poor bond strength and reduced mechanical properties. There is limited dental literature on the light transmission capability of different aesthetic posts, their impact on bonding performance, and the mechanical properties of resin luting cement [3]

This study evaluated the light transmission ability of Opaque fibre posts , Translucent fibre posts and Everstick posts at various depths. It also assessed the push-out bond strength of luting cement in different radicular sections.

MATERIALS AND METHODS

A total of 30 non carious single rooted premolar teeth extracted for periodontal or orthodontic purpose were collected for study. Teeth with carious lesion, severe attrition, fractures, cracks & developmental defects and with multiple roots were excluded.

SAMPLE PREPARATION AND METHODOLOGY :

Crowns were decoronated using diamond discs by standardizing the root length to 15mm. Working length was established by subtracting 1 mm from the measured length. Apical patency was maintained throughout instrumentation by using a size 15 K-file (Mani). The canals were instrumented using a crown-down technique with ProTaper nickel-titanium rotary files to F3. RC Prep (Premier, PA, USA) was used as a lubricant and irrigated with 2 mL of 2.5% sodium hypochlorite (NaOCl). The canals were dried with sterile size 30 paper points and obturated with size 30 gutta-percha cone (Diadent, Seoul, Korea) using AH-26 sealer.

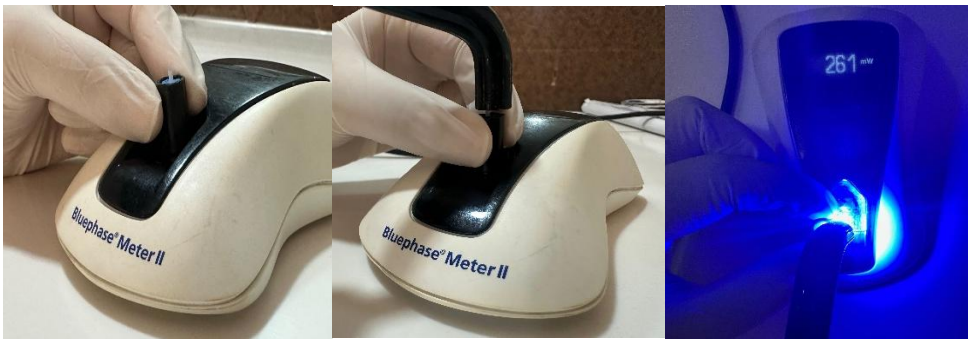
GROUP 1: Opaque fibre posts
GROUP 2: Translucent fibre posts
GROUP 3: Everstick post

Post space preparation of 10mm was initiated by Gates Glidden #1 drills (Mani) then followed using Peeso reamers #3 (Mani) and completed by the corresponding post drill (1.1 mm in diameter). After irrigation and drying of the canals, root canal walls were then treated with Parabond conditioner for 30s and adhesive for 30s. Excess was removed using paper points. Fiber posts were tried for proper length, and then they were sandblasted and placed in 24% H2O2 for 3 minutes, cleaned with 37% phosphoric acid and applied Monobond Plus silane (Ivoclar Vivadent; Liechtenstein). Dual-cure resin cement was injected in an apical-coronal direction (to prevent void formation). Fiber posts were covered with cement and slowly inserted into the root canal by finger pressure. Excess cement was carefully removed using a scalpel blade. Light curing of the cement was carried out using LED with a light intensity of 1,200 mW/cm2 for 40 s from the specimen surface.

ANALYSIS OF LIGHT INTENSITY REDUCTION

A hollow black plastic tube of 10 × 25 mm was taken and silicone impression material was packed into the tube. Each post was coated with petroleum jelly and was implanted vertically into the tube before the impression material sets. The post was sectioned, leaving 2 mm protruding above the surface of tube and was implanted until it comes into contact with the bottom of the tube.

