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Original Research

To Compare the Fracture Resistance and Bond Strength of Self Adhesively Luted Three Different Types of Posts With Influence Of Ferrule - An In Vitro Study

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ABSTRACT:
Background: Endodontically treated teeth or those which are grossly decayed and fractured often have very little amount of remaining coronal structure. Post and core provide reinforcements for restoration of the extensive loss of coronal tooth structure. The purpose of this study was to compare self adhesively luted cast metal, glass fibre reinforced posts and pre-fabricated metal post with influence of ferrule and evaluate them for their fracture resistance and bond strength.
Materials and Methods:60 extracted single rooted human mandibular premolars were used for this study. They were divided into 6 groups: Group 1: Cast metal post with ferrule Group 2: Cast metal post without ferrule, Group 3: Glass fibre post with ferrule, Group 4: Glass fibre post without ferrule, Group 5: Pre-fabricated metal post with ferrule, Group 6: Pre-fabricated metal post without ferrule. Endodontic treatment was done in all the specimens and post cementation and core buildup was done. 2mm of ferrule preparation was done in 30 teeth specimens. Artificial periodontal ligament formation done and mounted in the acrylic resin block. All the specimens were then tested for fracture resistance and bond strength by using universal testing machine.
Results: The fracture resistance and bond strength were tabulated and subjected to one-way ANOVA followed by post Hoc Tukey HSD test for multiple comparisons. There was statistically significant difference in ferrule groups for fracture resistance for all three posts. There was statistically no significant difference in non-ferrule groups for fracture resistance for all three posts. There was statistically significant difference in ferrule groups for bond strength for all three posts. There was statistically no significant difference in non-ferrule groups for bond strength for all three posts.
Conclusion: The results of this study indicated that cast metal post has best fracture strength with ferrule and glass fibre post has best bond strength with ferrule when compared to their other two peer groups. Advancement will provide better options.
Key Word: Post and Core, Fracture resistance, Bond strength, Ferrule, Cast metal post, Glass fiber post, Pre-fabricated metal post.

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Introduction

Post and core are used to restore endodontically treated teeth with extensive loss of coronal tooth structure and followed by crown. Extensive dental caries, iatrogenic loss of tooth structure, fracture, trauma, and pulpal pathology and endodontic treatment are the factors responsible for this type of restoration.[1] Restorations of the root filled tooth by a post to retain a crown was more than 200 years ago, when Fauchard used posts constructed from gold or silver.[4]There has been a significant betterment in post systems in recent years with respect to post and core materials, shape, design, bonding system and techniques.[2]

The strength and durability of a tooth restored with a post and core relied on the post material and length, root wall width and length, secure attachment of the post to tissues, presence of ferrule, and alterations in tooth load.[3]

The ferrule effect – the impact of a crown encompassing the remaining supragingival tooth structure – significantly enhances tooth resistance to fracture.The aim of the present study was to evaluate the fracture resistance and bond strength of endodontically treated teeth restored with cast metal post, pre-fabricated metal post and Glass fiber post was luted with dual cure resin cement with and without ferruling effect.[2,3]

Material And Method

This prospective comparative study was carried out in vitro of Department of Prosthodontics, Crown and Bridge & Implantology at Rajasthan Dental College & Hospital, Jaipur, Rajasthan. A total 60 specimens of premolars were used.

Methodology:

Sixty mandibular premolars with a single root and single canals that were free from fractures and with curved rootwere excluded. Working length was determined with 10 number K-file a length of 13±2 mm. (Photograph 1) The pro-taper rotary file system was used for cleaning and shaping until F3, and sealapex (a calcium hydroxide base sealer) was used to complete the obturation process with F3 GP.[3,4]

For ferrule group half of the crowns were prepared in such a way that 2 mm of tooth structure was remain from the CEJ with the help of diamond disc attached to the straight hand piece, which acted like ferrule and rest of the crowns were prepared from the CEJ. After that flat and taper diamond bur is used with airotor to gave a shoulder finish line to the prepare ferrule. (Photograph 2)

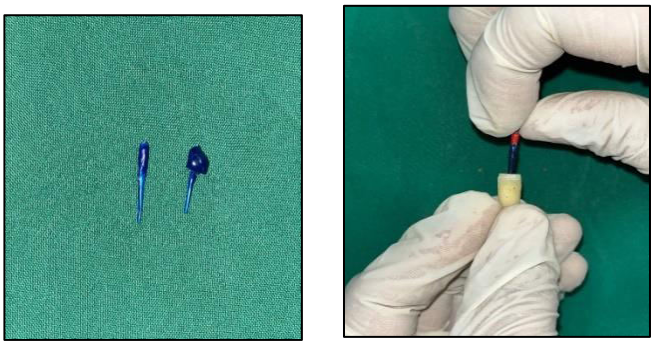
Using a peeso drill sequentially, GP material was removed until one third of the GP was still in the canal.Six groups were created out of the samples.(Table 1) Cast post was fabricated by using Pin-jets. Pin-jetwas used to create wax pattern of the canal and followed by spruing, investing, wax burnout, and casting sandblasting and finishing.[5] (Photograph 3).Glass fiber post and prefabricated metal post were used for other groups. (Photograph 4)

