ORIGINAL RESEARCH

Evaluating the Quality of Root Canal Obturation Performed by Undergraduate Dental Students: A Retrospective Clinical Study

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Abstract

Aim and objective: The aim of the study was to assess the quality of obturation performed by undergraduate dental students in the endodontic clinics at the Department of Conservative Dental Sciences, College of Dentistry, Prince Sattam Bin Abdulaziz University,

Materials and methods: In this retrospective study, records of 400 patients were randomly selected for whom root canal treatment was performed by 4th and 5th year undergraduate dental students between academic year 2016 to 2018, and in 2019, an intraoral periapical (IOPA) radiographs were evaluated by an experienced endodontist. These radiographs were taken in straight (head on) technique and shift/SLOB (Same Lingual and Opposite Buccal) technique (when needed). Statistical analysis of the data was carried out using SPSS software and Chi-square test. The Statistical significance level was set at $P = 0.05$.

Results: This study showed that a total 149 patients were treated by 4th BDS students, in which around 63.5% had done adequate obturation and 36.5% suffered from some or the other problems related to obturation. In comparison, 5th year BDS students had performed endodontic treatment in 251 patients, 71% of them were adequately obturated and 29% had inadequate obturation. There was a statistically significant difference regarding the length of the root canal obturation (P=0.001). The frequency of adequate obturation was significantly higher in anterior teeth compared to premolar and molar teeth.

Conclusion: Within the limitation of this study, it was shown that more training was required for both 4th and 5th year undergraduate dental students, as most of them had absence of homogenization in their obturation and as well as underfilling of the root canal system. Adequate training is necessary for the students at the preclinical and clinical levels under close supervision to improve the quality of root canal obturation.

Clinical significance: This study will help in evaluating dental students who are performing the endodontic treatment and any incoherence that exists can be dealt with better teaching approaches. In addition, this study will enable us to know what improvements are required, so that better equipment, as well as novel techniques in endodontics, can be used for the overall development of students in pursuit of excellence.

Keywords: Dental radiography, Endodontic treatment, Endodontist, Root canal obturation, Undergraduate dental students.

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Introduction

Many studies have shown that having a poor-quality filling inside root canal leads to periapical pathologies that have many repercussions. Consequently, bad-quality of root canal filling can be considered as a pivotal factor for formation of radiolucency in periapical region. Hence, all efforts should be directed in improving obturation quality, which can be appreciated in the radiographs and this requires proper knowledge, skills, and training of the operating professionals along with use of appropriate technology.[1]

Overall, a successful root canal treatment is the essence of proper biomechanical preparation involving adequate disinfection and shaping of canal as well as seal tight obturation. This ensures that teeth with high quality of root canal fillings have less chance of developing apical periodontitis and will help the treated teeth to last longer. If properly performed, then success rate can be between 73 and 97% of all cases. The evaluation can be done with the help of Intraoral radiographs along with clinical assessment and if required then histological analysis. However, the whole process is determined by instrumentation, level, and density of obturation done checked by radiographs. So, in undergraduate trainee, it is imperative that trained faculty members need to supervise them which will enhance their clinical efficiency to handle as dentists are required to perform root canal therapy adequately and as such cases as refinement of the said skills will continue way beyond their undergraduate level. If the supervision is compromised then most likely the quality of treatment that undergraduates do will fall drastically.[2]

Ideal canal filling during obturation inside the root is to avert fluid leakage as well as microorganism's percolation. Consequently, fluid-tight seal in coronal as well as apical area is recommended worldwide. But to achieve this, seal is cumbersome and technically challenging which has led to development of many new obturation techniques as well novel techniques to achieve the obturation seal. Traditionally, cold lateral compaction technique is mostly used as well as taught in various dental colleges to undergraduate students since this is a safe and effective method as well as less

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costly and serves as a standard to which all the other techniques are compared to.[3]

Lateral compaction is most often used for filling root canals with oval shape but this method is not that effective when canal orifice turns tapering.[4] Subsequently, warm vertical compaction technique was introduced, which helps in achieving tight impervious seal with the help of thermoplastic materials in canals where anatomy is irregular. However, this technique has its challenges, as the technique requires plasticizing gutta-percha and it requires a lot of skill and diligence. This technique has a major pitfall as during obturation process, the filling material might be forced beyond the apex,[5] which will initiate periapical pathology.[6]

