


Radiographic Analysis of Posts Performed by Undergraduate Dental Students: A Cross-Sectional Study

Jumana Almaghrabi¹, Alhanoof Alesawi¹, Esraa Attar², Shatha Alshali² 

¹Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia; ²Oral Maxillofacial Prosthodontics Department, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia

Correspondence: Jumana Almaghrabi, Faculty of Dentistry, King Abdulaziz University, P.O. Box: 80200, Jeddah, 21589, Saudi Arabia, Tel +966 126400000, Fax +966 126952437, Email Jojo_m_1995@hotmail.com

Introduction: Post and core restorations for endodontically treated teeth must meet certain prosthetic criteria to ensure the success of the final restoration. The aim of this study is to evaluate the quality of posts performed by dental students at King Abdulaziz University Dental Hospital (KAUDH), Jeddah, Saudi Arabia, utilizing periapical radiographs and whether the prosthetic criteria were strictly met by students.

Materials and Methods: This cross-sectional study included 661 digital periapical radiographs of posts performed by 6th-year dental students from September 2018 to April 2019. The assessment included the following factors: patient's age, patient's gender, tooth type, and arch. Post-related factors including post type, shape, diameter, length, and status of the remaining gutta percha were also evaluated. Statistical analysis was performed using SPSS. Descriptive statistics were generated, and the association between different variables was determined using chi-square test at $p < 0.05$.

Results: Posts were used to restore maxillary teeth (67%), and were particularly placed in premolars (44%). The majority of used posts were prefabricated tapered fiber posts (90%). The results were as follows: post diameter equal to one-third of root diameter, 50% met criterion; post length equal to two-thirds of root length, 33%; post length equal to or more than crown height, 93%; absence of space between gutta percha (GP) and post, 74%; and length of the remaining GP equal to 3–5 mm, 68%. Overall, 11% of the posts met all the ideal prosthetics criteria.

Conclusion: Most qualities of post and core restorations that were radiographically assessed were found to be acceptable and within the recommended prosthodontic criteria.

Keywords: post and core, post diameter, post length, post shape, gutta percha length, prefabricated post, cast post

Introduction

When endodontic treatment is performed on compromised teeth whether badly decayed, heavily restored, or fractured, the mechanical integrity is affected. Access cavity preparation, dentin removal for standard endodontic treatment procedures, and optimal preparation for subsequent restorative treatment can affect the mechanical integrity of the tooth.¹ To compensate for such weakness, different materials and techniques have been introduced in terms of modern principles of post and core utilization. However, evidence is still insufficient especially in terms of randomized clinical trials in this field of dentistry.¹

The retrospective studies that have been conducted were mainly about the mode of failure and survival rates of posts and cores. The in-vitro studies that have been conducted reported the major factors that can affect the overall prognosis.² They specifically compared the different types of materials used in the fabrication of posts and cores, different shapes of posts, and cements used. Yet, these factors are not of as much importance as the amount and quality of the remaining coronal dentin.^{2–4} Other variables that play an important role in the prognosis of endodontically treated teeth include arch position, the opposing dentition, periodontal condition, and endodontic treatment.⁵ In 1999, Morgano et al stated:

Although there are abundant new materials accessible for the restoration of pulpless teeth, the prognosis of these teeth depends foremost on the application of sound biomechanical rules rather than on the materials used for restorations.⁶

The awareness of the complexity of restoring pulpless teeth has been improved over the past few decades, yet this subject is still controversial.⁷ Fracture is one of the major incidents encountered in endodontically treated teeth. It was found that the risk of fracture of endodontically treated teeth is 3 to 4 times greater than vital teeth.² Fennis et al reported a correlation between root canal therapy and fracture location; such fractures are more subgingival and catastrophic in nature. Moreover, the lack of strategic internal structures of such teeth increases cuspal deflection during function, particularly premolar teeth with MOD cavities and endodontically treated teeth. Doubling the cavity depth will increase the cuspal deflection by a factor of 8.^{1,8} Therefore, the amount of circumferential dentin is the most important factor for fracture resistance to vertical and horizontal forces.⁹

