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OF MEDICINE AND HEALTH SCIENCES

# **THE RELATIONSHIP BETWEEN ENDODONTIC CASE COMPLEXITY AND TREATMENT OUTCOMES**

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## **ABSTRACT**

# **The Relationship between Endodontic Case Complexity and Treatment Outcomes**

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### **Introduction**

The primary goal of endodontic therapy is to prevent or heal apical periodontitis. Dental pulp has a complex internal anatomy, a thorough knowledge of both root and root canal morphology is, therefore, a fundamental prerequisite to help ensure optimal outcomes of root canal treatment.

### **Aim**

The aim of this work is to correlate between endodontic case complexities and treatment quality outcomes.

### **Materials and Methods**

A total number of 349 radiographs of patients who had received endodontic treatment during the period (2012-2015) at Hamdan Bin Mohammed College of Dental Medicine- Mohammed Bin Rashid University were selected. Unreadable radiographs due to technical errors, superimposed anatomical structures, and incomplete treatments were all excluded. From the original sample of 349, in total 51 radiographs were discarded. The final sample thus consisted of 298 root canal fillings of 211 patients treated by the endodontic residents.

All radiographs were individually evaluated following the American Association of Endodontic Case Difficulty Assessment Form. Base on this, the technical quality of the root filling which depends on two main parameters density of the root filling and the distance between the end of the root filling and radiographic apex was evaluated for each individual case.

## **Results**

The sample evaluated consisted of 53% of high, 35% of moderate and 12% of minimal difficulty cases. Adequate homogeneity of root canal fillings were found in 93% of the cases. This compared with 90% of cases with adequate length of root fillings. Thus 84% ( $0.93 \times 0.90 = 0.84$ ) of the cases were considered to have good quality endodontic work. There were statistically significant differences between the length of root canal filling and level of difficulty ( $p=0.016$ ) but, no statistically significant difference between homogeneity of root canal filling and case difficulty ( $p=0.794$ ).

## **Conclusion**

The referral pattern (53% high and 35% moderate difficulty) indicates that Hamdan Bin Mohammed College of Dental Medicine is considered a secondary/tertiary referral centre. A high percentage (84%) of the cases treated were proved to be adequate in terms of length and homogeneity. There were statistically significant differences between length of root canal filling and case difficulty but, not between homogeneity and case difficulty.

## **DEDICATION**

*I dedicate my dissertation work to my Almighty God, who gave me the strength and knowledge every day of my life. Sincere thanks to my parents and my family in law, I could have never completed this without their understanding, constant encouragement and unlimited support. I also dedicate this dissertation to my loving husband and daughters who have supported me throughout the process.*

## **DECLARATION**

I, Hessa Fezai, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

Signature:

Date:

## **ACKNOWLEDGMENT**

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## **CHAPTER ONE**

### **INTRODUCTION**

The primary goal of endodontic therapy is to prevent or heal apical periodontitis. A thorough knowledge of both root and root canal morphology is a fundamental prerequisite to help ensure optimal outcomes of root canal treatment.<sup>(1)</sup> From a biomechanical perspective this means cleaning, shaping, and disinfection that would allow for three-dimensional obturation of the root canal system.<sup>(2,3)</sup> This includes careful preoperative assessment and intraoperative care to identify the landmarks of normal morphology as well as any unusual anatomy of the root and root canal system. A good understanding of external and internal root anatomy will help to reduce the number of missed root canals during treatment, thus increasing the rate of favorable outcomes following root canal treatment.<sup>(4)</sup> However, the complexity of the root canal anatomy presents clinical challenges and difficulties that often jeopardize the primary goal of such therapy.<sup>(5,6)</sup> Knowledge of both normal and abnormal anatomy dictates the parameters of root canal therapy and can directly affect the probability of success.<sup>(7)</sup> Endodontic therapy should be preceded by a thorough knowledge of pulp chamber and root canal anatomy. Once this complex anatomy has been accessed, the outcome is directly related to the elimination and prevention of microbial contamination.<sup>(8)</sup>

## **1.1 Root Canal Anatomy**

The root canal anatomy of human teeth is complex and has been a source of immense research interest. As early as 1925 when Hess<sup>(9)</sup> studied the root canal anatomy by injecting Vulcanite resin into the root canals. Okumura<sup>(10)</sup> who stressed the advantages of dye injection and clearing of the teeth for studying the morphology and anatomy of root canals gave a simple root canal classification. Various techniques such as sectioning, radiography, dye penetration and clearing, post-treatment clinical examination to modern day cone beam computed tomography techniques have been used to study the root canal anatomy.<sup>(11-15)</sup> Similarly, various classifications for root canal morphology have been suggested by Okumura, Weine et al. and Vertucci.<sup>(10,12,13)</sup>

## **1.2 Components of The Root Canal System**

The entire space in the dentine of the tooth where the pulp is housed is called the pulp cavity. The outline corresponds to the external contour of the tooth.<sup>(16)</sup> However, factors such as physiologic aging, pathology and occlusion shape its size by the production of secondary and tertiary dentine and cementum. Nearly all root canals are curved particularly in a facial-lingual direction.<sup>(17)</sup> These curvatures may pose difficulties during the endodontic procedures because they are not evident on a standard two dimension radiograph. Normally more than one conventional radiograph (parallax views) are needed to help detect additional canals and unusual anatomical variations. A curvature may be a gradual curve of the entire canal or a sharp curvature near the apex. Double 's-shaped' canal curvatures can also occur.

### **1.3 Apical Region of The Root**

The classic concept of apical root anatomy is that there exist three anatomic and histologic landmarks namely the apical constriction (AC), the cemento-dentinal junction (CDJ) and the apical foramen (AF). <sup>(10)</sup>The anatomy of the root apex as described by Kuttler <sup>(18)</sup>shows the root canal tapering from the canal orifices to the AC which is generally 0.5–1.5mm inside the AF. It is considered to be the part of the root canal with the smallest diameter. It is the reference point most often used by dentists as the apical termination of shaping, cleaning and obturation procedures. The CDJ is the point in the canal where cementum meets dentine. <sup>(10)</sup> It is the point where pulp tissue ends and periodontal tissues begin. Its location in the root canal is highly variable. The mean distance between the major and minor diameters has been determined to be 0.5mm in a young person and 0.67mm in an older individual. <sup>(19)</sup> The increased length in older individuals is due to the increased buildup of cementum. Cementum reached the same level on all canal walls only 5% of the time. The greatest extension generally occurred on the concave side of the canal curvature. This variability reconfirmed that the CDJ and AC are generally not the same area and that the CDJ should be considered just a point at which two histologic tissues meet within the root canal. <sup>(20)</sup>