Density of the obturation material also plays a significant role in achieving a proper seal apart from proper adaptation of filling material and root canal. So as to reduce the chances of apical periodontitis, the obturation should be without voids and imperfections and should be homogeneous in nature.[7] Earlier studies indicated that students who performed obturation using traditional lateral compaction technique and assessed by radiographs were close to 53.2–90% close to ideal obturation.[8]

To assess the density and quality of root canal filling, radiographs are utilized. An ideal obturation should terminate within 0.5–1 mm short of the radiographic apex. Persistent development of periapical pathology is one the major outcomes, if the RCT is unsuccessful. So, undergraduate teaching of endodontics is imperative as well as challenging task.[9]

Thus, the aim of this retrospective study was to assess the quality of obturation performed by undergraduate dental students using lateral condensation technique, following objectives were evaluated with respect to quality of obturation in terms of length, taper, and density of obturation.

Materials and Methods

This retrospective study was carried out in Department of Conservative Dental Sciences, College of Dentistry, Prince Sattam Bin Abdulaziz University where post-obturation radiographs of root canal treatment performed by 4th year and 5th year undergraduate dental students were assessed. A random sample of 400 patient records from the academic period between 2016 and 2018 were selected and evaluated, after obtaining the consent from the institutional review board. The sample size of 400 was derived from previously available literature. The study has followed both inclusion and exclusion criteria. Inclusion criterion involves patient data that has both preoperative and postoperative radiographs and those patients whose root canal treatment was completed. Where the quality of radiographs was poor and lack of pertinent patient data was excluded from the study and those patients with age outside the range of 18–60 years and also where presence of incidence of various type of endodontic procedural errors were excluded from this study.

The root canal treatment was performed as per standard protocol in the students clinic under close supervision of an endodontists; a proper clinical history and patient details were obtained of each patient with a confirmative pulpal and apical diagnosis along with preoperative radiographs to assess the root and canal morphology. Teeth were isolated with a rubber dam, and estimation of the working length of the root canals was determined using radiographic method. Airotor handpiece was used along with round and as well as endo access burs for access cavity preparation. Stainless steel K-files were used for biomechanical preparation using the conventional step-back technique. Irrigation of the canals was carried out with 5.25% sodium hypochlorite solution. Obturation was done in all the teeth (anteriors, premolars, and molars) with lateral compaction technique utilizing Gutta-percha with AH-26 sealer. Temporary restorations were placed and all the patients were recalled after 7 days for placement of permanent restoration, if there were no clinical symptoms present after endodontic treatment. 4th year students concentrated mainly on anteriors and premolars with a few cases on molars as compared to 5th year students, where majority of cases comprised of molars.

A random sample of 400 patient records was selected that had their root canal treatment done, which was performed during 2016–2018, and in 2019, an intraoral periapical (IOPA) radiograph was evaluated. All radiographs (preoperative and postoperative) which were taken in straight as well as with shift/SLOB (Same Lingual Opposite Buccal) technique (when needed) were documented both electronically and as well as in their log-books, which was cross-checked for confirmation. To avoid any bias, a single eye was used, all the radiographs in this study were examined by an experienced endodontist with >10 years of clinical experience. The intraexaminer reliability was assessed at two intervals with a gap of 2 weeks using 20 radiographs (which were not included in the study) and it was found to be 95% reliable.

The obturation was assessed based on their taper, density, and length of root canal filling achieved after root canal treatment procedure Table 1. Teeth having missed canals were considered as a failure of the RCT (root canal treatment) of tooth as a whole. Presence of excessive voids throughout length of the root canal filling was considered as a failure for the density variable of obturation. Acceptable obturation quality was defined as adequate length and density with absence of any procedural errors. Results were drafted by faculty member on a student analysis form on a Microsoft Excel sheet, which were analyzed statistically by means of SPSS 20 software.

