

Quality of Endodontic Treatments Performed By Undergraduate Students at the Uqudent Using Rotary Nickel Titanium Files

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Abstract: A successful outcome for root canal treatment relies on adequate removal of micro-organisms from the canal system and prevention of recolonisation or propagation of residual micro-organisms through the placement of a root filling that obturates the space entirely, combined with a restoration that produces a satisfactory coronal seal. During instrumentation of the root canal, it is important to develop a continuously tapered form and to maintain the original shape and position of the apical foramen

Aim: To evaluate the radiographic quality of endodontic treatments performed by undergraduate students at the UQUdent using rotary nickel titanium files. As well as iatrogenic errors such as Root perforation, Fractured instrument while using Rotary Nickel Titanium Files.

Methodology: Endodontic records from 100 completed root canal treatments (RCT) performed by undergraduate students at the Dental School of Umm al Qura University , were randomly selected for examination

Results: Root canal fillings length was qualified acceptable in 134 out of the 150 root canals (89.3%). While 13 root canals (8.7%) showed that the length of obturation was shorter than 2mm of the radiographic apex whereas 3 out of the 150 root canals (2%) were obturated beyond the radiographic apex. While the homogeneity was concerned, 102 out of 150 root canals (68%) were homogeneously acceptably obturated whereas 48 root canals (32%) were scored as unacceptably obturated. Also there some iatrogenic errors were detected as ledges in 3 root canals (2%) and separated instrument in 3 root canals (2%)

Conclusion: Quality of root canal obturation performed by the fifth and sixth year students in uqudent was acceptable. In addition we suggest that the endodontic training courses of the dental students at the preclinical and clinical levels to be increased to gain more improvement and high quality root canals treatment which lead to long term survival rate.

Keywords: root canal treatments (RCT), endodontic treatments.

1. INTRODUCTION

Background:

A successful outcome for root canal treatment relies on adequate removal of micro-organisms from the canal system and prevention of recolonisation or propagation of residual micro-organisms through the placement of a root filling that obturates the space entirely, combined with a restoration that produces a satisfactory coronal seal.

Inferior technical quality of root fillings is considered to be the main cause of clinical failure. Incomplete obturation of the root canal leaves residual space for microbial colonisation and proliferation and may also imply that cleaning was incomplete.

During instrumentation of the root canal, it is important to develop a continuously tapered form and to maintain the original shape and position of the apical foramen. However, the presence of curvatures may cause difficulty in root canal instrumentation. The ability to keep the instruments centered is essential to provide a correct enlargement, without excessive weakening of the root structure. Several studies have shown that Ni-Ti instruments remain significantly more centered and demonstrated less canal transportation than stainless steel files.

2. REVIEW OF LITERATURE

1- Rotary Nickel Titanium Files instrumentation:

Several types of endodontic instruments have been recommended as being capable of achieving the primary objectives of root canal preparation. The shaping of curved canals presents a problem for operators when stainless steel instruments are used, and all preparation techniques have a tendency to move the prepared canal from its original axis. Parameters affected by preparation, such as the angle of curvature determined by a line from the apical termination to the point of departure from a straight line drawn through the middle of the coronal part of the canal, can have a significant effect on endodontic treatment success. The use of rotary Ni-Ti files for root canal preparation has significantly reduced the time required to prepare the root canal, with minimal deviations from the original canal path compared with manual instrumentation. (Stavileci,2015)

Several studies showed that the quality of root canal treatment (RCT) using hand instrumentation was poor compared with new techniques and instruments such as rotary instrumentation systems.

Krishna et al, 2010, evaluated the preparation time, change in working length, instrument failure and apical transportation in relation to stainless steel, hand Ni-Ti and Ni-Ti engine-driven instruments. The collected samples were randomly divided into 3 groups. Access preparation for each tooth was carried out. Cleaning and shaping of the mesio-buccal canals of all the teeth was carried out with 3 different sets of experimental instruments. Crown-down pressureless technique was performed in all the 3 groups. Then the working length was determined placing a No#15 file till the apex. They found that the Ni-Ti rotary instruments were found to take less time for root canal preparation than the other groups and it is statistically significant. Also no instrument deformation or separation was seen in Ni Ti hand group, the working length was maintained more often with the Ni-Ti hand group, the apical transportation was minimal with Ni-Ti rotary files when compared to stainless steel files group. Under the conditions of their study, Ni-Ti rotary files proved to be better than the other group files with respect to their parameters undertaken. (Krishna, 2010)