### **1.4 Root Canal Treatment**

Endodontic treatment is primarily the combination of chemo-mechanically preparation of the root canal space to facilitate the placement of a biocompatible material that seals the canal throughout its entire length. Ultimately the purpose is to remove microorganisms and provide a good quality three dimensional obturation. <sup>(2,3)</sup>

Preparation of the root canal system is recognized as being one of the most important stages in root canal treatment. <sup>(3,21)</sup> It includes the removal of vital and necrotic tissues

from the root canal system, along with infected root dentine and, in cases of retreatment, the removal of metallic and non-metallic obstacles. It aims to prepare the canal space to facilitate disinfection by irrigants and medicaments. Thus, canal preparation is the essential phase that eliminates infection. Prevention of reinfection is then achieved through the provision of a fluid-tight root canal filling and a coronal restoration. Although mechanical preparation and chemical disinfection cannot be considered separately and are commonly referred to as chemo-mechanical or biomechanical preparation.<sup>(22)</sup>

Schilder <sup>(3)</sup> described five design objectives:

1. Continuously tapering funnel from the apex to the access cavity.
2. Cross-sectional diameter should be narrower at every point apically.
3. The root canal preparation should flow with the shape of the original canal.
4. The apical foramen should remain in its original position.
5. The apical opening should be kept as small as practical.

And four biologic objectives:

1. Confinement of instrumentation to the roots themselves.
2. No forcing of necrotic debris beyond the foramen.
3. Removal of all tissue from the root canal space.
4. Creation of sufficient space for intra-canal medicaments.

The final objective of endodontic procedures should be the total obturation of the root canal space. One of the controversial debates regarding root canal therapy is the limit of instrumentation and final obturation. The great majority of studies confirm the

practice of staying short of the apex along with a homogeneous obturation to obtain the highest success rate of 90-94%.<sup>(23)</sup>

Many studies (Weine<sup>(24)</sup> Kuttler's<sup>(18)</sup> and Ingle<sup>(25)</sup>) have stated that obturation should terminate 0.5 to 1 mm short of the radiographic apex which corresponds to the narrowest diameter of the apical foramen located at CDJ. This, thus, avoids over instrumentation which can lead to displacement of toxins in to the periapical tissues and overfilling.<sup>(18,24,25)</sup>

### **1.5 Classification of Root Canal Treatment Complexity**

In order to improve the success rate of root canal treatment in general dental practice, the referral of difficult cases to dentists with advanced knowledge and training in endodontics should be made possible for the benefit of patients.<sup>(26-28)</sup> General Dental Practitioners (GDPs) must, therefore, be able to judge the difficulty of the endodontic case. A study has reported that 20% of general dentists refer all endodontic cases to endodontists, and another 20% never refer endodontic cases. The remaining 60% of general dentists selectively assess what cases to treat and to refer.<sup>(29)</sup>

Falcon et al.<sup>(30)</sup> have described the development of an index of restorative dental treatment need. With this index, which also comprised the components of need and priority for treatment, clinicians determined levels of complexity of treatment for endodontics, periodontics, and fixed and removable prosthodontics. The authors found that the treatment complexity component was a practical tool capable of being used by a range of dentists (Figure1).

Figure 1: Restorative Index of Treatment Need

## 5.2 Root Canal Treatment Assessment

### Root Canal Treatment Assessment (Permanent Teeth)

Conventional root canal treatment or retreatment is the clinical procedure of choice.

Surgical treatment should only be considered when conventional treatment is inappropriate.

- Single/Multiple root canals with curvature  $< 15^\circ$  to root axis that are considered negotiable from radiographic or clinical evidence through their entire length. No root canal obstruction or damaged access
- Incision and drainage

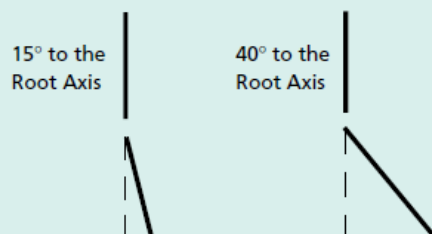
= Complexity 1

- Single/multiple root canals with curvature  $> 15^\circ$  but  $< 40^\circ$  to root axis that are considered negotiable from radiographic or clinical evidence through their entire length.
- Teeth with incomplete root development

= Complexity 2

- Single/multiple root canals with curvature  $> 40^\circ$
- Single/multiple root canals that are **NOT** considered negotiable from radiographic or clinical evidence through their entire length
- Periradicular surgery
- Teeth with iatrogenic damage or pathological resorption
- Teeth with difficult root morphology

= Complexity 3






The American Association of Endodontists (AAE) has published a complexity index<sup>(31)</sup> based broadly on patient, diagnostic and treatment considerations. Risk is related on a numeric scale to the degree of complexity as average, high or extreme risk. Those conditions present in the minimal difficulty were assigned a value of 1 point, moderate difficulty a value of 2 points. Furthermore, the conditions located in the high difficulty column were given a point value of 5. At the completion of the evaluation of each case, the sum of the point value of all conditions applicable compared to the recommendations given by the AAE. Based on the numerical value, dental students are able to determine whether the case is to be treated or referred. Though this system is widely advocated and forms part of the guidelines issued by the AAE, there appear to be only a few reports on its use in the literature .<sup>(37)</sup> The AAE Case Difficulty Assessment Form was introduced to assist in case selection in an educational setting (Figure2).

The Endodontic Department of the University of California, San Francisco, has developed a similar tool for assessing endodontic cases for undergraduate care. This case- selection system, which has been used for several years, is recommended for use in general dental practice to provide a method for assessing whether to treat or to refer<sup>(33)</sup> (Figure3).

The Canadian Academy of Endodontics (CAE) has also produced a complexity index<sup>(34)</sup> which provides a numerical value to quantify complexity based on the level of risk assigned (Figure4). Similarly the Dutch Endodontic Treatment Index (DETI)<sup>(35)</sup> comprises a short screening list to assess the risks and difficulty of root canal treatment. This assessment is summarised in (Figures 5 and 6).

Figure 2: American Association of Endodontists Case Difficulty Assessment Form and Guidelines



## AAE Endodontic Case Difficulty Assessment Form and Guidelines

<b>PATIENT INFORMATION</b>	<b>DISPOSITION</b>
Name _____	Treat in Office:    Yes <input type="checkbox"/> No <input type="checkbox"/>
Address _____	Refer Patient to: _____
City/State/Zip _____	
Phone _____	Date: _____

---

### Guidelines for Using the AAE Endodontic Case Difficulty Assessment Form

The AAE designed the Endodontic Case Difficulty Assessment Form for use in endodontic curricula. The Assessment Form makes case selection more efficient, more consistent and easier to document. Dentists may also choose to use the Assessment Form to help with referral decision making and record keeping.

