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Original Research

Digital post-core or conventional post-core: An invitro study

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ABSTRACT:

The purpose of this in vitro study was to check the accuracy of a post fabricated using conventional technique by casting to a post fabricated using digital technique by direct metal laser sintering (DMLS). **Aim:** To evaluate and compare the gap between post-core and the tooth in the apical region fabricated by conventional technique and by digital technique using parallel digital radiography. **Materials and Methods:** Twenty extracted permanent mandibular first and second premolars were selected. For conventional technique impressions were made using in lay pattern wax and for digital technique direct silicone impression was taken of post space which was scanned with mediti 500scanner. Casting was carried out for the conventional technique and digital metal laser sintering technique was carried out for the digital technique. The obtained posts were cemented using zinc phosphate cement. The apical gap of eachpost inthe canal was then evaluated with parallel digital radiography. **Result:** No significant differences were found among conventional and digital techniques in terms of gap (0.95 and 1.09mm; P>0.42). **Conclusion:** The conventional technique was more accurate than the digital technique in terms of gap. However, the gap in all the cases fell within the acceptable normal range.

Keywords: Conventional post, digital post, DMLS

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INTRODUCTION

Endodontic treatment removes the vital content of the root canal which leads to reduction of elasticity and increased brittleness of remaining tooth structure. To return to full occlusal and cosmetic function and for strong interior and exterior support the prepared tooth is reinforced by post core system.[1]

A one-piece foundation restoration for an endodontically treated tooth comprises of a post within the root canal and a core replacing missing coronal structure to form the tooth preparation.[2]

Prefabricated post and build ups are less suitable for teeth that lack coronal tooth structure or lack the ferrule effect.[1] A post needs resistance and retention. Resistance refers to the capability of post to withstand lateral and rotational forces. It is influenced by factors including ferrule presence, anti-rotational characteristics, and post length rigidity. Retention refers to the capability of post to resist vertical forces.[3]

Customized metal posts have been successfully used to restore endodontically treated teeth due to their excellent physical properties. To improve custom made post's marginal fit and its survival probability, cement volume is reduced. This provides excellent retention.[1]

The concave surface of the root canal can now be transformed into the convex surface of a post partially due to digital technology. This lessens the likelihood of root fracture while improving the biomechanics of endodontically treated teeth.[4] In this technique, an elastomeric material (GC flexceed) is used to make an intra canal impression which is scanned before the post is designed. It is important to point out that a post does not strengthen or reinforce a tooth.[5] This can be achieved only in case of perfect cohesion between post and tooth, which is partially achievable by fulfilling the following standard parameters for post placement in a tooth with normal periodontal support:

1. It should be 2/3rd the length of canal.
2. Radicular extension of the canal space should be at least equal to the coronal length of the core.[5]

Factors influencing clinical survival rate and prognosis of post restoration are loss of post's retention and root fracture.[4] Debonding is the most common failure of post. A post that is more than 2mm shorter than the prepared post space may cause endodontic lesions, breakage, and decreased retention. A greater cervical cement thickness is related to high microleakage.[1]

MATERIAL AND METHODS

For this in vitro investigation, twenty first and second permanent mandibular premolar teeth that needed to be extracted for orthodontic therapy were chosen. The teeth had patent apexes, were single-rooted, free of fractures, and non- carious. They had no anatomical or pathologic root deviations.

The teeth with any possible vertical or horizontal cracks were excluded. All the teeth after extraction, were rinsed under running water, cleaned and curetted. All the external debris was removed with an ultrasonic scaler. The teeth were stored in sterile distilled water in a fridge (4-5°C) until the end of research. The teeth were handled with latex gloves and the water was changed every week.

All the teeth were sectioned with a diamond disc, 2mm coronal to cement enamel junction under water irrigation.

Using a standard step-back technique and stainless-steel endodontic files (K- files=21mm; kerr corp.), root canal of each tooth was instrumented. During instrumentation the canals were extensively irrigated with 3% sodium hypochlorite (Septodont). After preparation the smear layer was removed with 17% ethylene diamine tetra acetic acid (EDTA; Prevest).

