A retrospective analysis of initial posterior root canal therapy on United States Air Force personnel

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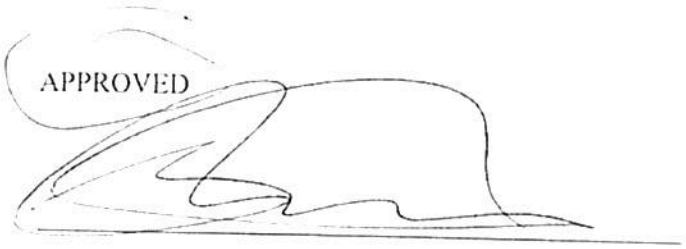

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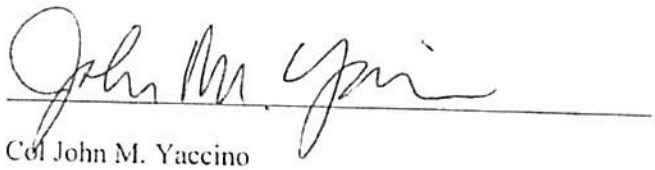

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A retrospective analysis of initial posterior root canal therapy on United States Air Force personnel

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Abstract

Introduction: The Air Force Dental Service (AFDS) has established evidence-based treatment standards for endodontics, including use of rubber dam, cuspal coverage restoration of endodontically treated posterior teeth, and three-dimensional filling of the canal system regarding length, taper, and density. The purpose of this retrospective study was to determine the effect of these standards on treatment outcomes of initial posterior root canal therapy (RCT) completed by Air Force (AF) dentists and to compare these outcomes with treatment referred to civilian providers.

Methods: Treatment and follow-up radiographs of AF members who had an initial posterior RCT completed in 2011 were evaluated. A survey of all radiographs was done to determine the (1) RCT obturation quality, (2) presence of pre- and postoperative periapical pathosis, and (3) presence and quality of cuspal coverage restorations.

Results: A total of 2,262 RCTs were examined with 1,960 RCTs meeting inclusion criteria for at least one evaluation category. For RCT obturation quality, 1,810 RCTs were evaluated and 96.0% were considered adequate. For cuspal coverage restorations, 1,856 RCTs were evaluated and of these 2.7% were inadequately restored. Incomplete and complete healing of preoperative lesions was 91.5% and 85.7% for AF and referred civilian providers, respectively. Survivability was 94.7% for AF endodontists, 94.4% for AF general dentists, 93.9% for civilian endodontists, and 78.4% for civilian general dentists. Overall, survivability was 94.1% (mean of 27 months).

Conclusions: In this radiographic analysis, evidence-based practices as followed in the AFDS and additional training resulted in improved treatment outcomes.

Introduction

Endodontics is rich with research identifying factors that positively influence root canal treatment (RCT) outcomes. Research identifies numerous factors, some of which include the use of a rubber dam (1), apical preparation size (2), position of obturation material in relation to radiographic apex (3), and cuspal coverage restorations (4-6). With this research, the Air Force Dental Service (AFDS) established evidence-based treatment standards for endodontics to ensure Airmen receive high-quality, safe dental care (7). These standards are taught at the two Air Force (AF) Postgraduate Endodontic Residencies, the 12 Advanced Education in General Dentistry Residencies (AEGD), and at AF bases worldwide through continuing education lectures. Adherence to these evidence-based standards is evaluated through the service's monthly peer-review program that reviews treatment notes and radiographs. These treatment standards are necessary for an Airmen population, who commonly find themselves on short-notice deployments to remote locations where dental services may be nominal.

According to the 2006 American Dental Association Survey of Dental Services Rendered, general dentists complete over 72% of RCTs annually. The majority of RCTs performed by civilian general dentists do not reflect evidence-based standards (8). Winward, et al evaluated nearly 3,500 posterior endodontically treated teeth, of which more than 52% of treatments were judged poor largely due to inadequate or irregular taper of obturation material, inadequate apical preparation size, voids in the obturation material, and obturation material considerably short of radiographic apex (8). In addition, lack of cuspal coverage restoration was associated with 97.5% of posterior endodontically treated teeth deemed hopeless and requiring extraction (8). This percentage is similar to Salehrabi and Rotstein, who did an 8-year outcome assessment of more than 1.4 million endodontically treated teeth and determined no complete coronal restoration was found in 85% of those teeth that required extraction (9). There have been many additional studies exploring the correlation between adequate coronal restoration and endodontic treatment success. Remarkably, Ray and Trope concluded the quality of the coronal restoration had a greater impact on treatment outcome than the quality of the endodontic treatment (4). In a systematic review, Gillen concluded both adequate endodontic treatment and adequate coronal restoration increased positive treatment outcomes (6). Furthermore, the use of a rubber dam during endodontic treatment is linked to higher success rates due to elimination of bacteria (re)contamination of the root canal system from the oral cavity (1, 11). However, it has been reported only 60% of general dentists always use a rubber dam during RCTs (12).

