

# Technical Quality of Endodontic Treatment Performed by Underperforming Undergraduate Dental Students

---

## ABSTRACT

**Objectives:** This study aims to evaluate the technical quality of root canal treatment performed by fifth-year underperforming students in the extra sessions of the 2018–2019 academic year. **Methods:** Periapical radiographs of teeth endodontically treated by underperforming undergraduate students at King Abdulaziz University College of Dentistry were collected. The quality of obturation was evaluated radiographically in relation to the length of obturation to root apex, homogeneity and density of obturation, root canal tapering, and incidence of mishaps (such as perforation, ledge, missed canal, separated instruments). The data were statistically analyzed by the Chi-square test (at  $P$ -value < 0.05). **Results:** The periapical radiographs of 70 treated teeth showed acceptable length, filling density and root canal taper in 96 (80%), 50 (41.7%) and 66 (55%) root canals, respectively. Only four teeth were subjected to mishaps. **Conclusion:** Under the circumstances of this study, the quality of endodontic treatment performed by underperforming students at the extra session was acceptable. However, more studies are needed to address the student underperformance source and hence amend the quality of root canal filling.

**Keywords:** Technical quality, Root canal treatment, Undergraduate students, underperforming students

## INTRODUCTION

Root canal treatment is an important part of comprehensive care in a dental education program[1]. The main objective of root canal treatment is to restore the tooth with diseased pulp and provide a provisional tight seal to prevent further pulpal and/or periapical pathosis[2]. The quality of root canal preparation and obturation will affect the treatment outcome[3, 4].

The main educational goal is to continuously assess the treatment quality to ensure that undergraduate students are competent for graduation. According to documents released by the American Dental Education Association in 2011, at the undergraduate level, a “competency” is defined as the ability to perform independent, unsupervised endodontic practical procedures with a degree of quality consistent with patient care and safety[5]. In the current endodontic curriculum of King Abdulaziz University (KAU), the prerequisite for the practical competency exam is that the student should perform endodontic treatment of at least six root canals.

At the end of the academic year of KAU 2018–2019 (10 days before the written exam), most of the undergraduate fifth-year students did not fulfill the minimum practical experience (MPEs) for the clinical competency exam. To give the students a second chance, the faculty provided

extra sessions, one for female and one for male students, before the scheduled times of the written exam to allow them to finish their MPEs. Throughout these extra sessions, the root canal filling quality differed from one student to another. Several studies have assessed the technical quality of endodontic treatment performed by undergraduates throughout the whole academic year[6–10]; this study aimed to evaluate root canal treatment technical quality performed by fifth-year underperforming students at KAU, specifically in the extra sessions of the 2018–2019 academic year.

## MATERIAL AND METHODS:

A total of 70 teeth received root canal treatment by fifth-year undergraduate students. Periapical radiographs were collected of all endodontically treated teeth carried out by fifth-year students during 15 April and 17 April 2019 at the Faculty of Dentistry, King Abdulaziz University. The radiographs of incomplete cases were excluded from this survey. Three radiographs (initial, working length and postoperative periapical) were used to assess the technical quality of root fillings. The quality of obturation was evaluated radiographically in terms of length of obturation to root apex, homogeneity and density of obturation, canal taper, and presence of mishaps (such as perforation, ledge, missed canal, or separated instruments). All root canal treatment

(RCTs) procedures were carried out by the underperforming fifth-year dental students under an endodontist's supervision with a staff-to-student ratio of 1 to 6. All RCTs were done under an aseptic technique with the use of a rubber dam. An apex locator (Root ZX 'J. Morita Corp., USA, Inc.') and radiographs were utilized to determine the working length. All teeth were instrumented using rotary nickel-titanium techniques using the ProTaper NEXT rotary system (Dentsply, Tulsa, Okla, USA), irrigated with 3% sodium hypochlorite solution. Roots were filled by the cold lateral compaction technique and gutta-percha and AH Plus root canal sealer (Dentsply, Tulsa, Okla, USA). A temporary restoration was applied to all teeth, followed by postoperative radiographs.

Two endodontists independently evaluated the technical quality of root fillings and the presence of procedural errors. Digital radiographs were examined using the R4 system ( Carestream dental LLC, Atlanta, GA). The final evaluation was agreed upon after comparing the final results. In case of disagreement, the examiners discussed the case until a consensus was reached.

Eight criteria were used to evaluate the quality of obturation [8]:

**Length:** 1) **Acceptable:** the filling is 0–2 mm short of the radiographic apex. 2) **Underfilling:** when the filling material was more than 2 mm from the radiographic apex. 3) **Overfilling:** when the filling obturation or sealer extrudes beyond the apex.