Conditions listed in this form should be considered potential risk factors that may complicate treatment and adversely affect the outcome. Levels of difficulty are sets of conditions that may not be controllable by the dentist. Risk factors can influence the ability to provide care at a consistently predictable level and impact the appropriate provision of care and quality assurance.

The Assessment Form enables a practitioner to assign a level of difficulty to a particular case.

#### LEVELS OF DIFFICULTY

MINIMAL DIFFICULTY	Preoperative condition indicates routine complexity (uncomplicated). These types of cases would exhibit only those factors listed in the MINIMAL DIFFICULTY category. Achieving a predictable treatment outcome should be attainable by a competent practitioner with limited experience.
MODERATE DIFFICULTY	Preoperative condition is complicated, exhibiting one or more patient or treatment factors listed in the MODERATE DIFFICULTY category. Achieving a predictable treatment outcome will be challenging for a competent, experienced practitioner.
HIGH DIFFICULTY	Preoperative condition is exceptionally complicated, exhibiting several factors listed in the MODERATE DIFFICULTY category or at least one in the HIGH DIFFICULTY category. Achieving a predictable treatment outcome will be challenging for even the most experienced practitioner with an extensive history of favorable outcomes.

Review your assessment of each case to determine the level of difficulty. If the level of difficulty exceeds your experience and comfort, you might consider referral to an endodontist.

## AAE Endodontic Case Difficulty Assessment Form

Criteria and Subcriteria	Minimal Difficulty	Moderate Difficulty	High Difficulty
<b>A. PATIENT CONSIDERATIONS</b>			
<b>MEDICAL HISTORY</b>	<input type="checkbox"/> No medical problem (ASA Class 1*)	<input type="checkbox"/> One or more medical problems (ASA Class 2*)	<input type="checkbox"/> Complex medical history/serious illness/disability (ASA Classes 3-5*)
<b>ANESTHESIA</b>	<input type="checkbox"/> No history of anesthesia problems	<input type="checkbox"/> Vasoconstrictor intolerance	<input type="checkbox"/> Difficulty achieving anesthesia
<b>PATIENT DISPOSITION</b>	<input type="checkbox"/> Cooperative and compliant	<input type="checkbox"/> Anxious but cooperative	<input type="checkbox"/> Uncooperative
<b>ABILITY TO OPEN MOUTH</b>	<input type="checkbox"/> No limitation	<input type="checkbox"/> Slight limitation in opening	<input type="checkbox"/> Significant limitation in opening
<b>GAG REFLEX</b>	<input type="checkbox"/> None	<input type="checkbox"/> Gags occasionally with radiographs/treatment	<input type="checkbox"/> Extreme gag reflex which has compromised past dental care
<b>EMERGENCY CONDITION</b>	<input type="checkbox"/> Minimum pain or swelling	<input type="checkbox"/> Moderate pain or swelling	<input type="checkbox"/> Severe pain or swelling
<b>B. DIAGNOSTIC AND TREATMENT CONSIDERATIONS</b>			
<b>DIAGNOSIS</b>	<input type="checkbox"/> Signs and symptoms consistent with recognized pulpal and periapical conditions	<input type="checkbox"/> Extensive differential diagnosis of usual signs and symptoms required	<input type="checkbox"/> Confusing and complex signs and symptoms: difficult diagnosis <input type="checkbox"/> History of chronic oral/facial pain
<b>RADIOGRAPHIC DIFFICULTIES</b>	<input type="checkbox"/> Minimal difficulty obtaining/interpreting radiographs	<input type="checkbox"/> Moderate difficulty obtaining/interpreting radiographs (e.g., high floor of mouth, narrow or low palatal vault, presence of tori)	<input type="checkbox"/> Extreme difficulty obtaining/interpreting radiographs (e.g., superimposed anatomical structures)
<b>POSITION IN THE ARCH</b>	<input type="checkbox"/> Anterior/premolar <input type="checkbox"/> Slight inclination (<10°) <input type="checkbox"/> Slight rotation (<10°)	<input type="checkbox"/> 1st molar <input type="checkbox"/> Moderate inclination (10-30°) <input type="checkbox"/> Moderate rotation (10-30°)	<input type="checkbox"/> 2nd or 3rd molar <input type="checkbox"/> Extreme inclination (>30°) <input type="checkbox"/> Extreme rotation (>30°)
<b>TOOTH ISOLATION</b>	<input type="checkbox"/> Routine rubber dam placement	<input type="checkbox"/> Simple pretreatment modification required for rubber dam isolation	<input type="checkbox"/> Extensive pretreatment modification required for rubber dam isolation
<b>CROWN MORPHOLOGY</b>	<input type="checkbox"/> Normal original crown morphology	<input type="checkbox"/> Full coverage restoration <input type="checkbox"/> Porcelain restoration <input type="checkbox"/> Bridge abutment <input type="checkbox"/> Moderate deviation from normal tooth/root form (e.g., taurodontism, microdens) <input type="checkbox"/> Teeth with extensive coronal destruction	<input type="checkbox"/> Restoration does not reflect original anatomy/alignment <input type="checkbox"/> Significant deviation from normal tooth/root form (e.g., fusion, dens in dente)
<b>CANAL AND ROOT MORPHOLOGY</b>	<input type="checkbox"/> Slight or no curvature (<10°) <input type="checkbox"/> Closed apex (<1 mm in diameter)	<input type="checkbox"/> Moderate curvature (10-30°) <input type="checkbox"/> Crown axis differs moderately from root axis. Apical opening 1-1.5 mm in diameter	<input type="checkbox"/> Extreme curvature (>30°) or S-shaped curve <input type="checkbox"/> Mandibular premolar or anterior with 2 roots <input type="checkbox"/> Maxillary premolar with 3 roots <input type="checkbox"/> Canal divides in the middle or apical third <input type="checkbox"/> Very long tooth (>25 mm) <input type="checkbox"/> Open apex (>1.5 mm in diameter)
<b>RADIOGRAPHIC APPEARANCE OF CANAL(S)</b>	<input type="checkbox"/> Canal(s) visible and not reduced in size	<input type="checkbox"/> Canal(s) and chamber visible but reduced in size <input type="checkbox"/> Pulp stones	<input type="checkbox"/> Indistinct canal path <input type="checkbox"/> Canal(s) not visible
<b>RESORPTION</b>	<input type="checkbox"/> No resorption evident	<input type="checkbox"/> Minimal apical resorption	<input type="checkbox"/> Extensive apical resorption <input type="checkbox"/> Internal resorption <input type="checkbox"/> External resorption
<b>C. ADDITIONAL CONSIDERATIONS</b>			
<b>TRAUMA HISTORY</b>	<input type="checkbox"/> Uncomplicated crown fracture of mature or immature teeth	<input type="checkbox"/> Complicated crown fracture of mature teeth <input type="checkbox"/> Subluxation	<input type="checkbox"/> Complicated crown fracture of immature teeth <input type="checkbox"/> Horizontal root fracture <input type="checkbox"/> Alveolar fracture <input type="checkbox"/> Intrusive, extrusive or lateral luxation <input type="checkbox"/> Avulsion
<b>ENDODONTIC TREATMENT HISTORY</b>	<input type="checkbox"/> No previous treatment	<input type="checkbox"/> Previous access without complications	<input type="checkbox"/> Previous access with complications (e.g., perforation, non-negotiated canal, ledge, separated instrument) <input type="checkbox"/> Previous surgical or nonsurgical endodontic treatment completed
<b>PERIODONTAL-ENDODONTIC CONDITION</b>	<input type="checkbox"/> None or mild periodontal disease	<input type="checkbox"/> Concurrent moderate periodontal disease	<input type="checkbox"/> Concurrent severe periodontal disease <input type="checkbox"/> Cracked teeth with periodontal complications <input type="checkbox"/> Combined endodontic/periodontic lesion <input type="checkbox"/> Root amputation prior to endodontic treatment