Dafalla *et al* 2010, compared hand stainless steel K-files and Nickel-Titanium Profile 0.04 taper 29 series rotary instruments for their efficiency, procedural errors and time consumed in preparation of root canal system. Samples were randomly divided into two experimental groups. Each group had a total of 34 canals. Group 1 was prepared by conventional methods with stainless steel hand K files and group 2 with the rotary method using NiTi Profile 0.04 taper 29 series. All teeth were embedded in acrylic resin blocks keeping the apex out of the resin. Subsequently, instrumentation was performed. The impressions of the prepared canals were made and assessed under the $\times 40$ magnification of stereomicroscope. They found that Profile 0.04 series 29 rotary systems prepared canals more rapidly, and showed low incidences of blockage, and only limited loss of working length. Canal preparation with K-file was time consuming and showed higher incidence of deformed instruments probably due to low elasticity of the stainless steel metal. (Dafalla.2010)

2- Quality of Root canal treatment:

A. Methods of evaluation of quality of root canal treatment:

A variety of methodologies have been used to evaluate the shaping ability of endodontic instruments, including simulated root canal models, decalcification techniques, sectioning techniques, and radiographic comparison. (Stavileci,2015)

Metzger et al, 2010, evaluated the quality of root canal preparation and root canal obturation in canals treated with either rotary or self adjusting files (SAFs), using three-dimensional micro-computed tomographic (CT) analysis. Teeth were selected from a large random collection of extracted human teeth that were recently extracted and two file systems were used: rotary nickel titanium files and SAFs. The canals were irrigated with 5 mL 3% NaOCl between the instruments, then obturated by lateral compaction technique with gutta percha and AH26 sealer. They found that the root canal surface unaffected area by root canal preparation was 16.7%, 60.2% in the SAF and rotary file groups, respectively. Which is

17.0% , 44.6% in the SAF and rotary file groups, respectively untouched by the root canal filling material .(Metzger , 2010)

Smadi et al 2015, evaluated the quality of root canal treatment (RCT) performed by undergraduate dental students at the Jordan University Dental Hospital using radiographic records. Two hundred and thirteen teeth were treated and included in the study. For each root filled tooth, at least three periapical radiographs were retrieved; preoperative, working length determination and postoperative. They concluded that the technical quality of root canal obturation performed by undergraduate dental students using cold lateral compaction was found to be poor with only 29.2% having adequate quality, regardless of student level. This low percentage suggested that the training course in endodontics had to be improved at both preclinical and clinical levels. (Smadi ,2015)

Stavileci et al 2015 , evaluated and compared the root canal shaping efficacy of ProTaper rotary files and standard stainless steel K-files using micro-computed tomography . Sixty intact maxillary second premolars were used. Each tooth was mounted in a sample holder before the micro CT scanning to allow reproducible orientation in the pre- and post-preparation scans. All teeth were scanned using CT system. The access cavities of all samples were prepared, and the root canals were localized and explored with size 15 K-files. All samples were divided into 2 groups of 30 teeth each. The root canals of the teeth in the first group were prepared with the ProTaper rotary system using a crown-down technique. The second group were prepared with stainless steel K-files (Diadent, France) using a step-back technique . When the preparation was completed, each sample was inserted into the micro CT scanner and teeth were re-scanned . (using the same parameters used for the initial scan) for comparison with the pre-preparation images . They concluded that both manual preparation with stainless steel files and motorized preparation with ProTaper left unprepared root canal surface, and both techniques caused slight straightening of the root canal after preparation (Stavileci, 2015)

B. Root canal treatment performed by undergraduate student:

Root canal cleaning along with the shaping procedure that is performed mechanically and biologically is an important stage of endodontic therapy. A continuously tapering funnel shape with the smallest diameter at the endpoint and the largest at the orifice has been deemed to be the most appropriate canal shape for filling with Gutta-percha and sealer.(Schilder , 1974)

Various instruments and techniques have been introduced in order to accomplish this task without complications such as transportation, ledging, strip perforations, or instrument separation. Since the introduction of nickel-titanium (Ni-Ti) to endodontics in 1988, Ni-Ti hand files and rotary instruments have been preferred due to their superiority in managing curved canals.(Walia , 1988)

Number of studies have investigated root canal preparation carried out by dental students with various techniques (hand and rotary Ni-Ti). The results showed that novice operators were able to prepare curved root canals with rotary files with less transportation and greater conservation of tooth structure. Results in a comparison of hand and rotary Ni-Ti files in the instrumentation by undergraduate dental students were promising for the rotary Ni-Ti files (Ünal, 2012)

Assessment of students' performance, opinions and views regarding the use of NiTi would provide insights into their technical clinical abilities and knowledge, and valuable feedback on teaching effectiveness. (AbuTahunet al , 2014) .