**Density of obturation:** 1) **Acceptable:**

The obturation appears homogeneous with uniform density, with an absence of voids within the filling and good adaptation without a gap between the filling material and the canal wall, and a gradual taper from the apex to the cervical level of the root canal. 2) **Poor:** visible voids within or between the filling material and canal walls.

**Taper of obturation:** 1) **Acceptable:** a gradual taper of the filling from coronal orifice to the apical region that reflects the proper canal shaping. 2) **Poor:** an inconsistent taper from the canal orifice to the apical root canal or the filling appeared as a single cone technique.

**Iatrogenic mishaps:** 1) **Acceptable:**

No evidence of ledge, perforation or separated instrument. 2) **Poor:** Presence of ledge or a fracture the instrument failed to bypass, or a perforation with lateral extruded material detected at any region of the root canal.

Statistical analysis was done by the chi-square test (at  $P$ -value < 0.05) using SPSS (Version 20, IBM Corp, Munich, Germany).

## RESULTS:

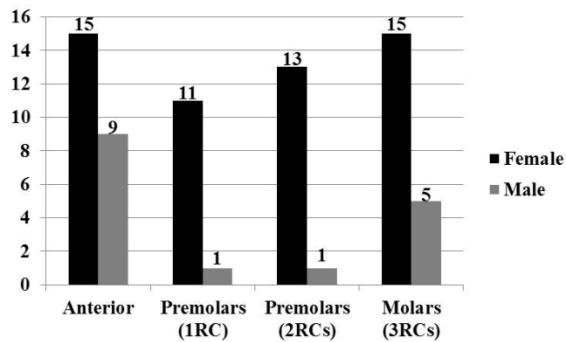
A total of 70 teeth were treated by 16 male and 54 female students. The treated teeth include 24 anterior teeth, 12 single-rooted premolars, 14 bi-rooted premolars and 20 molars (Figure 1). Multiple perforations (one at the furcal area and one at the super-crestal area of the mesial surface) of one molar were performed by one student. This case was referred to the postgraduate clinic, so it was excluded from the statistical analysis.

A total of 120 root canals in 70 teeth were evaluated radiographically according to the criteria described above (Table 1). An acceptable length was recorded in 96 (80%) root canals of 54 (77.1%) teeth, short filling was recorded in 7 (5.8%) of 4 (5.7%) teeth, and over-extended filling was recorded in 17 (14.2%) root canals of 12 (17.2%) teeth with a highly significant difference at  $P = 0.000$ . The acceptable density of root canal obturation was recorded in 50 (41.7%) root canals of 30 (42.9%) teeth, versus poor condensation in 70 (58.3%) root canals of 40 (57.1%) teeth with no significant difference at  $P = 0.185$ . The proper taper was recorded in 66 (55%) root canals of 35 (50%) teeth versus poor taper in 54 (45%) root canals of 35 (50%) teeth, with no significant difference at  $P = 0.904$  (Table 1). Five of the treated teeth were subjected to mishaps: two (one premolar and one molar) with a ledge that failed to bypass; two with a fractured instrument (one molar and one canine) at the apical third that was not retrieved and considered as part of the obturation; one molar with multiple perforations that was referred to the postgraduate clinic and excluded from the statistical analysis (Figure 2).

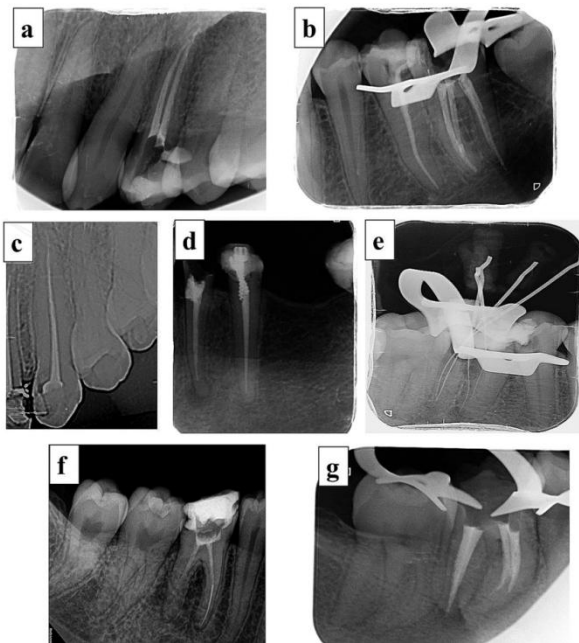
**Table 1:** Represents the radiographic evaluation criteria of technical quality of root canal obturation performed by 5<sup>th</sup> year student in the extra clinics.

