

# RADIOGRAPHIC TECHNICAL QUALITY OF ROOT CANAL FILLINGS PERFORMED BY UNDERGRADUATE DENTAL STUDENTS

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## ABSTRACT

*The main goal of three-dimensional obturation is to provide an impermeable fluid tight seal within the entire root canal system, to prevent oral and apical microleakage. There is substantial evidence that the quality of root canal filling has a significant effect on the outcome of root canal treatment. The objective of the study was to evaluate the radiographic technical quality of root canal fillings performed by under graduate dental students at College of dentistry, Aljouf University, Saudi Arabia. A total of 277 root canal fillings were studied. The quality of endodontic treatment was evaluated by periapical radiograph in relation to the length, density and taper of the root canal fillings. The iatrogenic errors were also recorded. The total no of root filled canals were 277 with the predominance of maxillary 173 followed by mandibular 104. Out of 277 canals 186 (67.2%) were straight and the highest number of straight canals were found in incisors 51 (27.4%) while 91 (32.8%) were curved, the most curved canals were observed in molars 56 (61.53%). There was significant difference ( $p=0.000$ ), showing that shape of a canal effects the acceptable filling of root canal and there was also significant difference observed for adequacy of density between different canal shapes. Adequate taper was found in 259 root canal fillings while inadequate taper in 18 root canal fillings. The result was statistically significant ( $p=0.03$ ). Separated instruments, ledge formation, strip perforation, furcal perforation and root perforation were present in 6 (2.2%), 18 (6.5%), 1 (0.4%), 1 (0.4%) and 4 (1.4%) root canals respectively. Overall the quality of root canal fillings performed by the students was satisfactory.*

**Key Words:** Dental students, iatrogenic errors, periapical radiograph, Quality, root canal fillings.

## INTRODUCTION

Root canal treatment constitutes the essential core of the specialty of endodontics. It involves cleaning and shaping the canal, disinfecting it and providing a three dimensional obturation. Research shows that root canal procedures have become increasingly predictable and successful. Primary objective of root canal treatment is to restore the tooth to its previous form, function and esthetics. Long term prognosis depends on several factors like the quality of the obturation and coronal and apical seal.<sup>1</sup>

Success is a very relative term and several strange criteria have been used to assess the success of root canal treatment. Clinical signs and symptoms can not always be relied upon to assess the success of root canal treatment. Epidemiological studies reveal high prevalence of apical periodontitis in root canal treated teeth, though most cases remain asymptomatic. So it is important to include radiographic criteria too.<sup>2</sup>

A combination of the radiographic criteria proposed by De Moor and Sequeira is often used to evaluate the quality of obturation.<sup>3</sup> This method assesses the length, density and taper of the obturated canals. Some studies do not use taper as an assessment criteria because it is too subjective.<sup>4</sup>

Importance of working length has always been highlighted in curriculum. Obturation, even though short, within the permissible range of 0.5 mm to 2 mm short of the apex has a healing rate of 87-94%. When shorter than 2mm from the apex the healing rate falls to 68-77.6%. Overfilled canals too are considered to have poor success rate of 75-76%. A homogenous densely radiopaque obturation devoid of voids is often considered satisfactory. Other variables that are often overlooked are the degree of disinfection and the fre-

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quency of mishaps and procedural errors. High level of micro leakage is associated with transported canals.<sup>5</sup>

Root canal procedures are highly technique sensitive as evident from the success rate which is 60-75% when performed by the general practitioner and 90% or more when performed by the specialist. The success found among cases performed by the students in teaching institutions is 33%. Unlike the medical curriculum, dental students attend clinical cases from the third year of dental school. The knowledge gained from lectures and the skills acquired in pre-clinical labs equip the students to provide oral health care to their patients. But due to inexperience, inadequacy in training and sometimes even lack of proper supervision students fail to provide care of acceptable standards.<sup>6</sup>

There is no scarcity of studies on the quality of endodontic treatment. Most of these are radiological assessments. Despite many inherent limitations, these studies provide fair correlation between procedural errors and negative treatment outcomes. This is very important in assessing the quality of training imparted and subsequently for designing new curriculum. So an extensive survey of the quality of root canal treatments performed in the under graduate clinics of the Aljouf University was carried out over a period of one year. There has been no published research on the technical quality of root canal fillings in our institution. Such studies are helpful in order to assess the effectiveness of dental care and to plan future dental training for the students. The objective of the present study was to assess the overall success percentage of root canal treatment provided in our student clinics. Quality of obturation was assessed radiographically as the indicator of success.