\*American Society of Anesthesiologists (ASA) Classification System

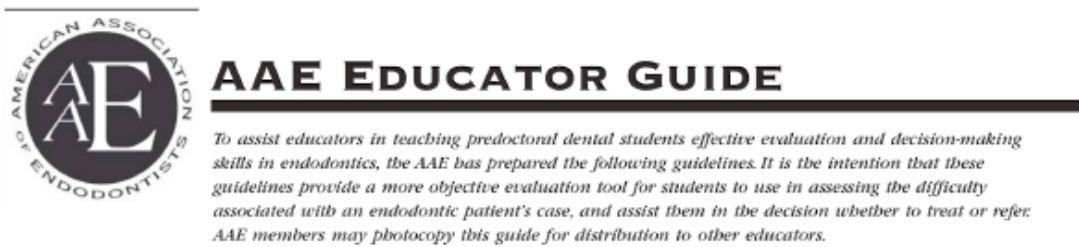
Class 1: No systemic illness. Patient healthy.  
Class 2: Patient with mild degree of systemic illness, but without functional restrictions, e.g., well-controlled hypertension.  
Class 3: Patient with severe degree of systemic illness which limits activities, but does not immobilize the patient.

Class 4: Patient with severe systemic illness that immobilizes and is sometimes life threatening.  
Class 5: Patient will not survive more than 24 hours whether or not surgical intervention takes place.

[www.asahq.org/clinical/physicalstatus.htm](http://www.asahq.org/clinical/physicalstatus.htm)

Figure 3: American Association of Endodontists Case Difficulty Assessment Form

## Educator Guide



### USE OF ENDODONTIC CASE DIFFICULTY ASSESSMENT FORM

In order to make the *Case Difficulty Assessment Form* a more objective exercise, it is recommended that a point score be assigned to each item within each difficulty category. This point system is offered for educational purposes only and is not recommended for clinical practice.

Those items listed in the Minimal Difficulty category are assigned a point value of 1.

Those items listed in the Moderate Difficulty category are assigned a point value of 2.

Those items listed in the High Difficulty category are assigned a point value of 5.

The following score ranges are recommended in making the decision whether to treat or refer:

- **Less than 20 points:** Dental student may treat—level of faculty supervision should be tailored to the student's level of experience.
- **20 - 40 points:** An experienced and skilled dental student may treat with very close supervision by an endodontist, or the case referred to a graduate student or endodontist.
- **Above 40 points:** The case should not be treated by a predoctoral dental student. The patient should be referred to a graduate student or endodontist.

The assignment of an objective "point score" will hopefully assist the dental student in critically evaluating the difficulty associated with treating each patient, assist him/her in making a treatment decision that will be in the patient's best interests, as well as enhance the student's educational experience.

Figure 4: Canadian Academy of Endodontics Case Classification According to the Degrees of Difficulty and Risk

Criteria and Subcriteria	Average Risk (1 unit / item)	High Risk (2 units / item)	Very High Risk (5 units / item)
<b>A. PATIENT CONSIDERATIONS</b>			
1. Medical history/ anaesthesia / patient management	<input type="checkbox"/> No medical problem (ASA Class I)	<input type="checkbox"/> Special attention: pacemaker / antibiotic allergy (ASA Class II) <input type="checkbox"/> Vasoconstrictor intolerance <input type="checkbox"/> Lack of cooperation / fear	<input type="checkbox"/> Complex medical history/ serious illness / disability (ASA Classes III and IV*) <input type="checkbox"/> Intolerance to anaesthesia <input type="checkbox"/> Resistance to anaesthesia
2. Diagnosis	<input type="checkbox"/> Signs and symptoms straight forward: clear diagnosis	<input type="checkbox"/> Differential diagnosis of usual signs and symptoms	<input type="checkbox"/> Confusing and complex signs and symptoms: difficult diagnosis <input type="checkbox"/> Indeterminable diagnosis
3. Mouth aperture and physical limitations	<input type="checkbox"/> Normal mouth aperture (35mm+)	<input type="checkbox"/> Reduced aperture (25-35mm) <input type="checkbox"/> Difficulty holding film	<input type="checkbox"/> Non-functional aperture (-25mm) <input type="checkbox"/> Limited reclination
4. Radiographic difficulties	<input type="checkbox"/> Average conditions	<input type="checkbox"/> Gagging <input type="checkbox"/> High floor (lower premolars and canines) <input type="checkbox"/> Narrow or low palatal vault	<input type="checkbox"/> Hard to solve superimposed anatomical structures
<b>B. TOOTH CONSIDERATIONS</b>			
5. Position in the arch and inclination	<input type="checkbox"/> Anterior or premolar <input type="checkbox"/> Small inclination (-10°) <input type="checkbox"/> Small rotation (-10°)	<input type="checkbox"/> 1st or 2nd molar <input type="checkbox"/> Moderate inclination (10-30°) <input type="checkbox"/> Moderate rotation (10-30°)	<input type="checkbox"/> 3rd molar <input type="checkbox"/> Extreme inclination (+30°) <input type="checkbox"/> Extreme rotation (+30°)
6. Tooth isolation and access / morphologic aberrations of crown	<input type="checkbox"/> Normal original crown morphology or one usable as is <input type="checkbox"/> No pretreatment required for isolation  <input type="checkbox"/> Stable clamp	<input type="checkbox"/> Taurodontism / microdens <input type="checkbox"/> Simple pretreatment required for isolation  <input type="checkbox"/> Unstable clamp (no retention)	<input type="checkbox"/> Fusion / dens in dente* <input type="checkbox"/> Extensive pretreatment required for isolation <input type="checkbox"/> Impaired access (post / core / broken instrument / amalgam...) <input type="checkbox"/> Porcelain / gold occlusal restoration or crown / splint <input type="checkbox"/> Clamp almost impossible to place
7. Canal and root shapes	<input type="checkbox"/> Canal path into J form <input type="checkbox"/> Small or no angle (-10°) in the canal <input type="checkbox"/> Single canal anterior or premolar  <input type="checkbox"/> Closed apex	<input type="checkbox"/> Canal path into J form <input type="checkbox"/> Moderate angle (10-30°) <input type="checkbox"/> Molar with 3 canals or less <input type="checkbox"/> Premolar or anterior with 2 canals <input type="checkbox"/> Previously initiated endodontic treatment <input type="checkbox"/> Crown axis different from root axis <input type="checkbox"/> Canal > 25 mm long	<input type="checkbox"/> Canal path into C or S form <input type="checkbox"/> Extreme angle (+30°) <input type="checkbox"/> Molar with 4 canals or more <input type="checkbox"/> Premolar with 3 canals <input type="checkbox"/> Canal subdivision in the apical or middle thirds <input type="checkbox"/> C-shape canal system <input type="checkbox"/> Internal canal wall of a curve < 2 mm thick, on X-Ray films  <input type="checkbox"/> Open apex
8. Canal calcifications	<input type="checkbox"/> Wide and clear canal	<input type="checkbox"/> Canal and chamber are visible but quite reduced <input type="checkbox"/> Pulp stones	<input type="checkbox"/> Almost undistinctive canal path in part or throughout <input type="checkbox"/> Canal no longer visible*
9. Resorptions		<input type="checkbox"/> Internal resorption (without perforation) <input type="checkbox"/> Apical resorption	<input type="checkbox"/> Internal resorption with perforation* <input type="checkbox"/> External resorption with* or without perforation
10. Mechanical perforation		<input type="checkbox"/> Supra-osseous root perforation	<input type="checkbox"/> Sub-osseous root perforation*
<b>C. ADDITIONAL FACTORS</b>			
11. Trauma history	<input type="checkbox"/> Uncomplicated crown fracture of mature or immature teeth <input type="checkbox"/> Radicular fracture in apical third <input type="checkbox"/> History of concussion	<input type="checkbox"/> Complicated crown fracture of mature teeth <input type="checkbox"/> Radicular fracture in middle third <input type="checkbox"/> History of subluxation / alveolar fracture	<input type="checkbox"/> Complicated crown fracture of immature teeth <input type="checkbox"/> Radicular fracture in cervical third <input type="checkbox"/> Other luxations / avulsion
12. Retreatment			<input type="checkbox"/> Retreatment
13. Periodontal - endodontic condition			<input type="checkbox"/> Mobility / pocket / fenestration / dehiscence <input type="checkbox"/> Furcation involvement <input type="checkbox"/> Root resection / hemi-section (expected or done)