Dental implants have gained considerable popularity as a treatment option for diseased teeth, which previously would have been treated with endodontic therapy. Iqbal and Kim reported survivability rates greater than 95% for single-tooth implants (14), which is similar to the 97.1% survivability rate of endodontically treated teeth published by Salehrabi and Rotstein following their large epidemiological study (9). It is important to clarify the success and survivability rates of endodontic therapies performed to evidence-based standards, including cuspal coverage restorations, to assist providers with negotiating the best long-term treatment option for teeth requiring endodontic treatment.

The purpose of this retrospective study of initial posterior RCTs completed by active-duty AF and referred civilian providers through the Active Duty Dental Plan (ADDP) was:
1) To evaluate the RCT obturation quality,
2) To assess the presence of pre- and postoperative periapical pathosis,
3) To determine the prevalence of endodontically treated posterior teeth with complete cuspal coverage restorations, and
4) To compare data for RCTs completed by AF versus referred civilian providers, thereby determining any positive or negative trends in treatment quality.

Materials and Methods

A list of active-duty AF members who had an initial posterior RCT completed by an active-duty AF or referred civilian provider through ADDP between 1 Jul 2011 and 15 Oct 2011 was compiled. The providers were divided into endodontists and general dentists groups, and the AF general dentists were further divided based on their amount of additional training in an AEGD residency. The primary investigator reviewed all pre- and postoperative radiographs, including bitewing, periapical, and panoramic radiographs, taken as part of the initial posterior RCT using MiPACS dental enterprise viewer software (LEAD Technologies Inc, Charlotte, NC). The dates of any postoperative radiographs were recorded to calculate the recall and survivability periods. The images were de-identified, exported into a Microsoft Office PowerPoint (Microsoft, Redmond, WA) presentation against a black background without image compression preserving resolution and assigned an image number. Two board-certified endodontists jointly evaluated all images for (1) RCT obturation quality, (2) presence of pre- and postoperative periapical pathosis, (3) presence of cuspal coverage restoration, and (4) restoration quality.

The RCT obturation was considered adequate (OA) if radiographs showed obturation of all canals with a uniform taper free of voids and termination between 0-2 mm from radiographic apex. The RCT was considered inadequate (OI) if radiographs showed obturation with a minimal taper, voids, or termination beyond or greater than 2 mm from radiographic apex. Obturation was also judged inadequate if radiographs showed inadequately repaired perforations or separated instruments that could not be bypassed.

Periapical pathosis was classified as either present (PP) or absent (PA). Periapical pathosis was considered absent if the periodontal ligament space was normal to slightly widened. All other radiographic appearances were considered to have pathosis present. Postoperative periapical pathosis was also classified as healing (PH), if radiographs indicated reduced pathosis compared to preoperative radiographs.

Cuspal coverage restorations were categorized as adequate (RA) or inadequate (RI). Restorations were considered adequate if radiographs showed a cast crown or restoration with all visible cusps capped and intact margins. All other restorations were considered inadequate, which included radiographs indicating an interim restoration or crown determined by material radiodensity or presence of radiolucent space in access consistent with a cotton pellet.

Any disagreement between the 2 examiners was resolved by giving the evaluation category the more favorable classification.

Differences between groups were examined statistically using the Fisher's exact test. A *P* value <.05 was considered to indicate statistically significant differences.

Results

A total of 2,262 RCTs were examined with 1,960 RCTs meeting inclusion criteria for at least one evaluation category. Of the included treatment, AF and referred civilian providers completed 1,142 and 818 RCTs, respectively. AF endodontists, AF general dentists with 1 year additional training, and civilian endodontists completed more than 91% of the treatments included in this study.