Peeso drills of the appropriate size were used to prepare the post gaps. Than, dual cure resin cement (Rely X luting – 2 by 3M) was used to lute the posts. After that, each group was split into two subgroups, "A" and "B" (n=5). Subgroups "A" and "B" pertain to the fracture resistance test and bond strength, respectively.[7]

By gradually adding composite and curing it with light cure, the core was built up. Every sample was set up on resin blocks that mimicked the look of periodontal ligaments with the help of light body material. Next, at a speed of 0.5 mm/min, the models for the fracture resistance test were loaded into the universal testing equipment. Clamps installed in the universal testing machine that ran in tensile mode at 0.5 mm/min were used to withdraw the posts from the models for the retention test while they were inside the testing apparatus.[8] (Photograph 5)

Photograph 1: shows 60 extracted premolars

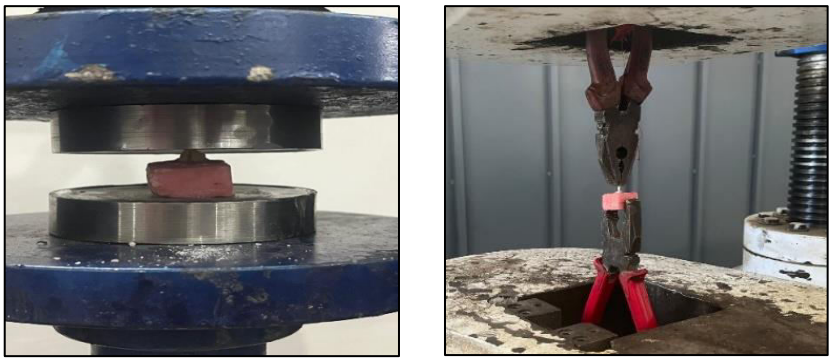
Photograph 2: Ferrule preparation



Photograph 3: Fabrication of cast post by using Pin-jets.

A **B** **C**

Photograph 4: (A) Cast metal post (B) Glass fiber post (C) Pre-fabricated metal post



A **B**

Photograph 5: (A) Fracture resistance test (B) Bond strength test

RESULTS

Mean fracture resistance value for Group 1 exhibited maximum Fracture resistance followed by Group 5, Group 6, Group 4, Group 3, and Group 2 respectively.Mean bond strength value forGroup 5 exhibited maximum bond strength followed by Group 3, Group 4, Group 6, Group 2 and Group 1 respectively. (Table 2).

Overall mean scores of Fracture resistance and bond strength for all specimens. Overall mean score for fracture resistance between ferrule and non-ferrule was 962.48±168.53 and 801.47±421.50. P value was 0.180, indicating that there is statistically non-significant (The level of significance P ≤0.05). Overall mean score for bond strength between ferrule and non-ferrule was 5.38±2.32 and 4.70±1.48. P value was 0.347, indicating that there is statistically non-significant (The level of significance P ≤0.05). (Table 3)

Table 1: Post materials and groups

Groups	MATERIALS	BRANDS
1. Cast post with ferrule	Ni-Cr Metal Pellets (Cast Metal posts)	Wirocer plus Bego
2. Cast post without ferrule		
3. Glass fiber post with ferrule	Glass Fiber posts, size – 1.5 mm	Reforpost - Angelus, Brazil
4. Glass fiber post without ferrule		
5. Pref. metal post with ferrule	Prefabricated metal post, Diameter – 1.5mm	Reforpost Metalico- Angelus, Brazil
6. Pref. metal post without ferrule		

Table 2: Showing one way ANOVA for fracture resistance and bond strength of all groups:

Groups	Fracture resistance (A)	Bond Strength (B)
1. Cast metal post with ferrule	1125.36±108.98	4.24±2.41
2. Cast metal post without ferrule	789.10±447.48	4.60±0.51
3. Glass fibre post with ferrule	790.52±88.49	5.18±2.93
4. Glass fibre post without ferrule	793.88±450.87	4.80±0.36
5. Pre-fabricated metal post with ferrule	971.58±97.33	6.72±0.74
6. Pre-fabricated metal post without ferrule	821.44±466.42	4.70±2.70
Total	**881.98±325.86**	**5.04±1.95**
F-value	**0.883**	**1.020**
P value	**0.508***	**0.428***

(Level of significance P≤ 0.05)

Table 3: Showing overall mean scores of Fracture resistance and bond strength

	Fracture resistance	Bond Strength
Ferrule	962.48±168.53	5.38±2.32
Non-ferrule	801.47±421.50	4.70±1.48
P value	0.180*	0.347*

(Level of significance P≤ 0.05)

Table 4: One way ANOVA for Fracture resistance for ferrule and non-ferrule groups.