Many studies have assessed the radiographic quality of root fillings performed by undergraduate students. Unal et al in 2011, evaluated the radiographic quality of root canal fillings performed by first and second clinical year dental students at the Dental Faculty in Suleyman Demirel University, Turkey during 2004 and 2006 using sample . Observers evaluated the samples with agreement levels of 'good' and 'very good'. The technical quality of the root filling was evaluated according to the density of the filling and the distance between the end of the filling and radiographic apex. They found that homogeneity and length was acceptable in (79.47%) . (Unal et al, 2011)

In 2013, Fonseka et al , determined the radiographic quality of root canal treatment performed by dental undergraduates covering six final year groups of students. A total of 2426 post endodontic radiographs were assessed to determine the radiographic quality of endodontic treatment. Three determinants were assessed and the radiographic quality was deemed acceptable or not acceptable based on length , homogeneity and taper . They found that canals were obturated within 2mm of the radiographic apex. Concerning homogeneity 72.8% of the post operative radiographs were homogeneously obturated whereas 27.2% were scored as unacceptable. (Fonseka et al, 2013)

Silvani et al in 2013, evaluated radiographically the quality of endodontic treatments performed by dental students at the University of Milan using a system consisting of NiTi single use tapered instruments, used in reciprocating motion . A total of 28 root canals were evaluated. Radiographs were collected and two independent evaluators, specialists in Endodontics, examined the pre- and the post-operative radiographies . Root fillings length was adequate in 26 of the 28 root canals evaluated (92.86%). (Silvani et al, 2013)

- **Aim of the study:**

To evaluate the radiographic quality of endodontic treatments performed by undergraduate students at the UQUdent using rotary nickel titanium files. And the incidence of iatrogenic errors such as root perforations, separated instruments while using Rotary Nickel Titanium Files.

3. METHODOLOGY

Endodontic records from 100 completed root canal treatments (RCT) performed by undergraduate students at the Dental School of Umm al Qura University , were randomly selected for examination. The inclusion criteria for this selection were:

- 1- All root canal treatments performed by 5th and 6th year undergraduate dental students on completely formed permanent teeth from 2014 to 2016.
- 2- Teeth treated using at least three, radiographs (preoperative, working-length (intermediate) and postoperative) of good quality that showed the entire length of the root and the periapical area. Cases with unreadable radiographs were excluded.
- 3- Root canal treatment done by rotary nickel titanium file.

Evaluation of the technical quality of root canal filling was based on the immediate postoperative radiograph. Two variables were examined, the length and the density of the root canal fillings. Iatrogenic errors including ledges, perforations (root and apical foramen) and separated instruments were also recorded. The detection of these errors was based on the comparison of initial, intermediate and final radiographs. Evaluation of the final root filling was performed by two independent investigators and the worst value was taken into account in case of discordance.

Evaluation criteria:

The technical quality of the root fillings and the presence of iatrogenic errors found on radiographs were evaluated, classified and recorded; root canal was the unit of assessment.

The criteria for radiographic classification of the technical quality of root fillings were based on two variables; length and density. They were classified as acceptable and unacceptable as follows:

1 - Acceptable: The filling material ends 0–2 mm short of the radiographic apex with no voids visible within the material or between material and the root canal walls.

2- Unacceptable:

- **A - Under-filled:** The filling material ends more than 2 mm short from the radiographic apex.
- **B - Density problem:** The filling material ends 0–2 mm short from the radiographic apex with visible voids within or between the material and the root canal walls. (Figure 1)
- **C - Over-filled:** Materials extruded beyond the apex.