Whether or not an endodontically treated tooth will require extra-coronal coverage depends largely on the amount of the remaining tooth structure, location of the tooth in the mouth, and the amount of occlusal forces that are applied to the tooth. Anterior teeth with only simple access cavity preparation will need a simple direct composite restoration to fill out access opening unless extra-coronal restoration is indicated for esthetic reasons.¹⁰⁻¹² A definitive extra-coronal restoration is required in posterior teeth to prevent cuspal deflection.⁶

A post is indicated when there is inadequate remaining coronal tooth structure to retain a core to ensure the success of the future indirect restoration.⁶ Clinical assessment and diagnostic periapical radiograph are essential to determine the post type, length, and diameter.¹³

Literature states that tapered posts are less retentive than parallel ones with clinically acceptable retention for both types. It was reported that parallel-sided posts distribute stresses more evenly and provide greater resistance to tensile and shear stresses than tapered posts.¹⁴ Ideal post length should be as long as possible without compromising the apical seal. Post length should be equal to or more than the clinical crown height.¹⁵ Others recommended that post length should be equal to 2/3 of the root length, and should leave 3 to 5 mm of gutta percha (GP) apically.¹⁶ Shorter than ideal post length can lead to lack of retention and generation of stresses that can lead to root fracture. Post length appeared more important than post diameter in determining the relative stresses at the cervical region; short wide posts led to elevated stress concentrations cervically. However, posts placed beyond two-thirds of the root increased stresses in the apical region.¹⁷ Trabert et al suggested that post diameter should not exceed one-third of the root diameter at any location.¹⁸ Extensive preparations could increase probability of root fracture, and research has shown that root size in relation to post size had a direct effect on root fracture.¹⁹ As for the gap between the post and the remaining GP, ideally no gap should exist. This gap may house microorganisms that would compromise the result of the endodontic treatment, potentiating the emergence of periapical lesion.²⁰ The length of remaining GP that is needed to maintain apical integrity and a proper apical seal should range from 3 to 5 mm.²¹ There are no drawbacks in leaving more than 5 mm of GP without compromising the ideal length of the post.²²

A few studies on radiographic assessment of posts placed in dental schools have been conducted worldwide; only a few were reported in Saudi Arabia.²⁰⁻²⁷ In Brazil, there was a study that reported radiographic assessment of 1000 endodontically treated teeth, restored with cast posts and cores, which showed that only 6.7% were satisfactory.²⁰ Mattoo et al conducted a cross-sectional study in 2018 to evaluate the quality of posts done by 6th-year dental students at Jazan University. They assessed 343 periapical radiographs and found that the quality was clinically acceptable.²² Al Subait et al examined 189 teeth at the dental center of King Abdulaziz Medical City and reported a tooth survival rate of 27.1% and success rate of 72.1%.²⁵ Mathar and Almutairi assessed the quality of 421 posts performed by dental students at Qassim University using periapical dental radiographs, and reported clinically acceptable results.²⁷

Only few studies on radiographic assessment of posts at dental schools have been conducted worldwide. The aim of this study is to evaluate the quality of posts performed by dental students at King Abdulaziz University Dental Hospital (KAUDH) utilizing periapical radiographs and whether the prosthetic criteria were strictly met by students.^{28,29}

Materials and Methods

This cross-sectional study was conducted at KAUDH, Jeddah, Saudi Arabia. The study was approved by the Research Ethics Committee of the Faculty of Dentistry at King Abdulaziz University, and conducted in accordance with the

Table 1 Principal Guidelines for Post Space Preparation

Post diameter	Equal to 1/3 of the root width
Post length related to the root length	Equal to 2/3 of root length
Post length related to the crown height	Equal to or more than crown height
Length of the remaining gutta percha	Range 3–5 mm in length
The space between post end and root canal filling	No space present

declaration of Helsinki. Informed consent was obtained for the review of dental records. Samples included digital periapical radiographs of 661 posts restoring endodontically treated teeth ($n=661$) by 6th-year dental students from September 2018 to April 2019. Data collection was based on information obtained from the student logbook and R4 program (CSR4 software, Carestream Dental LLC, USA). Allocated data for each sample were recorded in a form designed specifically for this study. If a radiograph of the post is not available or if the radiograph was of poor diagnostic quality, the sample was excluded.