The root canals were once again rinsed with normal saline and dried with paper points (Dentsply). A no.40 master file was used to prepare the apical third.

Endodontic obturation was done using lateral condensation technique with a master and accessory gutta percha points (Dentsply) and AH Plus sealer (Dentsply). Using a warm condenser, any excess material was removed. The apical and coronal openings were sealed with a temporary restorative material. All the samples were kept in distilled water at 37°C for 7 days.

Using upto no. 4 peeso reamer, gutta percha was removed after one week of obturation, leaving 5 to 6mm in the apex. To complete the preparation, the teeth were irrigated with normal saline, and divided into 2 groups (conventional and digital) using stratified random allocation. In conventional group, pattern wax was used to prepare the post and core. Core of 4mm was formed. The post pattern was immediately invested with a phosphate bonded investment and casted with type IV Cobalt based dental alloy.

In the digital group, an impression was made using custom tray and light body (a-silicone; flexceed). Next, prefabricated plastic posts were used with impression material to record the canal. Following this, a complete impression was taken and impressions were scanned using a laboratory scanner (Medit i500) after polymerization to acquire virtual digital models. The nexocad software was used to construct the post and core models with a cement space of 20 micrometer (figure 1). The post cores were printed using Cobalt-chromium powdered alloy (RitonRC01) indirect metal lasers intering machine. Under 0.5mPa pressure, all post-cores were polished, finished, and abraded with 150-micron aluminum oxide.

In accordance with the instructions provided by the manufacturer, ZnPO4 cement was used to cement the posts. Each post was coated with mixed cement and cement was inserted into the root canal with a lentulo spiral in clockwise manner. Finger pressure was used to seat the posts.[1]

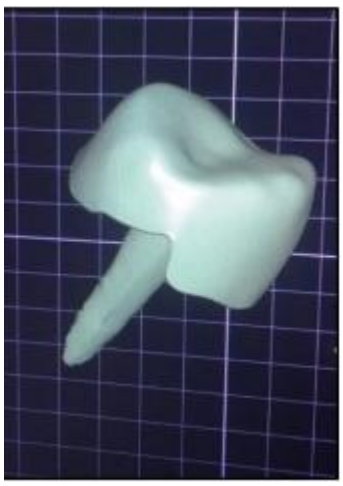

Figure 1: Virtual digital model with a cement space of 20 micrometer.

A radiovisography was used to evaluate the distance between the post and remaining apical gutta percha. All the apical gap readings were measured, and mean value was recorded.

A ruler tool in image editing software (adobe photoshop; cc) was used to perform all the measurements (figure

2) Each image was calibrated using the known dimension of the post.

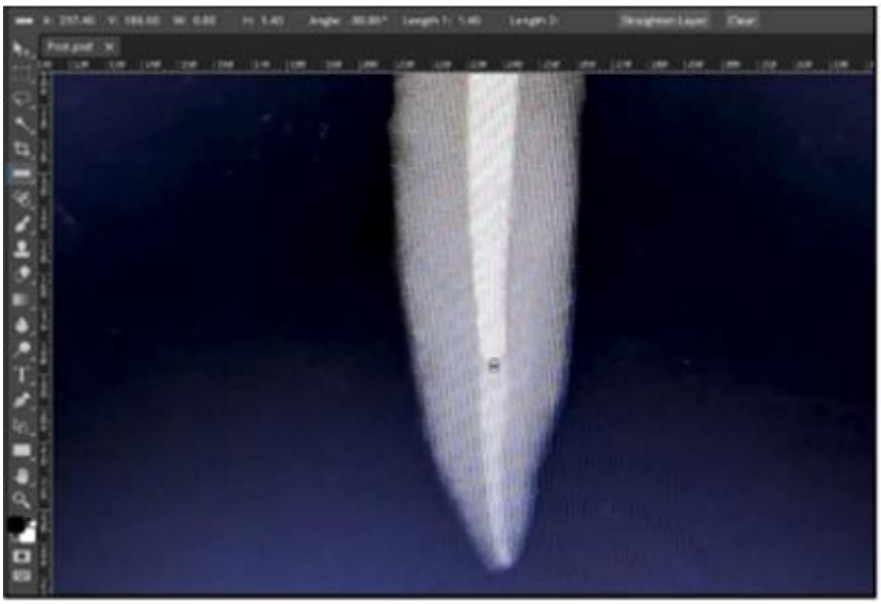

Figure 2: A ruler tool in image editing software to perform all the measurements.