## METHODOLOGY

Periapical radiographs of completed root canal treatment performed by undergraduate fourth and fifth year dental students during the period from 2014-2015 of the patients attending endodontic department of the college of dentistry, Aljouf university were studied. The approval of the study was taken from the ethics committee of the college. The exclusion criteria were patients younger than 16 years of age, records that did not include preoperative and postoperative periapical radiographs, poor quality radiographs, superimposed anatomic structures, incomplete endodontic treatment, third molars and all retreated cases. The inclusion criteria were patients endodontically treated for the first time by 4th and 5th year dental students, three periapical radiographs (preoperative, working length determination and postoperative) were present in the patient records, postoperative radiograph with long cone paralleling technique and showed the entire root and 2-3mm of the periapical area. All the endodontic cases treated by the students were under the direct supervision of the endodontists. The total numbers of students involved with the treatment of these cases were 35. The ratio of the supervisor to the students' was 1: 7. The total number of root canal fillings evaluated was 277.

Before checking the quality of root canal fillings the endodontic treatments were performed by the following method in our institution. Aseptic technique with rubber dam isolation was applied in all cases. After access cavity preparation, the root canals were prepared with step back technique using stainless steel k-files of 0.02 taper (Kerr Sybron, Romulus, MI, USA) and the canals were irrigated with 2.5% sodium hypochlorite while in few cases Gates Glidden drills (Premier Dental, Norristown, PA, USA) were used at the coronal third to facilitate straight root canal access to the apical third. In cases of calcified root canals Glyde (Dentsply Maillefer, Tulsa, Ok, US) was used. Root canal obturations were done with lateral condensation using AH 26 root canal sealer (Dentsply Maillefer, Tulsa, Ok, US) and gutta percha. Periapical radiographs were taken using long cone paralleling technique.

The postoperative periapical radiographs were examined to assess the technical quality and detection of iatrogenic errors of the root canal treated teeth. The radiographs were examined by the two investigators in a darkened room using an illuminated viewer box with magnification (2.5) whilst mounted in a cardboard slit to block off ambient light emanating the viewer box (Dentsply Rinn Corp. Elgin, IL, USA). In case of disagreement a third investigator evaluated the radiographs and a consensus was reached. A transparent ruler with 1mm gradations was used to measure the distance from the radiographic apex. An evaluation form was used to record the data collected from the postoperative radiographs. The data included tooth type, shape of the root canal, length, presence of voids and taper of root canal fillings, separated instrument, ledge formation, strip, furcal and root perforation were examined in each root canal. The three variables length, density and taper of the root canal fillings were used to assess the quality of canal fillings are as follows:

The root canal filling 0 to 2 mm from the radiographic apex was considered acceptable. The root canal fillings more than 2mm from the radiographic apex was considered underfilling while extending beyond the radiographic apex was considered over filling. The density was considered adequate when there were no voids present in root filling or between root filling and root canal walls and inadequate, when there were voids present in the root filling or between root filling and root canal walls. Similarly taper of root canal filling was considered adequate when there was consistent taper (good reflect to canal shape) from coronal to apical aspect of root canal and inadequate when there was no consistent taper (not reflect to canal shape) from the orifice to the apex of the root canal. The iatrogenic errors were recorded as follows:

Separated instrument was considered when a fractured instrument was found inside a root canal or with its tip extending into the periapical area. Ledge formation was diagnosed when the root filling was shorter than the working length or deviated from the original canal shape in teeth where root canal curvature occurred. Strip perforation was diagnosed when extru-

sion of filling material was detected in the lateral wall of any root. Furcal perforation was considered when extrusion of filling material through the furcation area was found out in multi-rooted teeth.