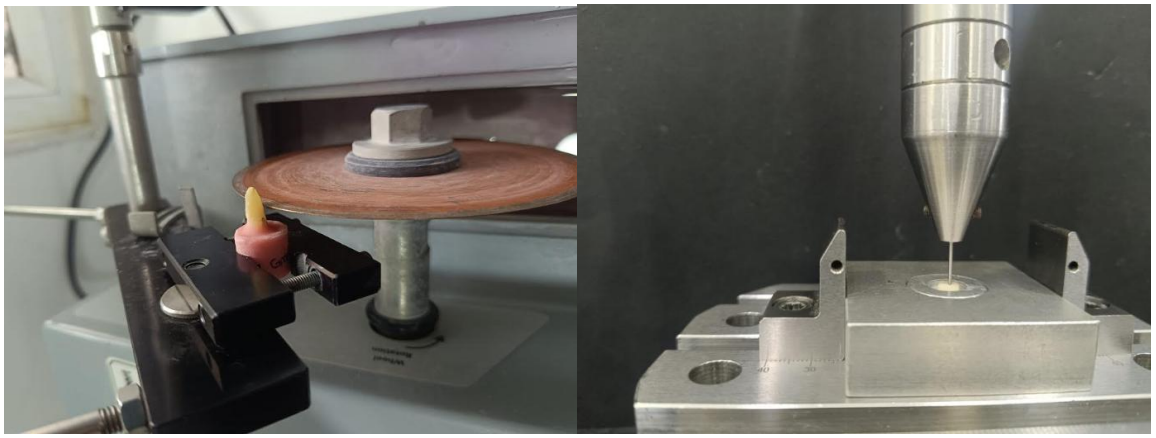
As the post was lubricated with petroleum jelly, it will facilitate the removal of post from the impression material. The plastic tube was placed vertically over the radiometer sensor area. The light source was placed over the coronal portion of post for 10 seconds; the transmitted light power was registered at the bottom surface in the dental radiometer. Mean irradiance power was recorded three times for each sample to avoid the errors and an average was calculated as the light transmission value. Everstick was packed in the silicone putty impression created by Prefabricated fibre posts and checked for light intensity reduction as mentioned above.



ANALYSIS OF PUSH-OUT BOND STRENGTH

Using low speed IsoMet saw (Buehler Worldwide Headquarters), post/dentin section (middle-apical third) were obtained from each sample with a thickness of 2 mm. Samples were submitted to a push-out test using a using universal LRX-plus testing machine (Lloyd Instruments Ltd.) at a crosshead speed of 0.5 mm/min. The fracture was confirmed by sudden drop in force measurements in the testing machine. The maximum failure load was recorded in N and converted into MPa, by

computed surface area measurements



STATISTICAL ANALYSIS

STATISTICAL ANALYSIS:

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0 Released 2013 Armonk, NY: IBM Corp.,will be used to perform statistical analyses.

Descriptive Statistics:

Descriptive analysis includes expression of Push out bond strength and Light Transmission values in terms of mean& SD for each group.

Inferential Statistics:

One-way ANOVA Test followed by Bonferroni's post hoc Test / Kruskal Wallis Test followed by Dunn's post hoc test [Based on the Data Distribution] will be used to compare the mean Push out bond strength and Light Transmission values between 3 groups.

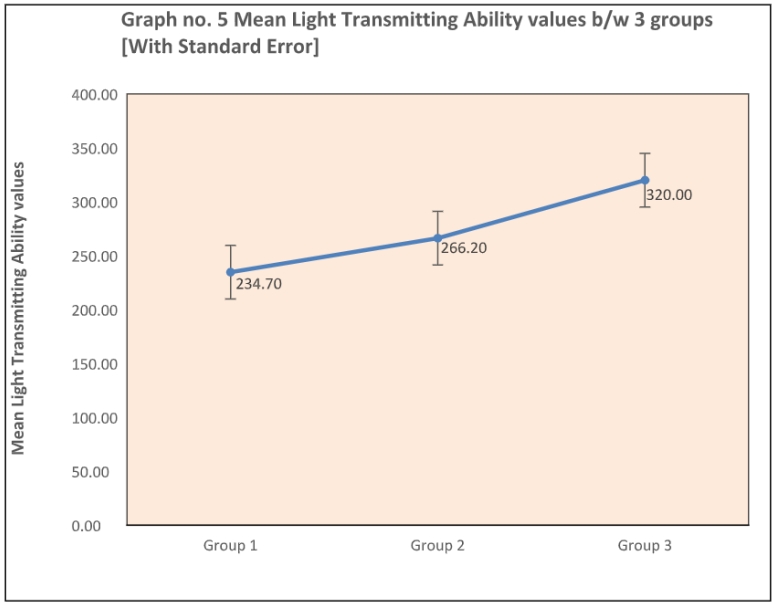
The level of significance will be set at P<0.05.