	Cast Metal post	Glass fibre post	Pre-fabricated metal post	Total	P value
Ferrule	1125.36± 108[a]	790.52± 88.49[b]	971.58± 97.33[a,b]	962.48± 168.53	0.001*
Non-ferrule	789.10± 447.48[a]	793.88± 450.87[a]	821.44± 466.42[a]	801.47± 421.50	0.993

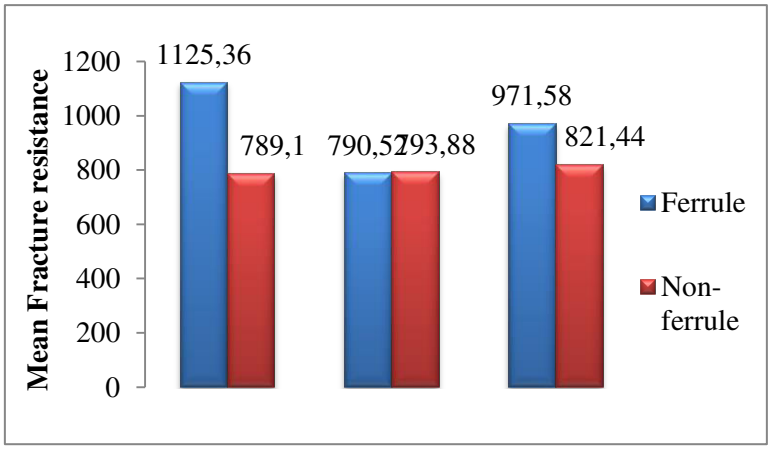
(Level of significance P≤ 0.05) 'a is not statistically significant to b.'

Table 5: One way ANOVA for Bond strength for ferrule and non-ferrule groups.

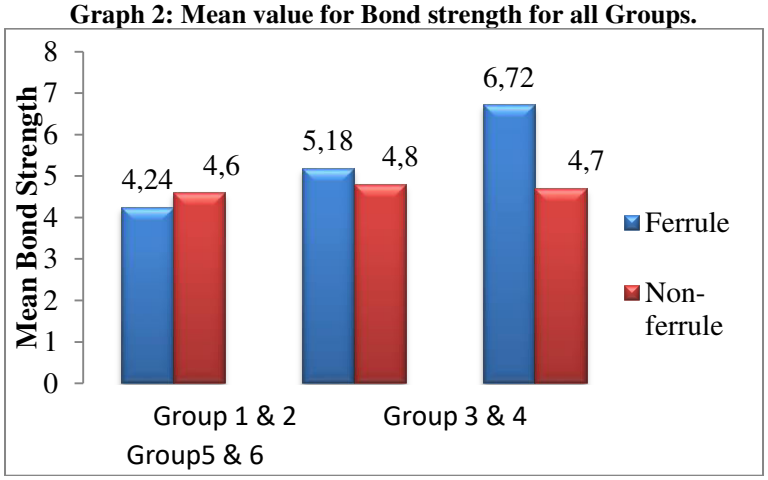
	Cast Metal post	Glass fibre post	Pre-fabricated metal post	Total	P value
Ferrule	4.24±2.41[a]	5.18±2.93[b]	6.72±0.74[a,b]	5.38±2.32	0.248*
Non-ferrule	4.60±0.51[a]	4.80±0.36[a]	4.70±2.70[a]	4.70±1.48	0.981*

(Level of significance P≤ 0.05) 'a is not statistically significant to b.'

Graph 1: Mean value for fracture resistance for all groups.



Graph 2: Mean value for Bond strength for all Groups.