**Statistical Analysis**

Statistical analysis of the data was carried out by using SPSS software version 21 (SPSS Inc., Chicago, IL, USA). The Chi-square test was used for statistical evaluation of the results. A P < 0.05 was considered significant.

**RESULTS**

Two hundred seventy-seven endodontically treated teeth were evaluated, with the predominance of maxillary 173 followed by mandibular 104. Out of the

TABLE 1: DISTRIBUTION OF ROOT CANALS ACCORDING TO THE TOOTH TYPE

Affected Tooth	Number of canals (Frequency)				Total
	1.0	2.0	3.0	4.0	
11	23	0	0	0	23
12	12	0	0	0	12
13	10	0	0	0	10
14	0	10	0	0	10
15	11	0	0	0	11
16	0	0	0	15	15
17	0	0	1	0	1
21	17	0	0	0	17
22	7	0	0	0	7
23	9	0	0	0	9
24	0	14	0	0	14
25	23	0	0	0	23
26	0	0	2	11	13
27	0	4	4	0	8
31	1	0	0	0	1
32	1	0	0	0	1
33	2	0	0	0	2
34	7	0	0	0	7
35	9	0	0	0	9
36	0	0	10	6	16
37	0	1	12	0	13
43	3	0	0	0	3
44	3	0	0	0	3
45	13	0	0	0	13
46	0	0	22	4	26
47	0	0	10	0	10
Total	151	29	61	36	277

TABLE 2: DISTRIBUTION OF SHAPE OF ROOT CANALS ACCORDING TO THE TOOTH TYPE

Affected Tooth	Shape of Canals Frequency (%)		Total	P-value
	Straight	Curved		
11	23 (100)	0 (0)	23 (100)	
12	10 (83)	2 (17)	12 (100)	
13	4 (40)	6 (60)	10 (100)	
14	6 (60)	4 (40)	10 (100)	
15	10 (91)	1(9)	11 (100)	
16	9 (60)	6(40)	15 (100)	
17	0 (0)	1 (100)	1 (100)	
21	12 (70.6)	5 (29.4)	17 (100)	
22	5 (71.4)	2 (28.6)	7 (100)	
23	7 (77.7)	2 (22.3)	9 (100)	
24	9 (64.3)	5 (35.7)	14 (100)	
25	19 (82.6)	4 (17.4)	23 (100)	
26	5 (38.5)	8 (61.5)	13 (100)	
27	0 (0)	8 (100)	8 (100)	0.000
31	0 (0)	1 (100)	1 (100)	
32	1 (100)	0 (0)	1 (100)	
33	1 (50)	1 (50)	2 (100)	
34	6 (85.7)	1(14.3)	7 (100)	
35	9 (100)	0 (0)	9 (100)	
36	0 (0)	16 (100)	16 (100)	
37	9 (69.3)	4 (30.7)	13 (100)	
43	3 (100)	0 (0)	3 (100)	
44	3 (100)	0 (0)	3 (100)	
45	12 (92.4)	1 (7.6)	13 (100)	
46	16 (61.5)	10 (38.5)	26 (100)	
47	7 (70)	3 (30)	10 (100)	
Total	186(67.2)	91(32.8)	277 (100)	

total 151 (55%) were single canal, followed by 61 three canals (22%), 36 two canals (13%) and 29 four canals (10%) presented in Table 1.

Table 2 shows the shape of the canals according to the tooth type. Out of 277 canals 186 (67.2%) were straight and the highest number of straight canals were found in incisors 51 (27.4%) while 91 (32.8%) were curved, the most curved canals were observed in molars 56 (61.53%). There was statistically significant difference between the number of straight and curved canals among different teeth (P=0.000).

