

# RETROSPECTIVE DIGITAL X-RAY ASSESSMENT OF ROOT CANAL TREATMENT PERFORMED BY UNDERGRADUATE IN THE KINGDOM OF SAUDI ARABIA

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## ABSTRACT

**Background:** Root canal therapy consists of a sequence of scientifically based technical procedures. The presence of an error in any of these procedures lead to a dire consequence. Errors are classified into errors related to working length, cleaning, shaping and errors related to the quality of obturation. The root canal system has complex and highly variable morphology that causes challenges to dental.

**Objective:** This study aims to assess the radiographic technical quality of root canal treatment performed by undergraduates in the western region of Saudi Arabia.

**Methodology:** A retrospective observational study design and focused on students and interns in the western region of Saudi Arabia. randomly selected cases performed by undergraduates. with criteria includes that all selected roots are the permanent maxillary and mandibular teeth, and all treated with manual or rotary files and we will randomly be collected. A Postoperative periapical digital radiograph only is used to conduct assessments.

**Result:** During the academic years 2018-2020, a total of 1,264 endodontic root canal treatment (RCT) was carried out by dental undergraduates in the western region of Saudi Arabia. Out of the total sample, (62.03%) were root canal treated in the mandibular jaw; and (37.97%) were root canal treated in the maxillary jaw all these cases were carefully analysed.

**Conclusion:** This was concluded within the focus of this research; the most common endodontic (RCT) procedural error was seen poorly filled were radiographically visible voids followed by overfilling.

**Key words:** Endodontic Error, Endodontic Mishaps, Root Canal Therapy.

## Introduction

Root canal therapy consists of a sequence of scientifically based technical procedures <sup>1-4</sup>. The main objective of endodontic root canal treatment is to remove or reduce the microbes from root canal space by biomechanically-instrumented root canals, irrigating, disinfecting, and obturation. <sup>5</sup> Root canal treatment may have taken multiple visits, based on scientific procedures, with one of the key reasons being that it took a substantial period to complete the treatment. <sup>6</sup> Thorough debridement and cleaning of the root canal system of any contaminated pulp tissue is the purpose of endodontic care so that the canal space can be formed and prepared to be filled with an inert material, thereby avoiding or reducing any risk of reinfection. <sup>7</sup> Endodontic therapy requires removal of such structures, formation, contamination of the cleaning cavity with disinfectant solutions, and blockage of infected canals <sup>8</sup>. The reason many teeth do not respond to root canal therapy is due to

procedural errors that restrict intracanal endodontic infection control and prevention <sup>9</sup>. It has been said that various factors lead to endodontic treatment failures. These include microbial cultures, residual necrotic pulp tissue, fractured instruments, overfilling of the root canal, mechanical perforations, root fractures, and periradicular lesions <sup>10</sup>.

Endodontic errors are also known as endodontic mishaps that can be resulted in a lack of knowledge, misunderstanding, or compromise in the sequence of proper procedures. These include errors related to cleaning and shaping (i.e., ledge formation, apical transportation, perforations, and instrument fracture), errors related to length (i.e., overfill and underfill), and errors related to the quality of obturation (i.e., voids, deficiency of uniform and continuous taper, and lack of homogeneity). The presence of such errors can produce dire consequences <sup>11</sup>. These accidents may occur during diagnosis. Also, they can occur during access preparation, cleaning and shaping, obturation,

and post-space preparation. One of several endodontic root canal errors is the Canal transportation that refers to stripping of dentin from the external wall of the curvature in the apical half of the canal, which is due to non-pre-curve & straighten up of the file and return to its original straight shape during the preparation of curved root canals. Ledge may be formed and also, the possible perforation of the canal<sup>12</sup>. The access of instruments to the apex is hindered by the Ledge formation, which is the iatrogenically formed irregularity in the root canal, and canal blockage caused by packing dentin chips and/or Residual tissue debris are the lesser-studied causes of root canal instrumentation<sup>13</sup>.