\* ASA Class IV, fusion / dens in dente, invisible canal, sub-osseous / resorptive perforation belong to Class 3 automatically.

**Results:**

Total \_\_\_\_\_

15 to 17 units:  
18 to 25 units:  
More than 25 units:

**Class 1**  
**Class 2**  
**Class 3**

**Disposition:**

☐ Accepted or ☐ Referred

Figure 5: Dutch Endodontic Treatment Index

**DETI ("Dutch Endodontic Treatment Index")**

yes

- ☐ Medical problems (ASA score  $\geq 2$ )
- ☐ Physical limitations/ cooperation of patient limited to poor
- ☐ Difficult diagnosis
- ☐ Premolar >2 canals
- ☐ Molar >3 canals/ third molar
- ☐ Canal subdivision in middle/ apical third
- ☐ Moderate to extreme rotation and/or inclination of tooth ( $> 10^\circ$ )
- ☐ Aberrant crown and/or root morphology/ very long tooth  $\geq 30$  mm
- ☐ Pretreatment required for isolation with rubber dam
- ☐ Crown, core and/or post present
- ☐ Moderate to extreme canal curvatures ( $> 10^\circ$ )
- ☐ Obstructions, resorption, calcification, perforation and/or open apices
- ☐ Retreatment
- ☐ Endodontic-periodontal lesion
- ☐ History of trauma

None of the abovementioned criteria is applicable  $\longrightarrow$  DETI score A  $\longrightarrow$  Initiate root canal treatment

One or more of the abovementioned criteria is applicable  $\longrightarrow$  DETI score B  $\longrightarrow$  Assess grade of difficulty with the Treatment Classification form