For RCT obturation quality, 1,810 RCTs were evaluated and 96.0% were considered OA. For AF providers, RCT obturation quality was considered OA in 96.6% for AF endodontists, 87.7% for AF general dentists without additional training, 95.1% for AF general dentists with 1 year additional training, and 90.5% for AF general dentists with 2 years additional training. For referred civilian providers, RCT obturation quality was considered OA in 97.0% for civilian endodontists and 90.3% for civilian general dentists. There was a significant difference in obturation quality between AF general dentists without additional training and AF endodontists ($P = .004$), AF general dentists with 1 year additional training ($P = .04$), and civilian endodontists ($P = .0018$).

The second evaluation category was periapical healing. For periapical healing, more than 1,850 RCTs were evaluated overall. Postoperative radiographs were available for 301 of the 508 teeth considered to have pathosis leading to a 59% recall rate. For AF providers, 332 teeth were considered to have pathosis preoperatively. The recall rate was 57%, and the healing rate was 91.5%. For civilian providers, 176 teeth were considered to have pathosis preoperatively. The recall rate was 63.7%, and the healing rate was 85.7%. AF endodontists, AF general dentists with 1 year of additional training, and civilian endodontists each have a healing rate of periapical pathosis of greater than 85%. Table 1 shows the percentage of RCT with complete and incomplete healing for each provider category. The remaining three provider groups contained a relatively small sample size for this evaluation category ($n = \leq 8$). There was no statistically significant differences between the groups.

Overall, 1,856 RCTs were evaluated for cuspal coverage restorations, and of these 2.7% were classified RI. The survival of teeth with RA was 95%, which was significantly greater than the 86% observed for teeth with RI ($P = .013$). A total of 50 RCTs were classified as having RI, of which 10% were extracted and 4% were retreated.

Overall, for the 1,960 RCTs evaluated, the survivability was 94.1%. The follow-up period ranged up to 47 months with a mean of 27 months. For AF providers, survivability was 94.7% for AF endodontists, 87.9% for AF general dentists without additional training, 96.5% for AF general dentists with 1 year additional training, and 88.3% for AF general dentists with 2 years additional training. For referred civilian providers, survivability was 93.9% for civilian endodontists and 78.4% for civilian general dentists. There was a significant difference between civilian general dentists and AF endodontists ($P = .0008$), AF general dentists with 1 year additional training ($P = .0002$), and civilian endodontists ($P = .002$). In addition, there was a significant difference between AF general dentists

without additional training and Air Force endodontists (P = .047) and AF general dentists with 1 year additional training (P = .007), and between Air Force general dentists with 1 year additional training and those with 2 years additional training (P = .012).

Of the treatments included in this study, the extraction rate was 4% and the retreatment rate was 2%. Premolars were most likely to be extracted or retreated.

Discussion

Data collected in a retrospective radiographic analysis has limitations. It is difficult to accurately determine the RCT obturation quality by radiographic evaluation alone. Periapical radiographs, though the most commonly used determinant, do not reflect the three-dimensional aspect of the root canal system. It is possible obturation voids and missed canals, along with other evaluation criteria, were undetected resulting in an overestimation of RCT obturation quality. The same difficulties are encountered when determining the presence of cuspal coverage restorations by radiographic evaluation alone. It is possible that clinically restorations do not provide full cuspal coverage resulting in an overestimation of the presence of adequate restorations. These difficulties are further amplified when panoramic radiographs are evaluated, which were used in this analysis when periapical and bitewing radiographs were unavailable. Second, it is incomplete to determine root canal treatment success by radiographically evaluating obturation quality and presence or absence of periapical pathosis. Radiographic analysis may indicate, but may not account for all clinical symptoms. The inclusion of clinical symptoms may negatively impact success.

AF endodontists provide didactic instruction and clinical mentorship in both the 1- and 2-year AEGD residencies, which are aimed at obtaining competency in core dental procedures including posterior RCTs. Cases are typically prescreened to match the clinical experience and skills of the residents. In this study, nearly half of the included RCTs completed by AF general dentists with 1 year additional training and 22% by AF general dentist with 2 years additional training were completed during their respective residencies with clinical supervision and assistance by an staff endodontist. The amount of additional training for the civilian general dentists in this study was unknown.