Perforation is a pathologic or iatrogenic communication between the root canal space and the periodontal tissues<sup>14</sup>. As a problem of perforation is coronal leakage has been one of the major causes of failure. Bacteria have been shown to penetrate the obturating materials of the root canal and impact the periapical tissues<sup>15</sup>. Like other dental operations, RCT procedures may be disrupted by unpredictable and undesirable circumstances called "Procedural Incidents." Complex therapies and poor prognosis for RCT may be important for the possible incidence of procedural incidents in primary stages<sup>16</sup>. Endodontic treatment failure can be assessed based on clinical signs and symptoms and radiographic observations of the tooth treated by the root canal<sup>17</sup>. According to that the accurate technique for evaluating the technical quality of RCT is radiographic evaluation<sup>18</sup>. This process of evaluation is critical because the consistency of obturation of the root canal significantly influences the therapy prognosis<sup>19</sup>. The technical consistency of root canal obturation is determined by many factors, including the distance between the end of the root canal obturation material and the root apex, density, presence of voids, and taper<sup>20</sup>. Some unforeseen or unwanted challenges that can affect the prognosis of treatment could be associated with Endodontics. The root canal system has a very complex and variable morphology This causes challenges to a dental student by whom errors may commonly occur. Some of the causes of endodontic failure that have been considered are endodontic procedural errors like missed canals, ledges, zipping, broken files, perforations, and voids in the root canal filling. A survey study for the evaluation of endodontic errors among undergraduate dental students in two dental schools in Riyadh, Saudi Arabia was conducted in 2013; the reported percentage of endodontic errors was 68%<sup>16</sup>.

Several studies report a strong association between apical periodontitis and inadequate technical quality of root filling. Furthermore, the quality standards of root canal therapy (RCT) performed in general practice and dental teaching hospitals have been shown to be unsatisfactory<sup>21</sup>. Among

the causes of poor-quality endodontic treatment in general practice is lack of expertise and previous studies have reported success rates >90% for nonsurgical RCT under controlled conditions. However, the high success rate decrease to 40–65% in cases where RCT is performed by general practitioners has been reported. There was a radiographical evaluation of the 315 roots of 105 teeth that were endodontically treated in preclinical practice in a 2015 retrospective cross-sectional study<sup>22</sup>. In 35.6% of the cases, the undergraduate dental students performed a technical quality of preclinical molar RCTs that was considered acceptable<sup>23</sup>. This study is done because there are not sufficient studies about procedural errors in root canal treatment done by undergraduates in the western region of Saudi Arabia and to identify the errors that the undergraduates make and developing the educational system within dental colleges in the western region of Saudi Arabia. The objective of this research is to assess the radiographic technical quality of root canal treatment done by undergraduates. And the secondary objectives are to determine the most common tooth and canal affected by root canal treatment errors and to find out the most tooth treated with root canal treatment.

#### Methods:

This is a retrospective study based on collected data from digital radiographic x-ray for endodontic root canal treatment performed by students and interns. During the academic years 2018-2020, a total of 1,264 endodontic root canal treatment (RCT) carried out by dental undergraduates in the western region of Saudi Arabia were selected to evaluate the radiographic quality of the root canal treatment. The subject was randomly selected, with inclusion criteria that are all permanent maxillary and mandibular teeth prepared with manual or rotary files by undergraduates male and female study in private or governmental colleges in the western region of Saudi Arabia, and an exclusion criterion are all primary maxillary and mandibular teeth and all root canal treatment performed by general dentists or specialists.

Working length and density of filling in the absence of iatrogenic errors determine the radiographic categorization of root treatment and they were classified as acceptable and unacceptable as follows:

1- The acceptable treatment is underfilling radiographic apex is 0-1 mm and the density of filling material is homogeneity with no visible void within the material and there is no iatrogenic error in canals.

2- The unacceptable treatment is the filling material ends more than 1mm from the radiographic apex or beyond the radiographic apex and when the density of filling material is not homogeny and there is a void between crown to the apical area and when there is iatrogenic error is observed in canals.

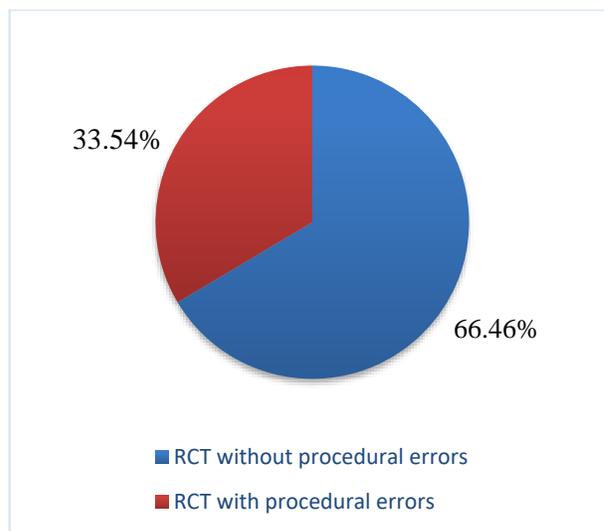
We use a postoperative periapical digital radiograph to conduct assessments for evaluation of complications of RCT (radiographs were already taken). the radiograph interpretation is done by the endodontist with many years of experience and assistance with authors.