FOCUS™ Intraoral X-ray imaging unit (KaVo™, Finland) was used. The unit produces high-quality dental images with a digital sensor. The sensor type is RVG using film xcp holder to adjust the position. Exposure is set at 60 or 70 kV and exposure time between 0.02 and 3.2 seconds, adult mode. The exposure time is based on the tooth type, patient size, and exposure mode. The patients' radiographs are viewed on the R4 system through "Kodak Dental Imaging". Data were collected and entered into an Excel spreadsheet by two calibrated dental interns. Data were considered "ideal" if falling under the guidelines given in Table 1.

Statistical analysis was performed using SPSS software (version 21, SPSS, Chicago, Illinois, USA). Descriptive statistics were generated, and the association between different variables was determined using the chi-square test at a significance level p value of 0.05.

Results

A total of 206 female patients and 116 male patients were included. The number of posts performed in patients between the ages of 18 and 35 years old were 329 posts (50%), while 155 posts (23%) were placed in patients between the ages of 36 and 45. One hundred and seventy-three posts (26%) were placed in patients older than 45 years old, and only four posts (1%) were placed in patients younger than 18.

Data were obtained from 661 postoperative periapical radiographs ($n=661$). Prefabricated fiber posts were used in 90% of the cases ($n=592$). Ninety-two percent were tapered in shape ($n=611$), and 8% were parallel-sided posts ($n=50$). Only 10% of the posts ($n=69$) were custom-made. Most of the teeth restored with posts were premolars (44%), followed by anterior teeth and molars (30% and 26%, respectively). Maxillary anterior and premolar teeth were most frequently restored by posts (27.4% and 27.2%, respectively), followed by mandibular premolar teeth (16.8%). Posts were more frequently used in the maxillary arch (67%) (see Table 2).

Posts were assessed according to the ideal prosthetic criteria. The following percentages accounted for posts that were classified as "ideal":^{16,18} post diameter equal to one-third of root diameter (50%), post length equal to two-thirds of root length (33%), post length equal to or more than crown height (93%), absence of space between GP and post (74%), length of the remaining GP equal to 3–5 mm (68%) (Figure 1).

Table 3 lists the breakdown of the assessed prosthetic criteria. Overall, 11% of the posts met all the ideal prosthetics criteria.

Discussion

The assessment of endodontically treated teeth restored with post and core restorations is based on specific criteria evaluated both clinically and radiographically. Results of the present study are based on radiographic assessment only using periapical digital radiographs.

Table 2 Post Frequency and Percentage in Relation to Arch, Type of Tooth, Type of Post, Shape of Post

Post Criteria		Frequency	Percentage
Arch	Mandibular Arch	217	33%
	Maxillary Arch	444	67%
	Total	661	100%
Type of tooth	Anterior tooth	201	30%
	Premolar tooth	291	44%
	Molar tooth	169	26%
	Total	661	100%
Type of post	Custom-made	69	10%
	Prefabricated fiber	592	90%
	Total	661	100%
Shape of post	Parallel	50	8%
	Tapered	611	92%
	Total	661	100%

The present study revealed that posts were more frequently used in maxillary teeth. These results supported the findings by Jamani et al, Al-Hamad et al, Mathar and Almutairi, and Mattoo et al.^{22,24,26,27} Our findings showed that most of the teeth restored with posts were premolars, followed by anterior teeth then molars. Our results agree with findings reported by Mathar and Almutairi, where 57.2% of the cases were premolars. These results disagree with some previously reported findings by Jamani et al and Al-Hamad et al, who reported that the most frequently restored teeth with posts were incisors followed by premolars.^{24,26,27}

The results of the present study showed that tapered prefabricated fiber posts were used in most of the cases (92%). Similar findings were reported by Mattoo et al (81%), Al-Hamad et al (62%), Mathar and Almutairi (89.1%), and Jamani et al (74%).^{22,24,26,27} This can be due to the fact that they are more conservative to the radicular dentin.³⁰