RESULTS:

Comparison of mean Light Transmitting Ability values b/w 3 groups using One-way ANOVA Test

Groups	N	Mean	SD	Min	Max	p-value
Group 1	10	234.70	3.77	230.0	240.0	<0.001*
Group 2	10	266.20	6.18	260.0	280.0	
Group 3	10	320.00	5.91	310.0	330.0	

Mean Light Transmitting Ability values

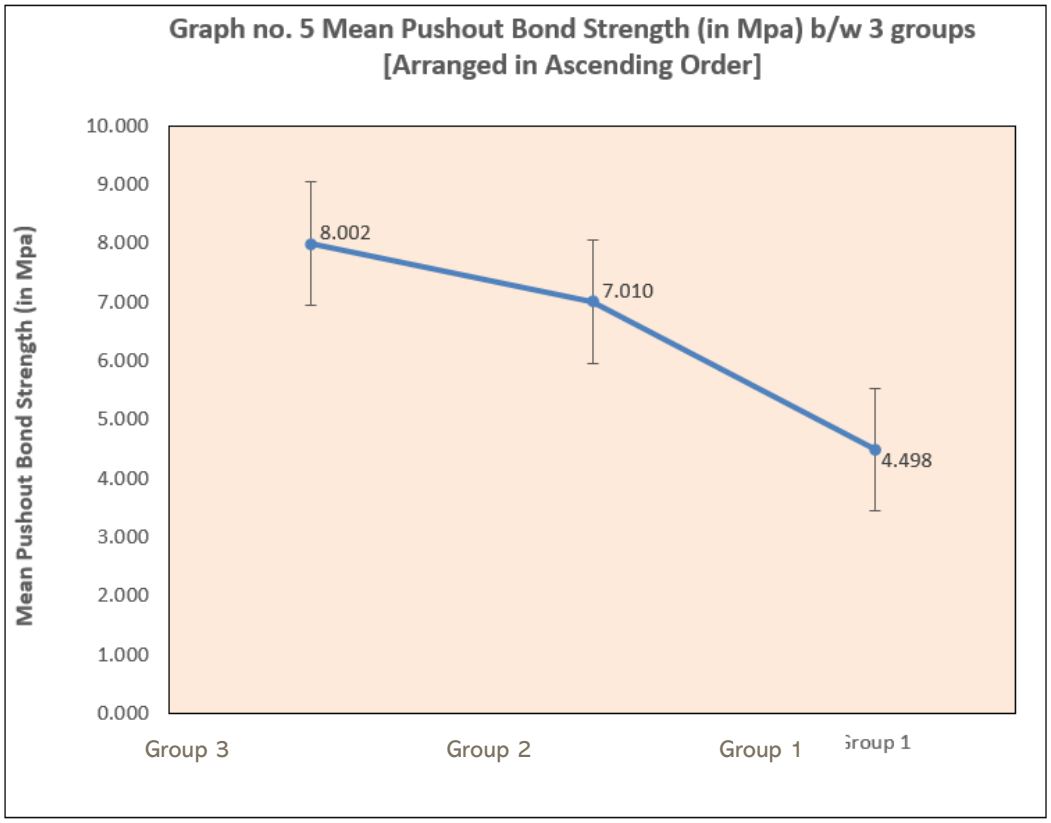


Statistically Significant

The Light Transmitting Ability values in Group 1 was 234.70 , in Group 2 was 266.20 and in Group 3 was 320.00. There was a significant difference in the mean Light Transmitting Ability values between 3 groups at p<0.001. Multiple comparison of mean differences between groups revealed that Group 3 showed significantly highest Light Transmitting Ability values as compared to Group 1 & Group 2 and the mean differences were statistically significant at p<0.001 & p=0.008 respectively. This was then followed next by Group 2 which showed significantly higher mean Light Transmitting Ability values as compared to Group 1 and the mean difference was statistically significant at p<0.001. This infers that the mean Light Transmitting Ability values was significantly highest in Group 3, followed by Group 2 and least in Group 1.