With the help of frequency analysis, various variables were calculated on the basis of root canal obturation which were assessed

Table 1: Criteria for the assessment of radiographic quality of root canal filling

Parameter	*Criteria*	*Definitions*
Length of root canal filling	Adequate	Root filling ending < 2mm from the radiographic apex
	Overfilled	Root filling beyond the radiographic apex
	Underfilled	Root filling ending > 2mm from the radiographic apex
Taper of root canal filling	Adequately tapered	Continuous tapering of the root filling from coronal end of the root till the radiographic apex
	Irregular and anomalous	Not tapering of the root filling from coronal end of the root till the radiographic apex
Density of root canal filling	Homogeneous	No voids present in the root filling or between root filling and root canal walls
	Irregular filling with voids	Irregular root canal filling with presence of voids in/or between root filling and canal walls.

for filling at the end of the root with radiographic apex, the density of the filling material, and taper from the orifice to apex. Chi-square test was utilized for analyzing the data, where level of significance was set at < 0.05.

Results

The teeth are grouped according to their locations in the jaws, i.e., upper and lower as shown in Figures 1 and 2, our study showed that a total of 149 patients were treated by 4th year BDS students, in which around 63.5% had proper obturation and 36.5% suffered from some or the other problems, which were evaluated by specialists. In comparison, 5th year BDS students performed endodontic treatment in 251 patients, 71% of them were adequately treated and obturated and 29% had endodontic issues Table 2.

Fourth year students performed endodontic treatment on single rooted teeth, i.e., anteriors and premolars with only few cases of operating molars. Whereas 5th year BDS students mainly performed RCT on molars and with a few cases of single rooted teeth with level of significance of 0.03. Ideal obturation length of root canal obturation was achieved in teeth treated by 5th year BDS students with a level of significance of 0.001 and Chi-square value of 9.57.

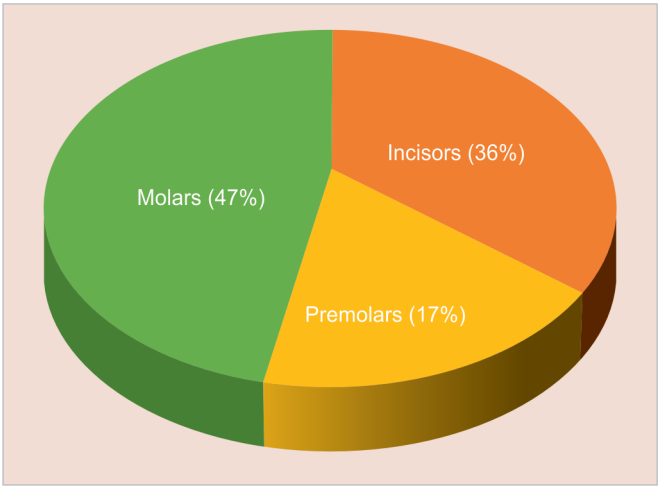

Fig. 1: Distribution of teeth types (%)

It was observed that taper of the obturated filling was better in case of 4th year BDS students, as they concentrated more on treating a single canal as compared to 5th year BDS students who focused their attention on obturating multiple canals, with a level of significance measured as 0.044 and a chi-square of 11.37. In comparison, 4th year BDS students performed better in terms of density of homogeneous obturation as compared to 5th year students with level of significance estimated at 0.04 and Chi-square value was 11.32, possibly due to obturation of single canals carried out by 4th year batch as shown in Table 3. However, treatments done by 4th year students shows that molars were difficult to treat due to multiple canals as compared to premolars and anterior teeth.

It was also observed that in anteriors, around 84.6% of cases had proper length of obturation as well as near to ideal taper in almost 98.6% cases. Few voids were visible in some cases leading to drop in adequate density of obturation to 92.3%. In case of premolars (maxillary and mandibular), 80% of cases achieved ideal taper of obturation filling. However, only 70% of cases had adequate length of obturation, perhaps due to curved canals in bicuspids. Number of voids was also on the higher side as compared to anterior teeth, where only 72.8% of cases had adequate and homogeneous density of obturation material.

