

Radiographic Assessment of Post-retained Crowns in an Adult Jordanian Population

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Abstract

Aim: The objective of this study was to radiographically assess and compare the quality of post-retained crowns fabricated at the Dental Health Centre of the Jordan University of Science & Technology (JUST).

Methods and Materials: Study data were collected in 2002 from existing dental records for all patients receiving treatment with post-retained crowns between October, 1997 and June, 1999. The posts were assessed radiographically to evaluate various aspects of the quality of post-retained crowns. All 129 posts were fabricated in the dental school.

Results: The most-frequently restored teeth were the maxillary incisors (38.8%). Sixty-two percent of the posts were tapered, while 38% were parallel-sided. The mean length of the posts was 0.95 mm (SD 0.41) with a range between 0.22-2.85 mm. Caries was diagnosed radiographically in 10.8% of cases with lesions located on root surfaces in 64.3% of them, while 35.7% of lesions were within the root canal. Three posts (2.3%) were deviated from the line of the root canal in the mesio-distal plane. No evidence of root filling was found in 2.3% of the cases. In the remainder of teeth 15.5% had gutta percha extended to the radiographic apex of the tooth, while 59.7% fell 0.5-1 mm short of the radiographic apex. Gutta-percha was extruded beyond the apex in 22.5% of the teeth. Space between the end of the post and the root filling was found in 22.2%. The percentage of canals with apparently completely healthy periapical tissue was 51.2%. In the rest of the cases 34.8% had areas of radiolucency at or near the root apices and 14% demonstrated widening of the periodontal space around the root apex. Root resection had been completed in 2.3% cases. Signs of external resorption were apparent in one case (0.78%).

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Conclusion: The standards of the treatment of the endodontically treated teeth made at the dental hospital were satisfactory but could be improved by a controlled academic supervisory environment and a strict scientific approach to fixed prosthodontics within the dental school.

Keywords: Post, design, assessment, quality, radiographs

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Introduction

The subject of the restoration of the endodontically treated teeth has been evaluated and discussed widely in the dental literature. There is still, however, much confusion regarding the ideal treatment despite the large number of *in vitro* and *in vivo* studies.¹⁻⁹

There are several factors that make the endodontically treated teeth a unique subset of teeth requiring restoration. The dentin of the non-vital teeth was thought to be significantly different from the dentin of vital teeth.^{10,11} However, more current research casts doubt on this assumption.^{12,13} Other factors that were reported in the dental literature include the amount of tooth structure lost during access cavity preparation¹⁴ and the effect of neuromuscular feedback loss after the removal of the pulpal tissues.¹⁵

The restoration of endodontically treated teeth is essential for long-term success and survival of the teeth.¹⁶ Unfortunately failure of post-retained crowns (PRCs) occurs frequently in clinical practice. Roberts¹⁷ found the failure rate of PRCs was higher than other advanced dental restorations and the reasons for failure are numerous.^{18,19} In the review of the clinical complications of fixed prosthodontics, Goodacre et al.²⁰ recently reported a different incidence of complications than those reported by Roberts. Posts and cores and conventional single crowns were found to have a comparable incidence of clinical complications, and both had a lower incidence of complications than resin bonded bridges and conventional fixed partial dentures. Several studies²¹⁻²⁹ discussed the factors that influence the retention of posts. The radiographic assessment studies of PRCs lead to the conclusion adherence to endodontic principles and careful post preparation and cementation were more important than the choice of a particular post

design or material for a successful outcome.^{30,31} On the other hand, Aksoy et al.³² reported the direct fabrication of cores on prefabricated posts were influenced by the choice of materials used. The use of adhesive resin was found to have a strengthening effect on the dowel-head retention of the core materials.

In view of the reported high failure rate of PRCs a study to point out the clinical errors which may lead to failure might be of importance to clinicians. The present study was undertaken to assess and compare radiographically the quality of PRCs made and fitted the Dental School of the Jordan University of Science & Technology (JUST).