Comparison of mean Pushout Bond Strength (in Mpa) b/w 3 groups using Kruskal Wallis Test

Groups	N	Mean	SD	Min	Max	p-value
Group 1	10	4.498	0.160	4.27	4.69	<0.001*
Group 2	10	7.010	0.082	6.90	7.15	
Group 3	10	8.002	0.342	7.51	8.52	



The Pushout Bond Strength in Group 1 was 4.498, in Group 2 was 7.010 and in Group 3 was 8.008. There was a significant difference in the mean Pushout Bond Strength between 3 groups at p<0.001. Multiple comparison of mean differences between groups revealed that Group 3 showed significantly highest Pushout Bond Strength as compared to Group 1 & Group 2 and the mean differences were statistically significant at p<0.001 & p=0.01 respectively. This was then followed next by Group 2 which showed significantly higher mean Pushout Bond Strength as compared to Group 1 and the mean difference was statistically significant at p=03. This infers that the mean Pushout Bond Strength was significantly highest in Group 3, followed by Group 2 and least in Group 1.

DISCUSSION:

The increasing demand for aesthetic, non-metallic restorative solutions has led to the development of fiber posts with resin matrices. These posts provide an elastic modulus compatible with dentine, ensuring uniform stress distribution and reducing the risk of root fractures. The effectiveness of luting cement polymerization is highly dependent on sufficient light transmission, particularly in deep root canals. The light-transmitting and scattering properties of endodontic posts play a crucial role in achieving optimal polymerization, particularly in the apical region, where conversion rates tend to be lower due to reduced light penetration.

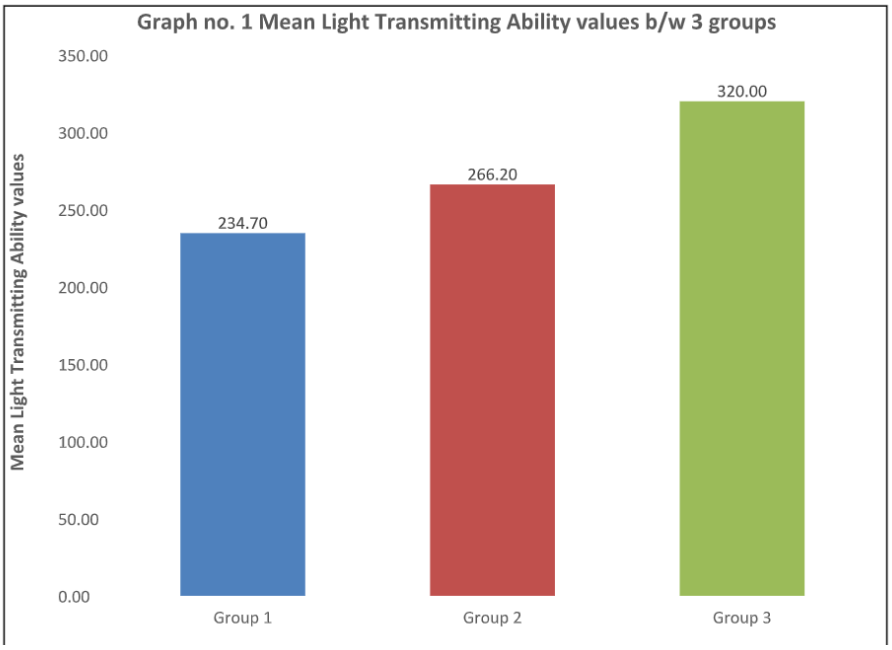
Among fiber post systems, the EverStick post stands out due to its unidirectional fiber arrangement, which allows greater light transmission to both the middle and apical sections of the root canal. Additionally, EverStick's multiphase polymer matrix, also known as semi-interpenetrating polymer network (semi-IPN), facilitates the diffusion of adhesive monomers. This process swells the polymer, enabling interdiffusion bonding, which enhances the adhesion between the post and the surrounding cement and dentin while minimizing stress at the post-dentin and post-cement interfaces. These features contribute to better mechanical performance and improved bonding reliability.