Table 3 summarizes the length and density of the root fillings according to the shape of canal. There is significant difference (p=0.000), showing that shape of

TABLE 3: LENGTH AND DENSITY OF ROOT CANAL FILLINGS IN STRAIGHT AND CURVED CANALS

Shape of Canals	Length	Density Frequency (%)		Total	P- value
		Adequate	Inadequate		
Straight	Underfilled	24(75)	8(25)	32(100)	0.00
	Acceptable	115(87.7)	16(12.3)	131(100)	
	Overfilled	21(91.3)	2(8.7)	23(100)	
Total		160(86.1)	26(13.9)	186(100)	
Curved	Underfilled	34(62.9)	20(37.1)	54(100)	
	Acceptable	13(68.5)	6(31.5)	19(100)	
	Overfilled	13(72.3)	5(27.7)	18(100)	
Total		60(65.9)	31(34.1)	91(100)	
Total		220(79.4)	57(20.6)	277(100)	

TABLE 4: TAPER AND LENGTH RELATIONSHIP OF ROOT CANAL FILLINGS

Taper	Length Frequency (%)			Total	P-value
	Underfilled	Acceptable	Overfilled		
Adequate	71(27.4)	147(56.8)	41(15.8)	259(100)	0.03
Inadequate	15(83.4)	3(16.6)	0(0)	18(100)	
Total	86(31)	150(54)	41(15)	277(100)	

a canal effects the acceptable filling of root canal and there is also statistically significant difference observed for adequacy of density between different canal shapes.

Table 4 presents the relationship of taper and length of root canal fillings. There is a significant difference between taper and length of root canal fillings ( $p=0.03$ ). Iatrogenic errors like fractured instruments, ledge formation, strip perforation, furcal perforation and root perforation were present in 6 (2.2%), 18 (6.5%), 1 (0.4%), 1 (0.4%) and 4 (1.4%) root canals respectively between different canal shapes.

## DISCUSSION

Radiographic technical quality of root canal fillings performed by undergraduate 4th and 5th year dental students at the College of Dentistry, Aljuf University was evaluated in the current study. A total of 277 root canal fillings were studied. Evaluation was based on the immediate post operative periapical radiograph. However there are some inherent limitations because a single radiograph provides only a two dimensional image and sometimes the root canal fillings or anatomical structures are superimposed hence making the quality assessment of the treatment difficult.

In epidemiological studies, different methods had been used for categorizing the quality of root canal fillings. Some studies used only length<sup>7,8</sup> while others measured length and density<sup>9,10</sup> and in addition to these, taper of the root canal fillings was also taken into consideration.<sup>11-13</sup>

Burke et al<sup>14</sup> concluded after his 5 years of follow up study that the root canal fillings are the most valuable component for perseverance of endodontically treated teeth. He found that pretreatment periapical pathology had no role in the long term survival of root canal treated teeth. On the other hand Chugal et al. were of the opinion that cleaning and shaping of root canal is important for success but the preoperative diagnosis is the most important factor.<sup>11</sup>

Many reasons were included for the consistency in the results. Most importantly the length measured on the radiograph is unreliable and it is considered as a precise filling. Some authors stated 0-2 mm filling from the radiographic apex was enough while others thought 0-3 mm. Quality guidelines for endodontic treatment states if the tip of the file during radiographic working length determination is  $\leq 3$  mm, no adjustment is required. In many previous studies and in the present one 0.2 mm was considered sufficient. The percentage of root canal fillings with adequate length was 54% in the current study. Our findings were almost similar to the previous studies by Ljiljana et al<sup>1</sup> and Eleftheriadis et al<sup>2</sup> who reported 57% and 63% adequate root canal fillings respectively. On the other hand it was higher than the study done by Elsayed et al<sup>10</sup> (45%). The results of adequate root canal fillings with adequate length were higher in the studies by Er et al<sup>8</sup> (69.6%) and Vukadinov et al<sup>11</sup> (89.7%) compare to the present study. This might be due to not using apex locator and taking multiple periapical radiographs in

the determination of working length in our student clinics.