Methods and Materials

Study data were collected in 2002 from existing dental records in the Department of Restorative Dentistry of the Dental Health Centre at the JUST. An existing treatment data base identified all patients receiving PRC treatment between October, 1997 and June, 1999. The data collected were from patients attending the Restorative Department for routine care or from patients who were referred to the department by general practitioners for a variety of reasons. The dental records were investigated, and those with no radiographs of the posts were excluded. Only radiographs of good diagnostic quality were included in the study. The parallel radiographic technique and Ektaspeed Plus Film[®] (Kodak, Japan) was employed in the dental hospital. Radiographs had to include a good view of the post and core to be included in the study. The final sample consisted of 129 posts from 100 patients of which 54 were females (54%) and 46 males (46%). The mean age of the patients was 29.3 years (SD 8.8) ranging between 16 and 56 years.



One observer examined all radiographs using a standardized viewing method. Films were examined in a darkened room using an illuminated view box with a magnification of 3.5X. The radiographs were mounted in a cardboard slit to block out ambient light emanating from the viewbox. The examination of the radiographs was carried out according to the technique used by Grieve and McAndrew³⁰; the outlines of the root, root-canal, and post were traced on a tracing paper and lines were drawn through the long axes of the outlines of the posts and root canals. Subsequently, measurements were made with a clear plastic ruler and a protractor. The tracing was completed by the same observer to ensure compliance with the measurement criteria and maintenance of acceptable intra-observer reproducibility. An assessment was made of the posts and crowns and the following data were recorded:

- Date of insertion
- Teeth involved and number per patient
- Post length {in mm}
- Presence of caries
- Presence of deviation of the post from the root canal

A similar qualitative assessment was made for the root canal fillings. The assessment was performed following the European Quality Guidelines for Endodontic Treatment.³³ The root canal treatment was considered unsatisfactory if there were voids or defects either within the root filling or between the filling and the root canal wall. The periapical condition was also assessed, and the distance between root apex and end of post was measured in millimeters.

Results

Seventy-seven patients of the 100 patients in the study had one post, 20 patients had two posts, and three patients had four posts resulting in a total of 129 posts. The mean time interval since insertion of the posts was 23.2 months (SD 26.4) with a range of 9-122 months.

Table 1 provides distribution of the teeth restored by PRCs. The most-frequently restored teeth were the maxillary incisors (38.8%).

Table 1. Distribution of the 228 teeth restored with PRCs.*

	Maxillary Teeth	Mandibular Teeth
Incisors	50 (38.8%)	12 (9.3%)
Premolars	36 (27.9%)	19 (14.7%)
Molars	4 (3.1%)	8 (6.2%)
Total	90 (69.8%)	39 (30.2%)

*The sample did not include either canines or third molars.

Eighty posts were tapered (62%), while 49 (38%) were parallel-sided (Figures 1 and 2).

All the tapered posts were fabricated using the indirect impression technique. The parallel-sided posts were prefabricated titanium (Radiax-Ankor[®], Dentsply Maillefer, Ballaigues, Switzerland). To minimize variation in measurements due to variation in radiograph techniques used, the length of the post was expressed as the post-to-crown length ratio (the length of the post divided by the length of the crown).³¹ The mean length of the posts was 0.95 mm (SD 0.41) with a range between 0.22-2.85 mm.

Caries was diagnosed radiographically in fourteen cases (10.8%). Nine of them (64.3%) had carious lesions on the root surface, while in five cases (35.7%) the lesions were within the root canal. Three posts (2.3%) were deviated from the line of



Figure 1. Prefabricated titanium post (Radiax-Ankor®, Dentsply Maillefer).

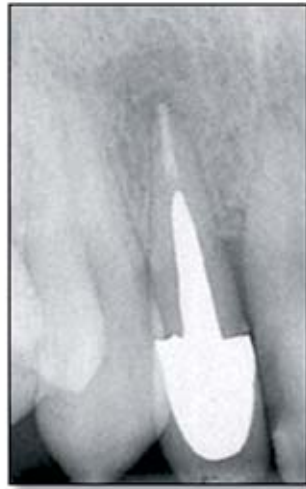


Figure 2. Cast tapered post.



Figure 3. Post on upper lateral deviated from the line of the root canal (in mesiodistal plane).