AF endodontists accounted for 64.5% and 37.7% of initial molar and premolar RCTs completed by an AF provider, respectively. Whereas, civilian endodontists accounted for 96.6% and 91.3% of initial molar and premolar RCT completed by a referred civilian provider. Collectively, endodontists completed nearly 75% of the molar RCTs in this study. Endodontists are also more likely to take over cases initiated by other providers following treatment complications, such as perforations or separated instruments. This has potential to negatively impact the success and survivability rates for endodontists, especially when these rates are compared side-by-side with general dentists.

Another factor with similar potential to negatively impact success and survivability was a trend toward referring teeth for RCTs to endodontists prior to removal of gross caries and restorability determination. A total of 78 teeth were extracted following RCT during the follow-up period of this study. Twenty-five percent of the extractions occurred within 60 days of treatment. Treatment narratives were not available for all these cases, prohibiting a detailed analysis. Radiographically, however, there appeared to be a trend toward referring a tooth for RCT prior to restorability determination.

Conclusion

In this radiographic analysis, evidence-based practices as followed in the AFDS and additional training resulted in improved treatment outcomes. AF providers had a healing rate of 91.5%. RCTs completed by endodontists or general dentists with additional training were associated with better treatment outcomes. The survival rates were 94% for endodontists overall and 95% for AF general dentist with some additional training compared to 88% for AF general dentists without additional training. The survival rate for civilian general dentists was 78%; their amount of additional training was unknown. This study also highlighted the importance of following evidence-based treatment standards, because the opportunity for retreatment was limited. The extraction rate of endodontically treated posterior teeth was double the retreatment rate.

References

(1) Goldfein J, Speirs C, Finkelman M, Amato R. Rubber dam use during post placement influences the success of root canal-treated teeth. J Endod 2013;39:1481-4.

(2) Card SJ, Sigurdsson A, Orstavik D, Trope M. The effectiveness of increased apical enlargement in reducing intracanal bacteria. J Endod 2002;28:779-83.

(3) Schaeffer MA, White RR, Walton RE. Determining the optimal obturation length; a meta-analysis of literature. J Endod 2005:31:271-4.

(4) Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root canal filling and the coronal restoration. Int Endod J 1995;28:12-8.

(5) Reeh ES, Messer HH, Douglas WH. Reduction in tooth stiffness as a result of endodontic and restorative procedures. J Endod 1989;15:512-6.

(6) Gillen B, Looney S, Gu LS, Loushine B, Weller R, Loushine R, Pashley D, Tay F. Impact of the quality of coronal restoration versus the quality of root canal fillings on

success of root canal treatment: a systematic review and meta-analysis. J Endod 2011;37:895-902.

(7) *Air Force Medical Service Dental Clinical Practice Guidelines; Air Force Instruction 47-101*. Washington, DC; Air Force Medical Operations Agency; June 2012.

(8) Winward B, Yaccino J, Kirkpatrick T. A panoramic survey of Air Force basic trainees: how research translates into clinical practice. J Endod 2014;40:1332-7.

(9) Salehrabi R, Rotstein I. Endondontic treatment outcomes in a large patient population in the USA: an epidemiological study. J Endod 2004;30:846-50.

(11) Van Nieuwenhuysen JP, Aouar M, D'Hoore W. Retreatment or radiographic monitoring in endodontics. Int Endod J 1994;27:75–81.

(12) Savani GM, Sabbah W, Sedgley CM, Whitten B. Current trends in endodontic treatment by general dental practitioners: report of a United States national survery. J Endod 2014;40:618-24.

(13) Iqbal MK, Kim S. For teeth requiring endodontic treatment, what are the differences in outcomes of restored endodontically treated teeth compared to implant-supported restorations? Int J Oral Maxillofac Implants 2007;22(suppl):96-116.