Software for statistical analysis was used, SPSS, version 22.0 from IBM Corp. Student T test was used to compare differences in gaps betweentwo fabrication methods.

RESULT

Table 1: Comparison of gap between post and core and the tooth in the apical region fabricated by conventional and digital technique.

Techniques	No. of Samples	Mean	Standard Deviation
Conventional	10	0.95	0.35
Digital	10	1.09	0.39
P>0.42 t=0.82 df=18			

20samples were examined in this study in which the mean±standard deviation of conventional technique is 0.95±0.35 and digital technique is 1.09±0.39. There was no significant difference in prepared post space among the two techniques as p>0.42 (table 1).

Although, the teeth fabricated using the conventional direct technique have the least apical gap compared to digital technique (figure 4).

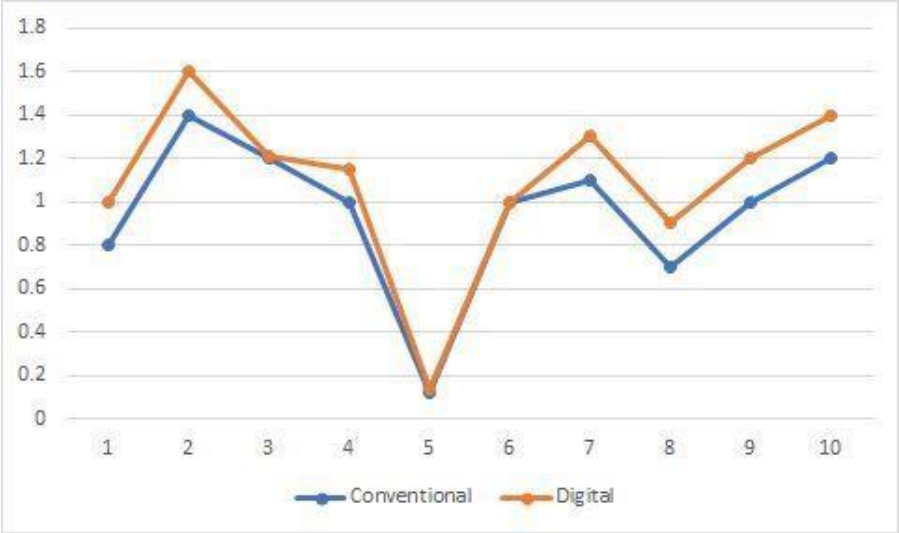

Figure 4: Correlation of apical gaps in conventional and digital post and core fabrication techniques.

DISCUSSION

After endodontic therapy, an appropriate restoration is essential to provide a strong coronal seal and to preserve the remaining tooth structure. Teeth without two or more walls require endodontic posts restoration for an increase in retention and stability improving the outcome of the therapy.[6] The accuracy of post placement, particularly in relation to the apical gap, is a critical factor in the success of post and core restorations.[1] In this study, we aimed to compare the accuracy between conventional and digital post and core techniques in terms of the apical gap by measuring the gap between the tip of the post and remaining apical gutta percha using periapical radiograph.

As there were no statistically significant differences in accuracy among post and cores made using various fabrication techniques, the null hypothesis that posts made using digital impression, an intraoral scanner and 3D printing technology would be as accurate as those made using a direct technique with casting was accepted.