Evaluated the technical quality: (homogeneous density of filling material from coronal area to apical area, over instrumentation, under instrumentation, and procedural errors of RCT in the x-ray. Criteria of error analysis: All the errors were divided into three major errors: first the errors during providing access cavity: Crown perforation, Missed canal, Furcation perforation. Second the errors during cleaning and preparation: Ledge, Apical Transportation, Broken instruments, root perforation. Third the errors during canal obturation: Void, Overfilling, Under filling.

**Results**

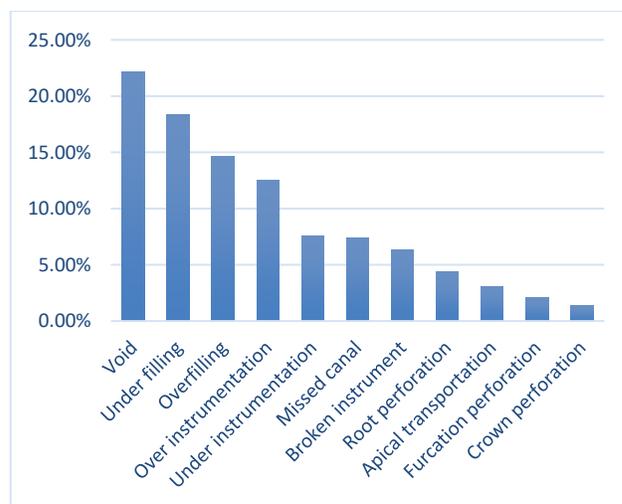
During the academic years 2018-2020, a total of 1,264 endodontic root canal treatment (RCT) was carried out by dental undergraduates in the western region of Saudi Arabia. Out of the total sample, 784 (62.03%) were root canal treated in the mandibular jaw; and 480 (37.97%) were root canal treated in the maxillary jaw all these cases were carefully analyzed.

Out of the total root canal treatment (RCT) was determined, 424 (33.54%) roots contained an endodontic (RCT) procedural error, and 840 (66.46%) roots without endodontic (RCT) procedural errors. (See Figure 1)



**Figure 1.** Frequency of endodontic root canal treatment procedural error

Frequency of endodontic (RCT) procedural error in all treated roots, was 424 (33.54 %). frequencies of endodontic (RCT) procedural error were as follows: obturation Void, 94(22.17%); obturation Under filling, 78 (18.39%); obturation Overfilling, 62 (14.63%); over instrumentation, 53 (12.5%); under instrumentation, 32 (7.55%); Missed canal, 27 (7.38%); Broken instruments, 62 31 (6.37%); root perforation, 19 (4.49%); apical transportation, 13 (3.07%); Furcation perforation, 9 (2.12%); and crown perforation, 6 (1.42%). (See Figure 2)



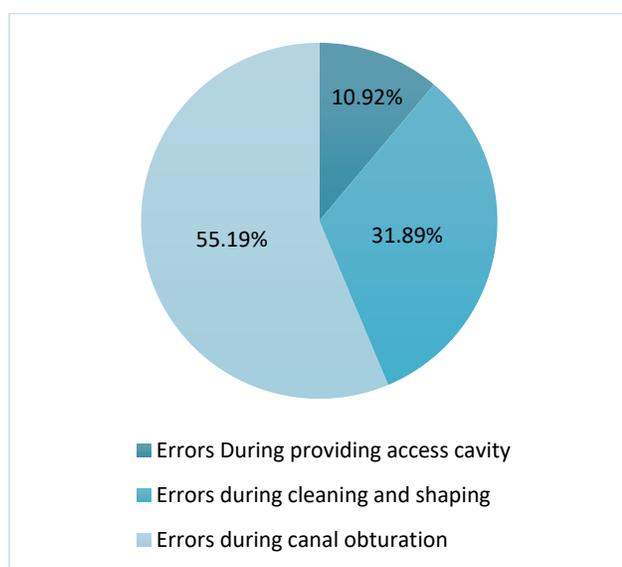
**Figure 2.** Frequency of endodontic (RCT) procedural errors in all treated roots.