Figure 4. Gutta percha extruded beyond the apex.



Figure 5. Post made on a tooth with radiolucency associated with the root apex.

the root canal in the mesiodistal plane (Figure 3). The average angle of deviation was 6.8° (SD 5.2) with the range being between 2.5°-19.5°.

Radiographic examination revealed three (2.3%) of the cases were devoid of root canal filling (Figure 1). Twenty-five cases (15.5%) had the gutta percha filling ending at the radiographic apex of the tooth, while in seventy-seven cases (59.7%) it ended 0.5-1 mm short of the radiographic apex. In twenty-nine cases (22.5%) gutta percha was extruded beyond the apex by distances ranging between 0.4 and 6 mm (Figure 4). Condensation of gutta percha was not satisfactory in six cases (4.7%).

The total number of canals that were root filled was 126. Twenty-eight (22.2%) of these canals had a space between the end of the post and the root filling (Figure 5). The mean length of the space was 1.03 mm (SD 0.36) with the range being 0.3-4.5 mm. Forty-five roots (34.8%) had areas of radiolucency associated with root apices (Figure 5).

Eighteen (14%) demonstrated widening of the periodontal space around the root apex. Sixty-six (51.2%) appeared to have apparently complete healthy periapical tissue. Root resection had been completed in three (2.3%) cases. Signs of external resorption were apparent in one (0.78%) case.

Table 2. Comparisons between posts made and fitted at the dental school and those made and fitted in private practice.

129 (56.6%)	Total number
75 (58.1%)	Post:crown length ratio ≥ 1
21 (16.3%)	Unsatisfactory fit of post to the walls of root canal
6 (4.7%)	Presence of caries
3 (0.78%)	Absence of gutta percha
63 (48.8%)	Radiolucency associated with root apices and widening of periodontal ligament
6 (4.7%)	Apical gutta percha <3mm
3 (2.3%)	Deviation of post
0 (0%)	Perforation
6 (4.7%)	Unsatisfactory condensation of gutta percha
7 (2.3%)	Extruded gutta percha
1 (0.78%)	External resorption

Discussion

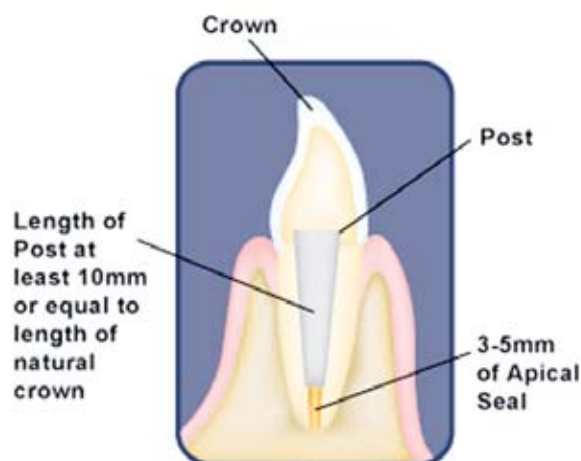
The assessment of post length was expressed as a proportion of the radiographic length of the post to the crown length rather than a finite measurement of the post because not all radiographs had been taken by the same operator using identical technique. According to Grieve and McAndrew³⁰ the actual measurements were taken in other aspects of the study, such as, the defects between the end of the post and the root filling. These measurements were generally small and, hence, less affected by the radiographic technique.

In the present study the teeth most frequently restored by PCR's were the maxillary incisors which reflect their greater susceptibility to trauma and esthetic value to the patients.

Although it is generally accepted the tapered smooth post is the least retentive,^{34,35,36} this design was more widely encountered in this study (62%). Similar retrospective studies^{37,38} carried out on a total of 1273 root treated teeth concluded tapered posts had the lowest success rates resulting in extraction of one-third of the treated teeth.