Figure 6: Endodontic Treatment Classification

criteria	1 unit per item average risk	2 units per item high risk	5 units per item extreme risk
<b>A. Patient considerations</b>			
1. Medical history, anaesthesia and patient management	<input type="checkbox"/> No medical problems (ASA Class I)	<input type="checkbox"/> Special attention (ASA class II) <input type="checkbox"/> Vasoconstrictor intolerance <input type="checkbox"/> Lack of cooperation/ fear	<input type="checkbox"/> <b>Complex medical history: (ASA class III and IV*)</b> <input type="checkbox"/> Allergy to anaesthesia
2. Mouth aperture and physical limitations	<input type="checkbox"/> Normal mouth aperture ( $\geq 35$ mm)	<input type="checkbox"/> Reduced mouth aperture (25-35 mm) <input type="checkbox"/> Difficulty holding radiograph	<input type="checkbox"/> Extremely reduced mouth aperture ( $\leq 25$ mm) <input type="checkbox"/> Limited reclination
3. Radiographic difficulties	<input type="checkbox"/> Normal conditions	<input type="checkbox"/> Strong gagging reflex <input type="checkbox"/> Narrow or low palatal vault/ high mouth floor	<input type="checkbox"/> Hard to solve superimposed anatomical structures
4. Diagnosis	<input type="checkbox"/> Signs and symptoms straight forward: clear diagnosis	<input type="checkbox"/> Differential diagnosis of usual signs and symptoms	<input type="checkbox"/> Confusing and complex signs and symptoms: difficult diagnosis
<b>B. Tooth considerations</b>			
5. Position in the arch	<input type="checkbox"/> Anterior or premolar	<input type="checkbox"/> 1 <sup>st</sup> or 2 <sup>nd</sup> molar	<input type="checkbox"/> 3 <sup>rd</sup> molar
6. Inclination and rotation of tooth	<input type="checkbox"/> No/small inclination ( $\leq 10^\circ$ ) <input type="checkbox"/> No/small rotation ( $\leq 10^\circ$ )	<input type="checkbox"/> Moderate inclination (10-30°) <input type="checkbox"/> Moderate rotation (10-30°)	<input type="checkbox"/> Extreme inclination ( $\geq 30^\circ$ ) <input type="checkbox"/> Extreme rotation ( $\geq 30^\circ$ )
7. Morphological aberrations of crown and isolation	<input type="checkbox"/> Normal, original crown morphology <input type="checkbox"/> No pretreatment required for isolation	<input type="checkbox"/> Taurodontism/ microdontism <input type="checkbox"/> Simple pretreatment required for isolation	<input type="checkbox"/> <b>Fusion/dens in dente *</b> <input type="checkbox"/> Extensive pretreatment required for isolation
8. Access to root canal system	<input type="checkbox"/> Normal access	<input type="checkbox"/> Discrepancy between crown and root axis <input type="checkbox"/> Amalgam build-up in pulp chamber without post	<input type="checkbox"/> Porcelain fused to metal, metal or porcelain crown <input type="checkbox"/> Composite build-up in pulp chamber <input type="checkbox"/> <b>Post/ cast post and core *</b>
9. Canal and root morphology	<input type="checkbox"/> Canal curvature into I form  <input type="checkbox"/> Small or no curvature ( $< 10^\circ$ ) <input type="checkbox"/> Anterior tooth or premolar with 1 canal	<input type="checkbox"/> Canal curvature into J form  <input type="checkbox"/> Moderate curvature (10-30°) <input type="checkbox"/> Anterior tooth or premolar with 2 canals <input type="checkbox"/> Molar with $\leq 3$ canals <input type="checkbox"/> Previously initiated, but not completed, endodontic treatment	<input type="checkbox"/> Canal curvature into C or S form <input type="checkbox"/> C-shape canal system <input type="checkbox"/> Extreme curvature ( $\geq 30^\circ$ ) <input type="checkbox"/> Premolar with 3 canals  <input type="checkbox"/> Molar with $> 3$ canals <input type="checkbox"/> Canal subdivision in middle or apical third <input type="checkbox"/> Very long tooth ( $\geq 30$ mm)
10. Apical morphology	<input type="checkbox"/> Closed (=mature) apex		<input type="checkbox"/> Open apex (immature apex/ apex resection without a retrograde filling)
11. Canal calcifications	<input type="checkbox"/> Canals clearly visible	<input type="checkbox"/> Pulp chamber/ canals are visible but quite reduced <input type="checkbox"/> Pulp stones	<input type="checkbox"/> Almost indistinctive canal path in part or throughout <input type="checkbox"/> <b>Canals invisible *</b>
12. Resorption		<input type="checkbox"/> Internal resorption without perforation <input type="checkbox"/> Apical resorption	<input type="checkbox"/> <b>Internal resorption with perforation *</b> <input type="checkbox"/> <b>External resorption with* or without perforation</b>
13. Iatrogenic incidents		<input type="checkbox"/> Supra-osseous perforations	<input type="checkbox"/> <b>Broken instrument *</b> <input type="checkbox"/> <b>Ledging *</b> <input type="checkbox"/> <b>Apical transportations *</b> <input type="checkbox"/> <b>Sub-osseous perforations *</b>
<b>C. Additional Factors</b>			
14. Retreatment of previously completed root canal treatment			<input type="checkbox"/> Retreatment of previously completed root canal treatment <input type="checkbox"/> <b>Silver cone section *</b>
15. History of trauma	<input type="checkbox"/> Uncomplicated crown fracture <input type="checkbox"/> Root fracture in apical third <input type="checkbox"/> Concussion	<input type="checkbox"/> Complicated crown (-root) fracture of mature teeth <input type="checkbox"/> Root fracture in middle third <input type="checkbox"/> Subluxation/alveolar fracture	<input type="checkbox"/> Complicated crown (-root) fracture of immature teeth <input type="checkbox"/> Root fracture in cervical third <input type="checkbox"/> Other luxations/ avulsions
16. Endodontic-periodontal lesion			<input type="checkbox"/> Mobility/ pocket/ fenestration / dehiscence <input type="checkbox"/> Furcation involvement <input type="checkbox"/> Root resection/ hemisection expected or completed
<b>Subtotal</b>	<input type="checkbox"/> <b>x 1 =</b>	<input type="checkbox"/> <b>x 2 =</b>	<input type="checkbox"/> <b>x 5 =</b>
<b>*These criteria belong to Class III automatically</b>		<b>Total:</b> →	<input type="checkbox"/> 15-19 units <b>Class I</b> <input type="checkbox"/> 20-25 units <b>Class II</b> <input type="checkbox"/> > 25 units <b>Class III</b>



Interestingly, in the UK root canal treatment accounted for approximately 18% of the total number of dento-legal claims in a five-year sample of completed cases between 1996 and 2001.<sup>(36)</sup> Thus, there are substantial medico-legal implications for dentists undertaking complex treatment that is beyond their competence.

A study carried out to evaluate the reproducibility of the Restorative Index of Treatment Need (RIOTN) system for grading the complexity of root canal treatment, concluded that the RIOTN system of grading the complexity of root canal treatment was incomplete; with moderate to poor reproducibility.<sup>(32)</sup> The complexity indices in use by the AAE, CAE and the Dutch ETC all have one thing in common: the ability to assign a cumulative numerical value, which increases with the degree of complexity. However, the RIOTN lacks the ability to provide a cumulative score. The CAE, ETC and AAE are less ambiguous in assessment of canal negotiability because they base their assessment of the canal on radiographic visibility only.<sup>(32)</sup> Grading complexity all define various aspects of root morphology further and score them appropriately based on the risk assessment and the RIOTN provides an unclear interpretation of 'coordinated medical history'.<sup>(32)</sup> The AAE, CAE and ETC all use the ASA11 (American Association of Anaesthesiology) classification which quantifies the degree of risk with regards to the medical history. A study done to analyse the specific influence of root canal anatomy on the accessibility of working length during root canal therapy, demonstrated, perhaps not surprisingly that posterior teeth, due to complex morphology, significantly influenced the working length accessibility compared to the canal morphology of anterior teeth (success rate of 93.43% versus 84.43%) in a single-factor model.<sup>(37)</sup> A further series of studies carried out over 4-6 years<sup>(38-41)</sup> revealed that certain factors influenced successful endodontic outcomes



such as absence of periapical radiolucency ,single rooted teeth , techniques used and absence of intraoperative complications i.e. endodontic mishaps.