Variable	Evaluation criteria	Evaluation per Teeth	Evaluation per root canals	P value
Length	Acceptable	54 (77.1 %)	96 (80 %)	0.000
	Under	4 (5.7 %)	7 (5.8 %)	
	Over	12 (17.2 %)	17 (14.2 %)	
Density	Acceptable	30 (42.9 %)	50 (41.7 %)	0.185
	Poor	40 (57.1 %)	70 (58.3 %)	
Taper	Acceptable	35 (50%)	66 (55 %)	0.904

	Poor	35 (50 %)	54 (45 %)	
Mishaps	Absent	67 (94.4 %)	117 (95.1 %)	0.000
	Present	4 (4.6 %)	6 (4.9 %)	
Total number		70	120	



**Figure 1:** Represents the distribution of teeth treated by fifth year undergraduate students, in the extra sessions. (RC : Root canals).



**Figure 2:** Examples of acceptable root canal obturation in tooth # 24 (a), poor condensation with evidence of voids in tooth # 36 (b), poor taper in tooth # 23 (c), short filling in tooth # 33 (d), furcal perforation in tooth # 46 (e), separated instrument in tooth # 36 (f), ledge at the mesial root canals of tooth # 46 (g)

## DISCUSSION:

According to the competency documents released by the American Dental Education Association in 2011, a “competency in

endodontics” is defined as the ability of undergraduates to establish independent, unsupervised endodontic practical procedures with a degree of quality consistent with patient care and safety to meet minimum practice standards described by the American Association of Endodontics 2018[5, 11]. In KAU, the documentation of fifth-year student competency in endodontics is determined by the student’s ability to perform root canal treatment in a minimum of 6 root canals with at least one unsupervised, unassessed case. Meeting this target allows the student to enter the final exam. The predictability of the treatment outcome may be based on the technical quality of final obturation[3]. The health of periapical tissues will be significantly affected by the endodontic treatment quality. The traditional manner of evaluating the technical quality of a root canal treatment is periapical radiographs based on the length, density, and taper of final obturation and the incidence of procedural mishaps[12, 13]. The quality of root canal treatment performed by undergraduates during a complete academic year has been reported for different dental schools [10, 14-17]. However, the current study evaluated the quality of root canals performed by fifth-year undergraduates who attended an extra session to permit them to complete the MPEs and take the final practical exam.

The treatment by competent undergraduates is expected to meet minimum standards as defined by the American Association of Endodontics[11]. In the current study, the acceptable length was recorded in 80% of root canals. This percentage is higher than that obtained in previous studies[6, 9, 12]. It may be attributed to the use of an electronic apex locator and confirmatory digital radiographs for working length determination.

Otherwise, the percentage of poor density (58.3%) accompanied with inadequate root canal taper (45%) was incomparable with a previous study [12]. The proper root canal taper is essential to allow deep penetration of spreader followed by insertion of a sufficient amount of axillary gutta-percha cones to achieve acceptable root canal obturation without evidence of voids[18]. In the current study, the extra sessions were not sufficient to allow these undergraduates to obtain proper taper; they were in a hurry to finalize their MPEs and take the practical exam, regardless of the treatment quality.

Root canal treatment is a technique performed by mechanical instrumentation associated with biomechanical debridement followed by complete root canal obturation to maintain a suitable

environment for healthy periradicular tissues[13]. It was suggested that the radiographic criteria of adapting obturating material are more precise to ensure the apical seal that, in turn, influences the treatment outcome[19]. The proper apical enlargement up to the full working length with continuous taper preparation, followed by well-compacted obturation without evidence of voids, is a significant factor that affects the treatment outcome[20]. The poor taper obtained in 55% of these root canals may be attributed to the students' inadequate endodontic training in using the rotary nickel-titanium (NiTi) instrumentation technique. Riberio 2018[10] suggested that poor filling density is the major cause of unacceptable root filling. The nonhomogeneous, less dense filling performed by undergraduates may be due to their inexperience with inadequate penetration of spreader, insufficient force and improper root canal tapering[6, 9]. However, there was no significant difference in the condition of root canal taper and filling density. The variety in the sample size and criteria used from one study to the other makes it difficult to compare studies.

The mishaps recorded in the current study were very few ( $\approx 5\%$ ); this could be due to the limited sample size included. Two of the 4 cases with mishaps had a ledge, which agrees with studies that described the most common error was ledge formation[10].

It seems that the dereliction of some undergraduates to submit their MPEs may be due to unavailable suitable patients. Some students were unlucky as they began endodontic treatment for several patients who failed to return to the clinic to complete the treatment.

A meta-analysis done in 2018 summarized that the technical quality of root canal treatment performed by undergraduate students is low[10] and that the most common cause of unacceptable root filling was root filling density, which is in agreement with this study.

Student underperformance could be attributed to different causes[21]: is the student, the curriculum or the tutor the source of the underperformance? More studies are crucial to find the essence of undergraduate dental students' underperformance in root canal treatment. A scheme to improve the quality of root filling is needed for endodontic education and training.