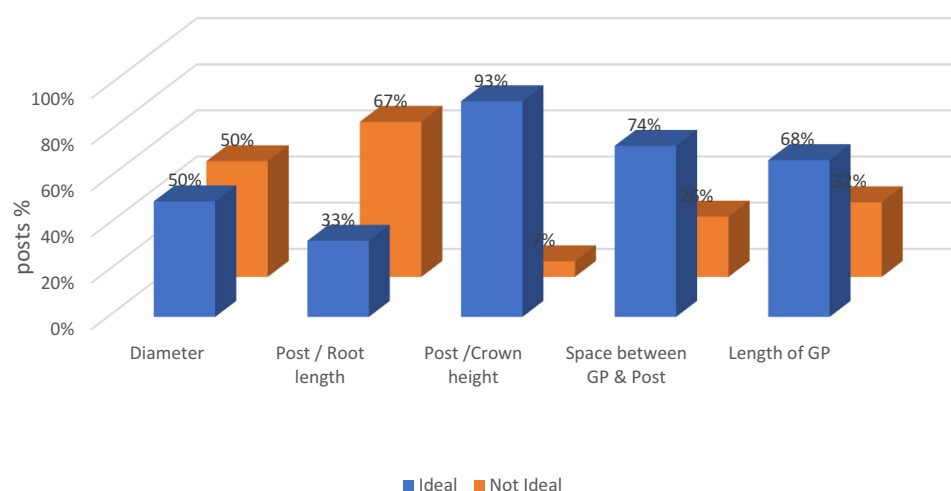
**Figure 1** Percentage of prosthetic criteria assessed (n=661).

Table 3 Overall Frequency and Percentage of Post Principles (Post Width, Post Length, Presence of Space, and the Length of Remaining Gutta Percha (GP))

Post Principle		Frequency	Percentage
Post width	Less than 1/3 of the root	293	44%
	Equal to 1/3 of the root	330	50%
	More than 1/3 of the root	38	6%
	Total	661	100%
Post length: root length	Less than 2/3 of the root	405	61%
	Equal to 2/3 of the root	217	33%
	More than 2/3 of the root	39	6%
	Total	661	100%
Post length: crown height	Less than crown height	44	7%
	Equal to crown height	126	19%
	More than crown height	491	74%
	Total	661	100%
Presence of space	Yes	172	26%
	No	489	74%
	Total	661	100%
Length of GP	Less than 3 mm	48	7%
	3–5 mm	448	68%
	More than 5 mm	165	25%
	Extended beyond the apex	35	5%
	Total	661	100%

In this study, a 2:1 ratio of post length:crown height was identified in 93% of the cases, which is much higher than the values reported by Mattoo et al (58%), Al-Hamad et al (37.9%), and Mathar and Almutairi (25.4%).^{22,26,27} However, this study showed lower values in terms of post length to root length (33%) in comparison to Mattoo et al (40.5%)²² and Mathar and Almutairi (60.8%) but was superior to the results of Jamani et al and Nimigeen et al (39.64% and 29.91%).^{23,24,27}

In terms of post diameter to root diameter, 50% of the cases in our study were equal to one-third. Much higher values were reported by Mendonca et al, Mattoo et al, and Mathar and Almutairi (80%, 82%, and 89.1%, respectively),^{20,22,27} whereas Nimigeen et al, Minguini et al, and Vital et al reported ideal results of 41%, 40%, and 45%, respectively.²³ These differences can be attributed to the small sample sizes used in their studies or due to the lack of expertise of the operator.

In our study, 74% of the cases showed absence of space between GP and the post. This observation is explained by the assumption that the student who performed RCT was also the one who proceeded with post preparation and the most knowledgeable regarding the presence of the area of root curvatures and further apical preparations.²² This value was similar to the results reported by Mattoo et al (75%) and higher than that reported by Mendonca et al (51.9%).^{20,22}

A total of (68%) of assessed cases in our study showed 3–5 mm of remaining GP in comparison to 55.7% of assessed cases in the study done by Meshni et al, and 28% of the cases reported by Mathar and Almutairi.^{22,27}

To be able to bring scientific evidence for clinical decision-making, further studies are recommended to observe data for a few years. Close clinical evaluation along with radiographic assessment is crucial for the success of the restorations of endodontically treated teeth with post and cores.

Conclusion

Most qualities of post and core restorations that were radiographically assessed were found to be acceptable and within the recommended prosthodontic criteria.

Disclosure

The authors report no conflicts of interest for this work.

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