## 1.6 Effect of Intraoperative Factors

The use of rubber dam is fundamental in endodontic treatment. As well as preventing inhalation and swallowing of endodontic solutions and instruments, it provides an aseptic environment. <sup>(42)</sup>With regards to mechanical preparation it seems likely that there is a small correlation between increased success rate and smaller apical size of preparation.<sup>(43)</sup>Current literature shows that the apical extent of root fillings should extend to within 0–2 mm of the radiographic apex .A recent meta analyses carried out

Comparisons (test vs. reference categories)	No. of studies	Odds ratio	95% CI	Heterogeneity	
				$\chi^2$ value	P value
Flush versus short (any pa status)	21	1.27	0.93–1.73	125.0	<0.001
Flush versus short (teeth with no pa lesion)	5	0.83	0.55–1.23	8.8	0.067
Flush versus short (teeth with pa lesion)	7	1.56	1.26–1.94	12.0	0.061
Flush versus long (any pa status)	21	2.34	1.87–2.93	56.1	<0.001
Flush versus long (teeth with no pa lesion)	5	3.72	2.48–5.60	4.8	0.304
Flush versus long (teeth with pa lesion)	7	1.74	1.36–2.21	10.2	0.117
Short versus long (any pa status)	24	1.80	1.34–2.42	117.6	<0.001
Short versus long (teeth with no pa lesion)	5	2.89	0.89–9.08	26.3	<0.001
Short versus long (teeth with pa lesion)	9	1.06	0.84–1.33	14.3	0.075

by Ng et al,<sup>(44)</sup> Showed that ‘flush’ obturations resulted in the highest success rate. This could be due to decreasing the tendency for foreign body reactions and proliferation of bacteria apically which can have a negative effect on endodontic outcomes.<sup>(44)</sup>

In the same study it was found that voids decreased the success rate of root canal treatment. In two similar studies <sup>(45,46)</sup> it was also found that teeth with flush root fillings were associated with a significantly higher survival probability than those with short root fillings. The results from these studies on overextended root fillings were, however, inconclusive due to lack of data. The studies also revealed heterogeneity of obturation on tooth survival are inconsistent. Obturation with voids had no significance on tooth survival (which was an opposite finding to Ng et al.<sup>(44)</sup>). For teeth with voids the 5 and

10 year survival were reported to be 85% and 62% respectively. For those without voids the survival rate was very similar at 86% and 68% respectively.<sup>(47,48)</sup>

Root canal treatments deemed unsatisfactory radiographically appears to exhibit lower success rates.<sup>(44,46,49)</sup> Unfortunately, many of the studies related to radiographic examination are subjective.<sup>(50-52)</sup> Technical quality of root fillings in an adult Swedish population<sup>(51)</sup> showed that more than 60% of the root-filled teeth were inadequately sealed. The defect most commonly found was incomplete obturation of the root canal. Periapical lesions were observed in 31% of the root filled teeth. In teeth with completely obturated root canals, only 7% had a periapical lesion, as compared to 45% of the teeth with inadequately sealed root canals. While technical quality of root canal treatment in a Taiwan population<sup>(52)</sup> showed approximately 70% of the teeth receiving RCT were either of inadequate filling length or sealing density. In that study, periapical lesions associated with teeth with RCT were not assessed because the periapical radiographs were submitted from different institutions without a standardized radiographic technique. The frequency of teeth with good quality endodontic work in anterior teeth (40.4%) or in premolars (33%) was significantly greater than that (18.4%) in molars ( $P < 0.001$ ). In general, anterior teeth or premolars have larger, straighter and fewer root canals than molars. Therefore, technically, anterior and premolar teeth are easier to treat than a molar, and a higher technical quality of root canal treatment can be expected. Petersson et al.<sup>(51)</sup> found that the percentage of teeth with complete obturation of the root canal without overfilling was 47% for premolars and 18% for molars.

The influence of coronal versus apical seal has been reported in the literature<sup>(53,54)</sup> with regards to loss of coronal seal it has been shown to lead to an increased risk of root canal failure.<sup>(53)</sup> In a recent meta-analysis.<sup>(54)</sup>, however, no significant difference in

healing was found between inadequate apical and coronal seal. Several authors have described the importance of apical leakage on the treatment outcome of root-canal treatment. <sup>(27,50,55)</sup> Apical leakage is still considered as a factor in the failure of endodontic treatment, but in recent years, more attention has been paid to coronal leakage.<sup>(53,54)</sup> Recent endodontic epidemiological studies carried out in different population groups report a high prevalence of apical periodontitis (AP) in connection with root filled teeth ranging from 16 to 65%.<sup>(27,50,55,56)</sup> The importance of a good coronal restoration, as well as good apical seal should be emphasized as the technical quality of both influence the periapical status.<sup>(56)</sup>

### **1.7 Effect of Operator Skill on Endodontic Outcomes**

Operator skill and experience have been shown to influence the outcome of endodontic treatments.<sup>(57-59)</sup> A study carried out in Brazil to evaluate radiographic quality of root canal fillings performed in a postgraduate program in Endodontics<sup>(57)</sup> aimed to evaluate the quality of 1,347 root fillings performed by postgraduate students in Endodontics according to 3 radiographic quality parameters. These parameters included apical extension, taper and homogeneity. The results showed 51.7%, 41.5% and 6.8% of perfect filling, satisfactory filling, and deficient filling, respectively. In a further study<sup>(59)</sup> carried out to evaluate the radiographic technical outcome of root canal filling provided by undergraduate students, it was found that 55% of root fillings were acceptable, the best outcomes were found to be predictably with anterior teeth 71% and the worst outcome with molar teeth 39%. In a similar study<sup>(49)</sup> carried out in a dental school setting it revealed that most of the good quality endodontic work was found in relation to anterior teeth (90.1%), whereas, the lowest were in molar teeth (46.6%) for both first and second clinical year undergraduate dental students ( $P < .001$ ). With regard

to technical quality of endodontic treatment carried out by Endodontic specialists, a study in Australia revealed<sup>(58)</sup> that the technical standard was high. Final obturations of 1351 canals (100 patients) treated by 6 Endodontic specialists were assessed radiographically. The percentage of obturations within less than 1mm of the radiographic apex was 74% and 86.1% of the cases were deemed to have homogenous obturations.

### **1.8 Purpose Statement**

- To classify the endodontic difficulties (AAE classification- Appendix I) of all cases presented at the postgraduate endodontic clinic at Hamdan Bin Mohammed College of Dental Medicine-Mohammed Bin Rashid University (HBMCDM-MBRU) over a period of 3 years.
- To determine the association, if any, between endodontic case difficulty and technical outcome.
- To test the null hypothesis that there is no difference between endodontic case difficulty and technical outcome ( $p < 0.05$ ).

## **CHAPTER TWO**

### **Materials and Methods**

This is a retrospective study to determine the relationship between endodontic case difficulty and treatment outcomes. For this purpose, 349 radiographs of patients who had received endodontic treatment during the period (2012-2015) at (HBMCDM-MBRU) were retrieved from MBRU data base. These represented all the radiographs taken during that period (partly Boston University and partly Hamdan bin Mohammed college of Dental Medicine). Unreadable radiographs due to technical errors, superimposed anatomical structures, and incomplete treatments were all excluded. From the original sample a total of 51 radiographs were discarded. The final sample thus consisted of 298 root canal fillings of 211 patients. All the patients were treated by endodontic residents.