The criteria for radiographic classification of the iatrogenic errors were as follows:

- 1- **Ledge:** A ledge was considered present if the apical extent of gutta-percha in the final radiograph deviated from the original curvature compared with the working- length radiograph.
- 2- **Perforation:** A perforation was diagnosed when extrusion of materials was detected in any area of the root (lateral wall or the foramen of the root).
- 3- **Separated instrument:** They were diagnosed through observation of the final radiograph and according to the radiopacity between the filling material and fractured instrument .(Figure 2) (Khabbaz , 2010)

Statistical analysis:

Data were collected, tabulated and then by using the Statistical Package of the Social Sciences (SPSS) program version data entry and analysis were performed. Data were expressed as frequencies and percentages.

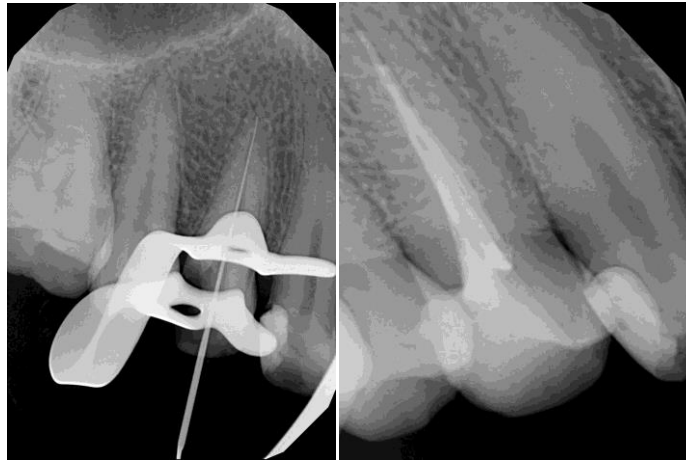


Figure 1: Periapical radiographs of tooth 14 a:preoperative, b:tooth length, c postoperative showing unacceptable density of root canal treatment " presence of voids "



Figure 2: Periapical radiographs of tooth 46 a: preoperative, b:tooth length, c postoperative showing a separated instrument in mesiolingual root canal

4. RESULTS

Root canal fillings length was qualified acceptable when postoperative radiographs showed that root canals were obturated within 0-2 mm of radiographic apex, this was found in 134 out of the 150 root canals (89.3%). While postoperative radiographs of 13 root canals (8.7%) showed that the length of obturation was shorter than 2mm of the radiographic apex whereas 3 out of the 150 root canals (2%) were obturated beyond the radiographic apex . [table 1 , figure 3]

Where the homogeneity was concerned, post operative radiographs showed that 102 out of 150 root canals (68%) were homogeneously acceptably obturated whereas 48 root canals (32%) were scored as unacceptably obturated (table 2 , figure 4)

Also there some iatrogenic errors were detected as ledges in 3 root canals (2%) and separated instrument in 3 root canals (2%). (table 3, fig 5)

| Table 1 :Acceptable and unacceptable root canal filling | | | | | |
|---|--------------------|-----------|---------|---------------|--------------------|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Acceptable | 134 | 89,3 | 89,3 | 89,3 |
| | unacceptable under | 13 | 8,7 | 8,7 | 98,0 |
| | unacceptable over | 3 | 2,0 | 2,0 | 100,0 |
| | Total | 150 | 100,0 | 100,0 | |