DISCUSSION

According to the study's findings, anatomically designed posts outperformed other types of posts in terms of the tooth's ability to withstand fracture and maintain its attachment. Numerous studies have elucidated the various mechanical testing techniques used to assess the fracture resistance and bond strength of posts in relation to various canal cleaning, shaping, and obturation techniques, as well as ferrule type, design, and height, and types of restorative materials. In this work, endodontically treated teeth with artificially created periodontal ligaments surrounding them were used to test the fracture resistance and bond strength of three distinct types of posts, each with a different form, using a universal testing machine. The study's findings verified how the three posts would behave differently under tensile and compressive load.[3,9]

All the posts used in the present study were different like cast metal post, glass fiber post and pre-fabricated metal post. Cast post and core was selected because it follows exact shape and anatomy of the prepare canal. That was very important factor for the post, because it assured the exact fit of the post to the canal and also help into better retention, but it has flexural strength compare to glass fiber post.

The results of our study showed that mean fracture resistance value for Group 1 (Cast metal post with ferrule) exhibited maximum Fracture resistance followed by Group 5 (Pre-fabricated metal post with ferrule), Group 6 (Pre-fabricated metal post without ferrule), Group 4 (Glass fibre post without ferrule), Group 3 (Glass fibre post with ferrule), and Group 2 (Cast metal post without ferrule) as per statistical analysis. Bond strength of test specimens showed that Mean value for Group 5 exhibited maximum bond strength followed by Group 3, Group 4, Group 6, Group 2 and Group 1. That suggested that the cast metal post with ferrule (Group 1) had maximum fracture resistance and Pre-fabricated metal post with ferrule (Group 5) had maximum bond strength. So, here P was insignificant ($P>0.05$ set as insignificant) one way ANOVA for fracture resistance test and also same for the bond strength test.

On subjecting the mean value for fracture resistance of ferrule Group to one-way analysis of variance was found to be statistically significant and non-ferrule group found to be insignificant. For bond strength, ferrule and non-ferrule groups to ANOVA were found to be significant but ferrule group is lower than the non-ferrule group.

In 2019, a study was undertaken by Bacchi A, Caldas R A, Schmidt D, Detoni M, Souza M A, Cecchin D, Farina A P, et al. did a study and observed that the presence of ferrule enhanced fracture strength with both types of posts. The mean fracture strength values for groups with ferrule exceeded those reported for functional or parafunctional loads in the literature, unlike fiber post and core without ferrule, which did not meet the standards for parafunctional loads.[1]

On subjecting the mean value of ferrule Groups to Post Hoc Tukey HSD analysis for Multiple comparison between Group 1 vs Group 3 was significant, Group 1 vs Group 5 was non-significant, Group 3 vs Group 5 was significant. (The level of significance $P \leq 0.05$). For without ferrule groups it was non-significant. For bond strength, ferrule and non-ferrule groups to Post Hoc Tukey HSD analysis was done, between ferrule and non-ferrule test groups were found non-significant.

For fracture resistance, overall mean score of ferrule group is higher than the non-ferrule group. This suggested that the ferrule played important role and provide better fracture resistance. For bond strength, overall mean score of ferrule group and non-ferrule group was almost similar and didn't vary in large amount. This suggested that the ferrule is not that much important in case of bond strength. Overall mean score for both fracture resistance and bond strength were found statistically non-significant. [10] (Graph 1)

In 2018, a study was conducted by Pomini M C, Machado M M, Quadros G P, Gomes G M, Pinheiro L O, and Samra A P did a study and came to the conclusion that self-adhesively luting, when combined with ferrule, increases the fracture resistance of teeth restored with CPC as opposed to CFP. In CFPs and CPCs, root fractures were more common when the ferrule was absent. CPCs and CFPs had comparable bond strengths, with the exception of the apical part of the root. The current study's results were in line with those of this study.[4]

The current in-vitro investigation is limited in terms of its clinical applicability and is unable to provide exact outcomes. Consequently, more assessments, including clinical trials and in vivo investigations, are needed to validate our in vitro findings. It should be noted that the findings of each of these investigations may be related to the various luting cements, luting techniques, and surface treatments used to various post systems.

CLINICAL CONSIDERATION

- When choosing a post for a clinical case, knowledge of which material offers superior fracture resistance and bond strength can help guide decision-making.
- The ferrule effect on post-performance should assess the presence or absence of ferrule in restorative cases involving post placement to optimize long term out comes for the clinician.
- Select appropriate Treatment planning.

I. SCOPE FOR FUTURE RESEARCH

- Long term evaluation will provide better evaluation

- Effect of variation in ferrule design will provide accurate design selection for the various clinical conditions.
- Biomechanical studies will also enhance critical evaluation.

CONCLUSION

The current in-vitro investigation is limited in terms of its clinical applicability and is unable to provide exact outcomes. Consequently, more assessments, including clinical trials and in vivo investigations, are needed to validate our in vitro findings. It should be noted that the findings of each of these investigations may be related to the various luting cements, luting techniques,different type and surface treatments used to various post systems.

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