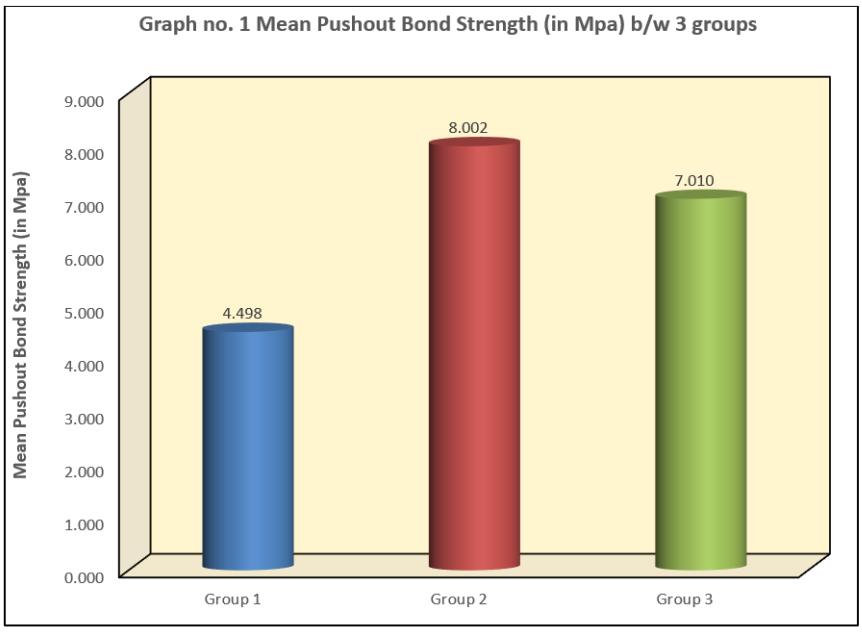
While translucent fiber posts generally allow for greater light transmission compared to opaque posts, their woven fiber structure leads to increased light scattering. This scattering effect hinders light penetration, particularly at the middle-apical junction, which can negatively impact polymerization efficiency in these regions. Consequently, despite their superior light transmission compared to opaque posts, translucent fiber posts may still face challenges in ensuring uniform polymerization throughout the root canal. The reduced light exposure in deeper areas can lead to compromised bond strength and mechanical properties of the luting cement.

A study conducted by Aldhafyan et al. highlighted the advantages of dual-cure resin cements over light-cure and self-cure resin cements. Dual-cure cements initiate polymerization through both light activation and chemical curing, allowing them to compensate for areas that are not well-illuminated, such as deep post spaces. This ensures a higher degree of conversion even in the absence of direct light exposure. Therefore, dual-cure resin cements are particularly beneficial for fiber post

cementation, as they provide more reliable polymerization in challenging clinical scenarios.

The light intensity reduction among different post materials follows a specific trend: opaque posts exhibit the highest reduction (26.66%), followed by translucent posts (22.18%), while EverStick posts show the lowest reduction (19.5%). This pattern directly influences the bond strength of luting cement, with EverStick demonstrating the highest push-out bond strength (8.002 MPa), followed by translucent posts (7.010 MPa), and opaque posts (4.498 MPa). This data suggests that higher light transmission contributes to improved bond strength, making EverStick a favorable choice for clinical requiring strong and durable adhesion.





Ultimately, the reduction in light intensity correlates with a decrease in bond strength at the middle-apical junction. To optimize polymerization and mechanical performance, dual-cure resin cements should be activated with additional light curing whenever possible. This ensures a higher degree of conversion and better adhesive properties, particularly in deeper root canal regions. Clinicians should carefully consider the type of fiber post and luting cement used to maximize the success and longevity of post restorations.

CONCLUSION

Within the limitations of this in vitro study, the following conclusions were drawn:

1. Light intensity reduction

Opaque > Translucent > Everstick

26.66% > 22.18% > 19.5%

2. Push-out bond strength

Everstick > Translucent > Opaque

8.002Mpa > 7.010Mpa > 4.498Mpa

3. A reduction in light intensity directly impacts the polymerization of resin luting cement, leading to decreased bond strength at the middle-apical junction. In deeper regions of the root canal, where light penetration is limited, incomplete conversion of the cement results in weaker adhesion and compromised mechanical properties. This highlights the importance of selecting materials that enhance light transmission to ensure optimal bonding performance. Additionally, the use of dual-cure resin cement with supplemental light activation significantly improves the degree of conversion, ensuring better polymerization and stronger adhesion, even in areas with minimal light exposure.

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