Table 1: Percentage of RCT with complete and incomplete healing for each provider category

Provider	n = PP	Recall Rate (n)	% Complete Healing	% Incomplete Healing
AF endodontists	194	60.8% (118)	81.4%	9.3%
AF general dentists without additional training	16	25% (4)	75%	25%
AF general dentists with 1 year additional training	106	55.7% (59)	78.0%	13.6%
AF general dentists with 2 year additional	16	50% (8)	100%	0%

training				
Civilian endodontists	172	63.4% (109)	67%	19.3%
Civilian general dentists	4	75% (3)	66.7%	0%

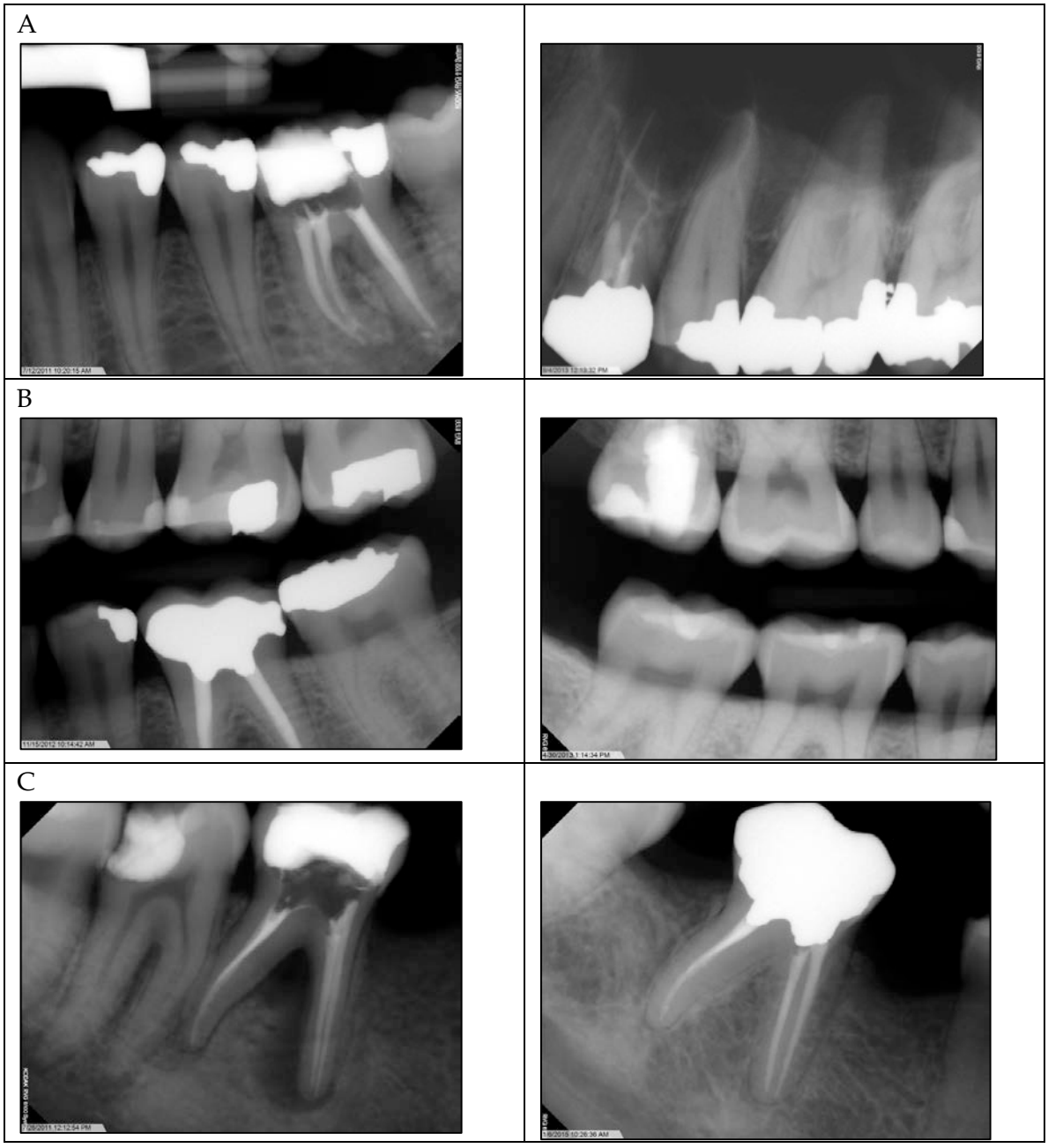

Figure 1. Represents examples of teeth deemed to have (A) adequate (left) and inadequate (right) RCT obturation, (B) adequate (left) and inadequate (right) cuspal coverage restorations, and (C) RCT teeth with periapical pathology present (left) and absent at 42 month recall (right).