Absolute guidelines for optimal post length are difficult to define. Ideally the post should be as long as possible without jeopardizing the apical

seal or strength and integrity of the remaining root. Maintaining an apical seal of 5 mm is considered satisfactory.³⁹ It is generally accepted the length of the post into the root canal should normally be at least 10 mm or equal to the length of the natural crown as measured from the gingival margin of the preparation.^{40,41} In the cases of short roots and tall clinical crowns an apical seal of 3 mm is considered acceptable.⁴² Generally, 3-5 mm is needed to maintain the integrity of the apical seal.⁴³ Nevertheless, post length ranging from 8 to 12 mm, depending on the length of the root, is generally considered satisfactory.⁴⁴ A long post will not only ensure optimal alveolar bone support but



will also benefit stress transfer and retention.⁴⁵ On the other hand, excessively long posts that enter the narrow apical part of the root may weaken it⁴⁶ and disturb the apical seal.⁴⁷ One study¹⁹ reported the acceptable post length was achieved in only 18% of the cases. In our study the acceptable post length was achieved in 58% of the cases. Although there was a wide range of post lengths, the shortest was less than a quarter of the length of the crown. This will obviously result in reduced retention and allow the crown to act as a lever, which might result in root fracture.³¹

With regard to the apical seal, recommended 3-5 mm distance from the apex was achieved in most of the cases in this study; only 4.7% of the cases had less than 3 mm apical gutta percha.

Approximately 16% of the posts had an unsatisfactory fit along the walls of the root canals. This poor fit could lead to early loss of restorations, microleakage, and caries. One of the possible explanations for this defect is a poor canal impression technique. This may also account for the high proportion of cases (28 cases) that showed a space between the end of the post and root filling. However, post adaptation to the canal walls remains a controversial subject. The ideal lute thickness has been suggested as 24-40 μm .⁴⁸ A thicker lute may not lead to increased cement strength but may actually impair post retention.^{49,50} Conversely, it has been stated cement thickness has little effect on post retention.⁵¹ Although it has been proposed a loose fitting post can create a long lever arm, definitions of loose-fitting and well-adapted post appear to be vague. The thickness of cement becomes critical if the fit of the post is compromised. A relatively well-adapted post, which is not tight within the canal, would appear to fulfill the criteria of stress transfer and retention.⁴³

Endodontically treated teeth should have a well-condensed gutta percha filling terminating 0.5 to 1 mm from the radiographic root apex.⁵² This ideal apical relationship was achieved in about 60% of the cases in the present study.

Our study showed the root fillings of about 4.7% of the cases were inappropriately condensed and in 2.3% there was no evidence of root canal filling. This demonstrates a compromised standard of root canal treatment and emphasizes

the importance of assessing the presence and/or the quality of a root filling before proceeding with post fabrication. The traditional goal of PRC treatment is a well-fitting, biologically sound, and anatomically designed restoration supported on a sound endodontic foundation. Therefore, it is essential for the clinician to assess the quality of the root filling before a root-filled tooth is restored particularly if it was placed by another operator.⁵³

The retrospective study of Turner¹⁸ on failed post crowns found many failures were associated with unsatisfactory endodontic therapy. However, Vire⁵⁴ examined the causes of failure of all root-treated teeth regardless of the type of restoration and found endodontic treatment failures contributed to 7% of all failures.

In the present study the relatively high percentage (34.9%) of cases with periapical radiolucency or widening of the periodontal ligament does not necessarily indicate active pathology. Since the endodontic history was not available for some of the cases, it is difficult to draw conclusions from the radiographic evidence of the periapical radiolucent areas alone. It is possible a number of cases had been root filled recently and had incomplete periapical healing.

Poor impression technique or poor laboratory work may have accounted for the cases that had a space between the end of the post and the root filling. In some cases the post space may have been prepared adequately with regard to length but the preparation was not optimally utilized to extend the post fully into the prepared canal. It may be that a use of good impression material and technique would help to reduce these problems. Perhaps the use of either pre-formed or burn-out style posts rather than simply taking impressions of post holes would reduce the problem of inadequate post fit.³¹

Conclusions

This study showed the ideal design characteristics of post crowns were achieved satisfactorily in the majority of the cases. This could be improved by a controlled academic supervisory environment and a strict scientific approach to fixed prosthodontics within the dental school. A revision of the courses in the field of fixed prosthodontics at some dental schools would be beneficial.

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