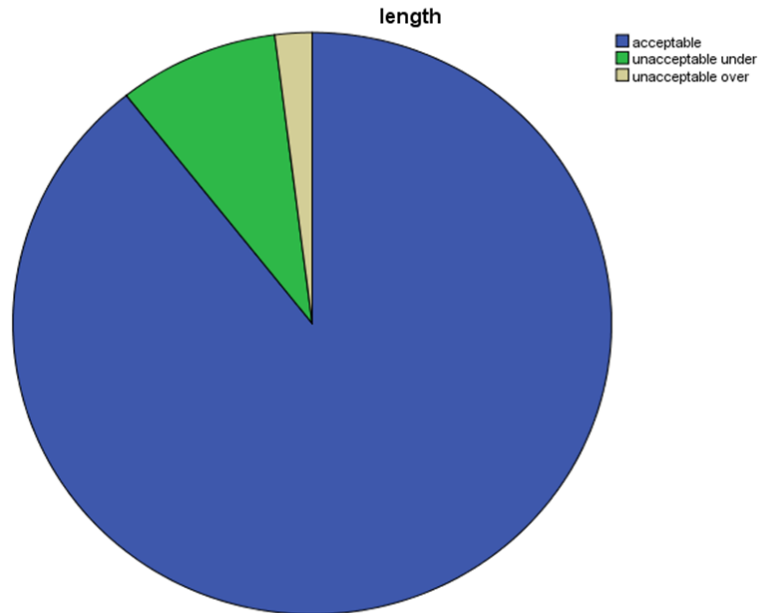


Figure 3: A pie chart showing acceptable and unacceptable root canal filling

| Table 2 : The quality of density of root canal fillings | | | | | |
|---|--------------|-----------|---------|---------------|--------------------|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | acceptable | 102 | 68,0 | 68,0 | 68,0 |
| | unacceptable | 48 | 32,0 | 32,0 | 100,0 |
| | Total | 150 | 100,0 | 100,0 | |

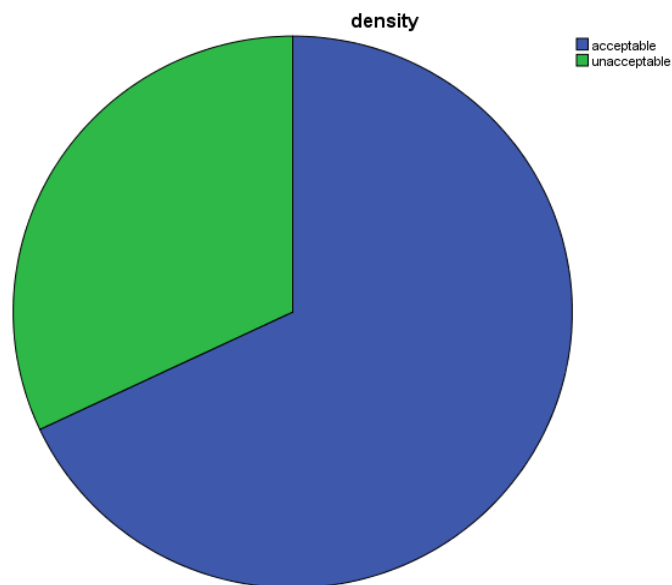


Figure 4: A pie chart showing the quality of density in root canal fillings

| Table 3 : Iatrogenic errors as ledge and separated instrument: | | | | | |
|--|----------------------|-----------|---------|---------------|--------------------|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Non | 144 | 96,0 | 96,0 | 96,0 |
| | separated insturment | 3 | 2,0 | 2,0 | 98,0 |
| | Ledge | 3 | 2,0 | 2,0 | 100,0 |
| | Total | 150 | 100,0 | 100,0 | |

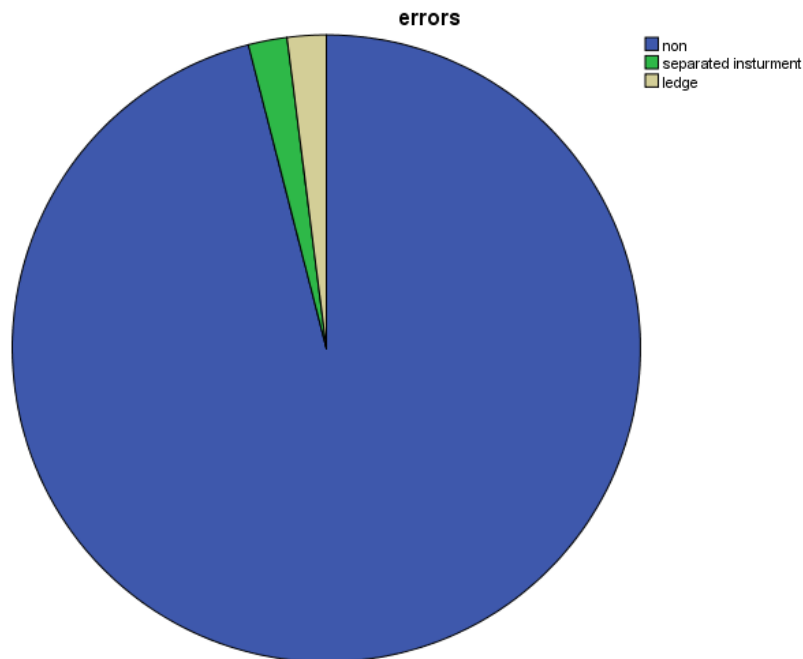


Figure 5: A pie chart showing Iatrogenic errors as ledge and separated instrument