The upper right molar roots showed the highest frequency of endodontic (RCT) procedural errors in the overall study (56.72%), while the lower root incisors showed the lowest frequency of endodontic (RCT) procedural errors (18.32%). (see Table 1)

**Table 1:** The distribution of (RCT) procedural errors.

Type of Tooth & Roots	(With) procedural error	(Without) procedural error
Upper molar roots	56.72%	43.28%
Lower molar roots	41.53%	58.47%
Upper premolar roots	38.21%	61.79%
Lower premolar roots	32.64%	67.36%
Upper incisor roots	25.32%	74.68%
Lower incisor roots	18.32%	81.68%

All the procedural endodontic (RCT) errors were classified into three (RCT) phases errors. Procedural errors during providing access cavity, errors during cleaning and shaping, and errors during canal obturation. The endodontic procedural errors during canal obturation showed the highest frequency (55.19%), while the errors during providing access cavity showed the lowest frequency (10.92%). (See Figure 3)



**Figure 3.** Frequency of endodontic (RCT) procedural error among three (RCT) phases errors.

### Discussion:

This research was conducted to analyse the endodontic (RCT) procedural error and to detect the most frequent procedural error of RCT performed by dental undergraduate between 2018-2020. The levels of inter-examiner variability and intra-examiner reproducibility affect the assessment of endodontic (RCT) procedural error during radiographic interpretation. In our research, the high inter-examiner variability and intra-examiner reproducibility values supported a high level of reliability of the evaluation of the material. A Postoperative periapical digital radiograph only is used to conduct assessments. Any radiographs showing tooth superimposition over root canal filling and anatomical structures were excluded to ensuring the radiographic analysis is not mistaken.

In compliance with the European Guideline and preceding RCT outcome studies by dental graduates, RCT radiographic standard standards have been established <sup>24, 25</sup>.

Many studies report, periapical health and improved outcomes of RCT were most likely to be associated with dense root fillings, 0 to within 2 mm from the radiographic apex. <sup>26</sup> In the present study, these radiographic criteria were used to measure the accuracy of root fillings conducted by undergraduate students. Specific criteria have been used by others <sup>24</sup>

In this study, it was found that undergraduates treated more root canals in the mandibular more than the maxilla. An endodontic RCT procedure error was observed in a significantly great minority (33.54%). The trend appears similar to some Smadi L 2015 et al <sup>27</sup> and different from others <sup>5, 28, 29</sup>. These variations can exist based on various standards used in the assessment, methods, radiographic criteria, sample size, educational process, etc.

The most frequent endodontic (RCT) procedural error was voids (22.17%) (see Figure 2). Similar findings from other studies show that voids Adequate in length, but inadequate in density, when the filling ending was situated 0-2 mm short of the radiographic apex, but there were radiographically visible voids. <sup>25</sup> However, other studies have not incorporated the voids variable. The anatomy of root canal treatment of the anterior teeth is less complicated than those of the posterior teeth. The frequency of endodontic (RCT) procedural error in this study was the highest for the upper molar roots (56.72%), followed by the lower molar roots (41.53%); and the frequency of an endodontic RCT (without) procedural error in this study was the highest for the lower anterior teeth (81.68%), followed by the upper anterior teeth (74.68%); this result was consistent with that of previous studies <sup>5, 30, 31</sup>.

The potential limitations of the methodology used should be known. The nature of the retrospective analysis restricted the details available to that which comes from the radiographic record base. Moreover, technical errors may have been introduced by the underlying limits of radiographic examination and interpretation. The radiographs were not taken in a purely uniform and reproducible way. Besides, the radiographic appearance of the measured parameters is influenced by shifts in beam and sensor angulation. Periapical radiographs cannot often correctly represent buccolingual root canal curvatures, as well as technical errors. For example, the effect of either a ledge or apically packed dentin chips and debris can be a short filling. Also, it has been seen that the radiographic appearance of the root

canal filling and its adaptation and compaction have a minimal association.

Overall, the results of this study showed a significantly great minority of endodontic (RCT) procedural error that could be attributed to several reasons: the study design, the radiographic criteria applied, the inexperience of undergraduate students, the endodontic curriculum, or the lack of proper equipment but we suggest a need for undergraduate and supervisors to be more meticulous during steps of root canal treatment.

### Conclusion

This was concluded Within the focus of this research; the most common endodontic (RCT) procedural error was seen poorly filled were radiographically visible voids followed by overfilling. Posterior teeth showed higher frequencies of endodontic (RCT) procedural error compared to anterior teeth.

### Conflicts of interest:

The authors have no conflicts of interest to declare.

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### Ethical approval:

The Institutional Review Board at Alfarabi College, Jeddah, Kingdom of Saudi Arabia (reference: IRB 20-8/3) approved this study.

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