The present study demonstrated significant correlation between root canal filling length and the curvature of canals which were in agreement with the previous published research. Inadequate length of root canal filling was considerably more in curved canals than in straight canals.<sup>8,15</sup> The existing study and other previous studies both support the significance in correlation between filling length and curvature of root.<sup>12,13</sup>

The density of root canal filling is an important factor for the success of endodontic treatment. The results of this study were more than the previous studies done as it showed 79.42% adequate density while others decided only 27.6%-72.6%.<sup>8,15,16</sup> In contrast to the study by Moussa-Badran et al<sup>17</sup> in this study there was no considerable correlation between tooth type and density of the filing, although a scarcely variant criteria was used, makes it difficult to compare.

One of the important roles in preservation of endodontic treatment teeth is played by procedural errors. This might proceed to incomplete instrumentation and/or obturation. This study showed procedural errors like ledges in 6.5% and separated instruments were found in 2.2% of cases. A considerable difference in results studied by Khabbaz et al<sup>15</sup> where ledges were found in 54.8% and separated instruments in 0.9% of the total cases. Also 13.6% of ledges and 0.5% of separated instruments reported by Baltoet al.<sup>16</sup> Rafeek et al<sup>18</sup> reported instrumental separation in 1.5% which is lesser in contrast to this study. Such difference in the ledges in the current and parallel studies may be due to different examiners and the different definitions of ledge. Strip, furcal and root perforations were present in 0.4%, 0.4% and 4% of the root canal fillings respectively in contrast to Ljiljana et al reported perforations of crown and/or canal walls in 3.1% of root canal fillings. Khabbaz et al<sup>15</sup>, did not find any missed canals and reported root canal and apical foramen perforation in 11.8% and 32.6% of the canals respectively.

The low levels of procedural errors by the students were due to the direct supervision of the staff and showing each step of root canal treatment to their supervisors. The results of current study were at a better level than previous studies, such as studied by Sidaravicius et al<sup>19</sup> and reported by Kirkevang et al.<sup>20</sup>

The preclinical and clinical techniques in endodontic use are presumed to be very strong. Preclinical practical experience is one of the most important principal undertaking clinical practices. A student of university has been taking part in multiple semesters. The endodontic teaching in our college of dentistry starts in fifth semester with one lecture and two practical sessions per week. The students are taught basic principles

of endodontic and clinical practice on extracted teeth during this period. They perform root canal treatment on three anterior, two premolars and at least one molar during these sessions. Students are required to pass written and practical exam of preclinical endodontics to promote to the course of clinical endodontics (4th year) on patients. Endodontic clinical practice on patients starts in the 4th year in our clinics. The students are allowed to perform root canal treatment on anterior and premolars in fourth year while in fifth year they do molars endodontic treatment as well. The supervisor to students' ratio is 1:7 almost similar to that reported in other studies.<sup>6,8,10</sup> Modern adjuncts in endodontic treatment such as NiTi rotary files and electronic apex locator were not used in the present study. It has been shown that electronic apex locators are more accurate than radiographs to measure the working length of the root canal. Furthermore NiTi rotary instruments shape the root canal better than conventional stainless steel instruments with less iatrogenic errors.<sup>21</sup>

## CONCLUSION AND RECOMMENDATIONS

Within the limitations of the current study, it was concluded that the root canal fillings performed by the undergraduate dental students of 4th and 5th year at college of dentistry, Aljouf University was satisfactory considering the students' lack of experience. Molar teeth are most difficult to treat endodontically due to their complex anatomy so focus on these teeth should be made. Modern new techniques and Nickel-Titanium Files should be incorporated into the preclinical and clinical curriculum of endodontics. It would be useful to incorporate self-assessment of the quality of endodontic treatment in curriculum to improve preclinical and clinical training in endodontics. The students will be able to judge their own work and maintain/improve the quality after graduation.

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- 1 Iftikhar Akbar:** Principal Author, design of the study, introduction and discussion
- 2 Fayyaz Alam:** Data Collection and Methodology
- 3 Muhammad Raza:** Statistics and compiling results.