Considering molars, proper length of obturation was achieved in only 65.7% cases with some of them facing the ledge formation issue. 77.5% of cases had taper near to ideal. However, a major setback came from density of obturation in case of molars, where only 59.8% could successfully manage to have a homogeneous obturation Table 4.

Discussion

Each and every step during the root canal treatment process needs to be done properly and diligently with strict asepsis in biomechanical preparation and disinfection of canals, as it will affect treatment outcome. The success rate of such an ideal preparation will come close to almost 94%. However, errors can creep up in various ways in which inaccurate estimation of length of canal leading to inadequate filling or overfilling of the root canal. Sometimes, ledge formation perforations, instrumentation breakage, and apical transportation can occur along with obturation anomalies such as inadequate homogeneity, voids, and irregular taper; these all mishaps lead to poor outcome as well as

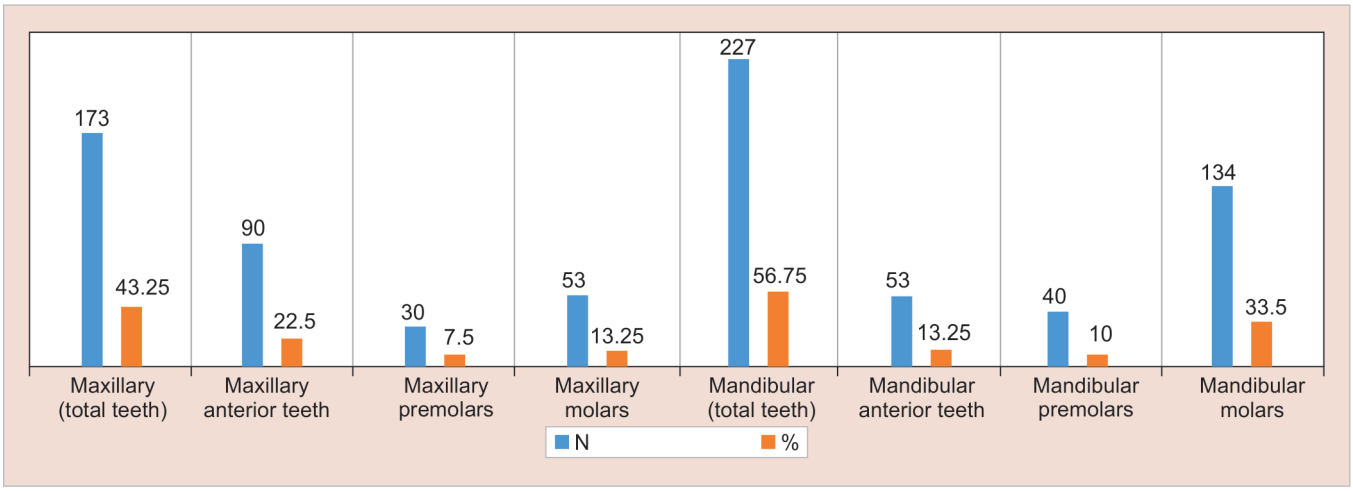

Fig. 2: Distribution of maxillary and mandibular teeth (teeth types) *N* = 400

Table 2: Teeth types, level of difficulties, and obturation status

Teeth type	*Sample size (N = 400)*	*Level of difficulty (4th year)*	*Level of difficulty (5th year)*	*Obturation status (4th year)*	*Obturation status (5th year)*
Anteriors	143	Low	Low	63.5% (adequately filled) 36.5% (inadequately filled)	71% (adequately filled) 29% (inadequately filled)
Premolars	70	Medium	Low to medium		
Molars	187	High	Medium to high		

Table 3: Analysis of obturation achieved based on individual teeth type

Teeth type	*Length*	*Level of significance*	*Taper*	*Level of significance*	*Density*	*Level of significance*
Anteriors	84.6	9.57 ($p = 0.001$*)	98.6	11.37 ($p = 0.044$*)	92.3	11.32 (p=0.04*)
Premolars	70.0		80.0		72.8	
Molars	65.7		77.5		59.8	

Chi-square test*

Table 4: Comparison of the cumulative obturation done by 4th and 5th year BDS students on various parameters