## CONCLUSION:

Under the circumstances of this study, the performance of underperforming dental students

in the extra session was acceptable because they performed adequate obturation with acceptable length, filling density and root canal tapering in 80%, 41.7% and 55% of root canals, respectively. However, more studies are needed to address the source of student underperformance and hence improve the quality of root canal filling.

**Ethical Approval:** Ethical committee of Faculty of Dentistry, King Abdulaziz University (#244-04-21)

## List of Abbreviations:

MTA: Mineral Trioxide Aggregate; RCs: Root Canals; RCT: Root Canal Treatment

## COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## REFERENCES:

- [1] Dadresanfar B, Akhlaghi NM, Vatanpour M, Yekta HA, Mohajeri LB. Technical quality of root canal treatment performed by undergraduate dental students. *Iran Endod J.* 2008;3:73.
- [2] Hülsmann M, Peters OA, Dummer PM. Mechanical preparation of root canals: shaping goals, techniques and means. *Endod Top.* 2005;10:30-76.
- [3] Endodontology ESo. Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. *Int Endod J.* 2006;39:921-30.
- [4] Kirkevang LL, Hørsted-Bindslev P. Technical aspects of treatment in relation to treatment outcome. *Endod Top.* 2002;2:89-102.

- [5] Association ADE. ADEA Competencies for the New General Dentist:(As approved by the 2008 ADEA House of Delegates). Am Dental Educ Assoc; 2011.
- [6] AbuMostafa A, Ahmad IA, Alenezy G, AlZoman A. Quality of root canal filling performed by undergraduate students in a Saudi Dental College. *J Dent Oral Hyg.* 2015;7:64-70.
- [7] Abu-Tahun I, Al-Rabab'ah MA, Hammad M, Khraisat A. Technical quality of root canal treatment of posterior teeth after rotary or hand preparation by fifth year undergraduate students, The University of Jordan. *Aust Endod J.* 2014;40:123-30.
- [8] Balto H, Al Khalifah S, Al Mugairin S, Al Deeb M, Al-Madi E. Technical quality of root fillings performed by undergraduate students in Saudi Arabia. *Int Endod J.* 2010;43:292-300.
- [9] Khabbaz M, Protogerou E, Douka E. Radiographic quality of root fillings performed by undergraduate students. *Int Endod J.* 2010;43:499-508.
- [10] Ribeiro D, Reus J, Felipe W, Pacheco-Pereira C, Dutra K, Santos J, et al. Technical quality of root canal treatment performed by undergraduate students using hand instrumentation: a meta-analysis. *Int Endod J.* 2018;51:269-83.
- [11] Endodontics AAo. Treatment standards. 2018.
- [12] Eskandarloo A, Karkehabadi H, Hashemi SZH, Ahmadi M, Hendi SS. Radiographic quality of root canal obturation performed by fifth year students of hamadan dental school. *Iran Endod J.* 2017;12:236-41.
- [13] Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature—part 1. Effects of study characteristics on probability of success. *Int Endod J.* 2008;40:921-39.
- [14] Kielbassa AM, Frank W, Madaus T. Radiologic assessment of quality of root canal fillings and periapical status in an Austrian subpopulation—An observational study. *PLoS one.* 2017;12:e0176724.
- [15] Román-Richon S, Faus-Matoses V, Alegre-Domingo T, Faus-Llácer VJ. Radiographic technical quality of root canal treatment performed ex vivo by dental students at Valencia University Medical and Dental School, Spain. *Med Oral Patol Oral Cir Bucal.* 2014;19:e93.
- [16] Saeed HM, Faraj BM, Saeed KMM, Hamagharib DS, Talabani RM, Khursheed DA. Quality of Root Canal Fillings Performed by Undergraduate Dental Students in the School of Dentistry, University of Sulaimani. *J Dent Med Sci.* 2015;14:105-9.
- [17] Silvani M, Brambilla E, Cerutti A, Amato M, Gagliani M. Root canal treatment quality in undergraduate program: a preliminar report on NiTi reciprocating files. *G Ital Endod.* 2013;27:33-7.
- [18] Schilder H. Filling root canals in three dimensions. *J Endod.* 2006;32:281-90.
- [19] Allison DA, Michelich RJ, Walton RE. The influence of master cone adaptation on the quality of the apical seal. *J Endod.* 1981;7:61-5.
- [20] Sjögren U, Hägglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. *J Endod.* 1990;16:498-504.
- [21] Cleland JA, Knight LV, Rees CE, Tracey S, Bond CM. Is it me or is it them? Factors that influence the passing of underperforming students. *Medical education.* 2008;42:800-9.