Based on the results of this study, a larger apical gap was observed in digital technique as compared with the conventional technique. This can be explained by the fact that in digital fabrication technique, insufficient space makes it difficult to ensure the flow of light body material leading to air entrapment at the canal end.[1]

Rayyan etal(2016) in his previous study had compared the accuracy of post and core fabricated with direct and indirect technique. It revealed that direct fabrication and novel indirect fabrication technique(3D printing and milling)had no effect on post accuracy[7] since there was a similar fit of the post in the canal. The accuracy of post and core has been found to be important for prognosis of endodontically treated tooth. Moshonov et al in 2005 showed the relation of periapical problems and the gap between gutta percha and post. It recorded that the presence of gap between post and gutta percha causes more periapical problems than when the gap was absent.[8]

Hendietal(2019) in a similar, previous study measured the gap from gutta percha to the tip of the post using periapical radiograph to determine the accuracy and had significantly different results in all three groups. Their study showed results contradictory to our study as apical gaps and retention were significantly different.[1] However, Piangsuk, T. (2023) carried out a study about new fabrication techniques for a post and core. The results of the volumetric comparison in his study revealed that there was no evidence of statistically significant difference in accuracy among 3D printing, milling and direct technique for post and core fabrication.[9]

Pitigoi-Aron etal carried out a study comparing indirect and direct techniques to fabricate cast post and core in nine endodontically treated human premolars. They found that the indirect method provided CPCs with a better fit and higher accuracy.[10]

In our study, the measured values of the gap were less than the acceptable clinical cutoff point of 2mm, which defines acceptance of all the posts after cementing, below which dislodgment and fracture may occur.[11] Jafarian etal. supported this as in their investigation, which had mentioned that the cast posts and cores made from the conventional direct impression were better fit in the round and oval canals compared to ones fabricated using fully digital system (milled posts and cores).[11]

Post fabricated using digital technique was unable to record the post space's terminal end with the same level of accuracy as post fabricated using pattern wax. However, the coronal part of canal was well captured with scanner in digital technique. According to Khanduti etal in 2021, since the accuracy of the post fit in the cervical portion is most important, no significant difference between groups was seen in the distance or space area within the post and canal walls. However, the direct casting method was substantially more precise than the digital method in apical part.[4]

Research by Merve Benli et al showed that digital impression technique gave similar results compared with the conventional group indicating that post and cores fabricated with the digital technique could be anal ternative to conventional casting for metal-post-and-core fabrication.[12]

Many studies also examined the survival time of custom-fabricated, cast post and cores by evaluating, type of prosthetic restoration, location (upper, lower jaw), type of tooth (anterior, premolar, molar), age of the post and cores, fabrication technique (direct, indirect), number ofroot posts,postand core alloy and luting material. Balkenhol et al in their study observed that post and cores luted with phosphate cement exhibited the highest survival probability compared to the post and cores luted with glass ionomer cement. GIC as a luting agent has a higher risk of failure with high-gold alloy. High gold containing alloy has significantly higher survival probability compared to the posts fabricated from a semi-precious alloy.[13]

The in-vitro aspect of this study limited the effectiveness of both approaches in comparison to clinical settings, where factors like saliva and temperature may affect outcomes. The impressions were made in laboratory easily but space in the oral cavity had an effect on clinicians' accuracy leading to an impact on the final results. Thermal change of the light body impression material was not duplicated which could possibly led to in accuracy. Since digital radiography had been used to estimate the gap, none of the accuracy-related characteristics were considered.[1] The accuracy of the apical gap is crucial for the long-term success of post and core restorations.[14] A minimal apical gap ensures optimal seal and reduces the risk of bacterial microleakage, which can lead to post-operative complications, such as recurrent caries and endodontic failure. Additionally, a precise fit and adaptation contribute to the overall stability and retention of the post, which is

critical for the restoration's longevity. One of the study's limitations is that the effects of saliva and temperature changes in the oral cavity were not replicated in our study.[15] Further research simulating the oral environment is advised, because it is possible that the results have been influenced by the situations in clinical practice.

CONCLUSION

Based on the results drawn on the basis of this invitro study, the following conclusions were drawn:

1. The conventional methods of producing posts and cores were more precise in terms of gap than digital methods.
2. Digital technique could be considered appropriate because they produce posts and cores with gap values that fall within the acceptable normal range.

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