Participants	*Length*	*Taper*	*Density*
4th year	Overfilled (12%)	Adequately tapered (82%)	Homogeneous (46.5%)
	Underfilled (24.5%)		Irregular filling with voids (53.5%)
	Adequately filled (63.5%)	Irregular and anomalous (18%)	
5th year	Overfilled (7%)	Adequately tapered (67.8%)	Homogeneous (57%)
	Underfilled (22%)		Irregular filling with voids (43%)
	Adequately filled (71%)	Irregular and anomalous (32.2%)	

prognosis of the endodontic treatment. In case of underfilled root canal, success rate comes down to almost 68% and in the case of overfilled obturated canal, success rate is just over 76%.[10] Root canal fillings, which are inadequate, will lead to microleakage ultimately resulting in root canal failure.[11] Periodontitis was observed in many cases studied by Erikson and Bjertness; where the root canal filling was not of adequate density.[12]

Self-evaluation after a dentist graduate is very important about his/her development of their skill for carrying out proper endodontic treatment. It is important to recognize any deficiencies that they face in doing treatment procedure. Continuous training as well updating their knowledge is needed even after passing out of graduation to sharpen their skills.[1] According to Ahmed et al., interns were assessed in their obturation process of the endodontic treatment. He came to conclusion that around 45% had problems with working length determination and in turn obturation problem. Five teeth also showed instrument fracture inside the root canal.[13]

It has also been observed that so as to properly fill all the irregular areas such as isthmus areas or lateral canals, [5,14] warm vertical compaction is much better than lateral condensation technique which is most commonly used at undergraduate level.[15] While using warm vertical compaction technique, complications such as extrusion of root obturation filling material from apical foramen as well as increased heat-related destruction to nearby periodontal tissues[16] can be noteworthy disadvantages of this technique.

The results clearly demonstrated that 5th year BDS students had more experience as compared to 4th year students. However, since most of the 4th year students had treated mostly on single rooted teeth, the density of obturation was better as compared to 5th year BDS students, who treated multiple canals of molars. Few cases also showed numerous voids in obturation which was done. Barrieshi-Nusair et al. conducted a radiographic study to assess the quality of root canal treatment performed by dental students at the dental teaching center in Jordan and it was noticed that 61% of teeth had proper root canal filling, whereas 34.5% had underfilled and 4.5% of teeth had overextended filling of the root canal system.[8]

To enhance a root canal filling of molars as well as teeth with curved canals, adequate training is required as there are always some glitches in treating them. With training in pre-clinical laboratories as well attending various seminars to refresh and update the knowledge base, will certainly help in treating problematic cases in endodontics. It helps the students to get acquainted with procedures as well as precautionary measures so as to manage cases with curved canals. It is imperative that some sort of supervision is necessary as cases need to be given to the undergraduate students on their level of experience and handling difficulties.[17] in case of 4th year BDS students, they need to get accustomed to simpler cases of anterior teeth and later proceed to more complex ones, which will certainly reduce margin of error as well. 5th year students should be encouraged to handle cases of molar root canal treatment so that later on, they can smoothly handle difficult cases of curved canals as well. Whereas cases of higher difficulties should be referred to specialists.[18]

It is imperative that a dentist should develop skills, which will enhance their self-evaluation so that they can utilize this in solving complex endodontic cases.[19] It is also important for a student to be an active learner, which is desirable to understand new techniques.[20,21] A survey conducted in 2013 showed that 92% of dental students preferred interactive techniques for grasping new knowledge, group-based case-related discussions.[22,23] Therefore, it all depends upon the teachers to initiate such sessions for the students so that they can be engaged in a better way for learning.[24,25] However, the limitation of this study was related to Intraoral periapical (IOPA) radiographic analysis, as it does not replicate the exact quality of root canal obturation since IOPA is a 2D (dimensional image) of a 3D (dimensional object), so there is a possibility of superimposition of anatomical structures when radiographs were assessed.

Conclusion

Within the limitation of this study, it has shown that more training was required for both 4th and 5th year undergraduate dental students, as most of them had absence of homogenization in their obturation and as well as underfilling of the root canal system. Adequate training is necessary for the students at the preclinical and clinical levels under close supervision to improve the quality of root canal treatment.

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