5. DISCUSSION

This study was carried out to evaluate the quality of root canal treatment performed by undergraduate dental students using rotary nickel titanium files. At least three radiographs (preoperative, working-length and postoperative) of good quality were needed for each case to detect the original pathway of the canal. The analysis of adequate radiographs is important for successful rotary canal preparation. The root anatomy should be evaluated carefully as well as the existence, extent and position of canal curvatures.(Winter,2008).Additional radiographs during the treatment phase usually help to determine canal dimensions, curvatures. Assessment of quality of root canal filling was made using postoperative periapical radiographs. The post-operative radiographic appearance would give an idea about the success rate, however long term evaluation is necessary to deem clinical success (Cohen . 2011)

In the current study the quality of endodontic treatment performed by undergraduate students using rotary NiTi files was considered because recent experimental and clinical evidence showed that NiTi rotary files promoted improved preparation quality and reduced the incidence of preparation errors (Winter , 2008).

In this study, the following parameters were evaluated: the length of the root canal filling, the presence or absence of voids (density of obturation) , and iatrogenic errors as ledge and separated instrument. These parameters were chosen because several studies showed that the success of root canal filling depended on the absence of a pretreatment periapical lesion, root canal fillings with no voids, obturation to within 2.0 mm of the apex, and an adequate coronal restoration. (Torabenijade, 2015). Better success was achieved when the procedures terminated at or within 2 mm of the radiographic apex. Obturation shorter than 2 mm from the apex or past the apex resulted in a 20% lower success rate. Adequate length of obturation would ensure that the entire canal has been instrumented upto the apex of the tooth and could be presumed that an apical seal has been achieved. This would prevent subsequent ingress of microbes and infective material into the canal (Cohen , 2011)

In this study root canal filling was qualified acceptable when obturation terminated 0-2mm from apex. Many endodontists considered obturation within 2mm of the radiographic apex acceptable based on Kuttler's description of the anatomy of the root apex where the apical constriction (AC), was found to be 0.5 to 1.5 mm coronal to the Apical foramen . The AC is the part of the root canal with the smallest diameter and is the considered as the apical termination for shaping, cleaning, and obturation. Postoperative pain was greater and the healing process might be compromised generally when this area was violated by instruments or filling materials (Cohen , 2011)

The density of obturation was our second evaluation parameter. It ensures that the canal has been effectively debrided and most of the open dentinal tubules being sealed. It also ensures proper vertical and lateral compaction leading to improved sealing ability of the obturation material. The voids if present can affect the outcome of treatment as these voids could result in connection of voids with each other opening up either apically or coronally. Further the tissue fluids, proteins and bacteria can seep into these empty spaces which act as a reservoir of irritants leading to failure of endodontic treatment. (Mustafa ,2013).

Our third evaluation parameter was the presence of iatrogenic errors as ledges and separated instrument. As their presence might adversely affect the prognosis.(Torabenejad, 2015)

In this study 150 obturated root canals were evaluated from which, 134 root canals had adequate length obturation which have better prognosis . In a 5 year follow up study Burke et al. conducted that length of the root canal filling is the most important factor for the success of endodontically treated teeth.(Burke , 2009) Whereas 13 root canals were underfilled which may be due to a ledge created during preparation. Insufficient flaring, a poorly adapted master cone , and inadequate condensation pressure.

Over fillings were found in 3 cases in the present study which might be due to the consequence of overinstrumentation through the apical constriction or lack of proper taper in prepared canal. When the apex is open naturally or its constriction is removed during cleaning and shaping, there is no matrix against which to condense, uncontrolled condensation forces extrusion of materials . (Torabinejad, 2009).

Inadequate density of root canal filling was found in 48 root canals (32%) of the cases which may lead to failure of root canal treatment because of microleakage along the root filling.(Eriksen , 2001) Eriksen and Bjertness reported that the incidence of apical periodontitis was higher in root filled teeth with inadequate densities.(Eriksen, 1991) . The results of the present study indicated that adequate density occurred in 68% of cases which increase the success rate of root canal treatment with good coronal seal.

Some iatrogenic errors were detected as ledges in 3 root canals (2%) and separated instrument in 3 root canals (2%). However the percentage was negligible.

6. CONCLUSIONS

Under the conditions of this study, it was concluded that quality of root canal treatment performed by the fifth and sixth year students in uudent was acceptable. The quality of root canal obturation was good but better results could be obtained.

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