The radiographs were individually evaluated in accordance with AAE Endodontic Case Difficulty Assessment Form .These included patient consideration, diagnostic and treatment consideration, trauma history, endodontic treatment history and Periodontal-Endodontic Condition. The relevant data obtained for the cases were appropriately categorized as minimal difficulty, moderate difficulty and high difficulty, Appendix 1

#### **2.1 Difficulty Categories**

The selected sample (n=298) were divided into categories minimal, moderate and high difficulty. In order to perform this, two guidelines widely in use (AAE and RIOTN) were separately assessed using the Agree II tool (see Appendix II).<sup>(60)</sup>

Agree II assesses guidelines across 6 domains which are:

- 1.Scope and purpose
- 2.Stakeholder involvement
- 3.Rigour of development
- 4.Clarity of presentation
- 5.Applicability
- 6.Editorial independence

Of the two guidelines assessed, the AAE was eventually selected for this work (Figure 2). Additionally, thirty cases were randomly selected from the original sample of 298 and assessed also using RIOTN. The result of these thirty cases are tabulated (Table 1). The corresponding outcomes using AAE guidelines are also shown on the same table.

Table 1: Classification of Case Difficulty/Complexity According to AAE and RIOTN

(Thirty Randomly Selected Cases)

NO	Patientt ID	Tooth	AAE	RIOTN
1	ALHBA001	12	1	1
2	ALMAL008	21	1	1
3	ALMSH007	25	1	1
4	DUPEL000	22	1	1
5	KAUBI000	24	1	1
6	ALSRO002	14	1	1
7	BALAH000	11	1	1
8	GANEL000	13	1	1
9	KAMJO000	14	1	1
10	KHIAB000	35	1	1
11	ELHOS000	24	2	2
12	HAMSA005	45	2	2
13	HAMSA005	16	2	2
14	HAMSA005	21	2	1
15	MANRE000	11	2	1
16	RAHAS000	26	2	1
17	SHAZA000	25	2	1
18	SINSU001	45	2	1
19	ZAIAD000	46	2	3
20	YASMN000	45	3	2
21	ELMAM000	45	3	3
22	ALNEM000	15	3	1
23	ABDAT001	45	3	3
24	ABDSA009	24	3	2
25	ALIHO000	22	3	3
26	AMIMO000	21	3	3
27	ATTJI000	45	3	3
28	ALCRO000	36	3	3
29	IBRKH002	11	3	3
30	FULAN000	37	3	1



### **2.1.1 Minimal Difficulty**

Preoperative condition indicates routine complexity (uncomplicated). These types of cases would exhibit only those factors listed in the minimal difficulty category. Achieving a predictable treatment outcome should be attainable by a competent practitioner with limited experience, see examples of such cases in Figures 7 and 8.

### **2.1.2 Moderate Difficulty**

Preoperative condition is complicated, exhibiting one or more patient or treatment factors listed in the moderate difficulty category. Achieving a predictable treatment outcome will be challenging and usually carried out by competent, experienced practitioner, see examples of such cases in Figures 9 and 10.

### **2.1.3 High Difficulty**

Preoperative condition is exceptionally complicated, exhibiting several factors listed in the moderate difficulty category or at least one in the high difficulty category. Achieving a predictable treatment outcome will be challenging for even for the most experienced practitioner with an extensive history of favorable outcomes, see examples of such cases in Figures 11 and 12.

Figure 7: Minimal Difficulty Case 1

Periapical radiograph, tooth #35. The root has evidence of distal caries. The root has no dramatic curvature and shows evidence of patent canal.



Figure 8: Minimal Difficulty Case 2

Periapical radiograph, tooth #22. The root has no dramatic curvature and shown evidence of patent canal.



Figure 9: Moderate Difficulty Case 1

Periapical radiograph, tooth #11, reveals a normal pulp space. There is evidence of complicated crown fracture.



Figure 10: Moderate Difficulty Case 2

Periapical radiograph, tooth #26, reveals a reduced pulp space and extensive coronal destruction.

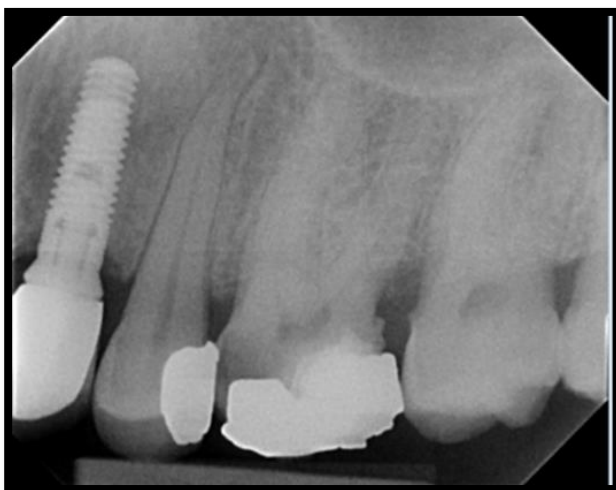


Figure 11: High Difficulty Case 1

Periapical radiograph, teeth #12, 11, 21 reveal previous nonsurgical endodontic treatment, with full coverage crowns. There is evidence of a periapical radiolucency in relation to #21. Posts are present in #12 and #11.



Figure 12: High Difficulty Case 2

Periapical radiograph, tooth #45, appears to have a patent canal and shows evidence of resorption in the coronal third of the canal.



## 2.2 Pilot Study

Initially, a relatively small sample of 20 radiographs were randomly selected by the investigator as a pilot study to help determine the sample size for the study and, at the same time familiarize the investigator with AEE standards. The 20 cases were categorized into one of the three difficulties in accordance with AEE standards. The ratios of difficulties minimal: moderate: high in this sample of 20 were 0: 6: 14. ie. the majority were high difficulty which was not surprising in a secondary referral centre. Similarly all the cases n=298 were categorised and tabulated, representing all the raw data in this study. (Appendix I)

This process was repeated after 3 months. The purpose of the time separation between the two assessments was aimed to minimize any risk of the observer giving an opinion that was contaminated by the memory of the previous viewing.

Both intra and inter-observer kappa scores were calculated and, as it happens, found to be 0.90 in both cases. This high figure indicates a strong level of agreement, refer to (Table 2) for kappa scores.<sup>(61)</sup>

Table 2: Interpretation of Cohen's Kappa

Value of kappa	Level of agreement	% of data that are reliable
0-.20	None	0-4%
.21-.39	Minimal	4-15%
.40-.59	Weak	15-35%
.60-.79	Moderate	36-63%
.80-.90	Strong	64-81%
Above .90	Almost perfect	82-100%

### 2.3 Power Calculation

A power calculation was carried out to determine the minimum sample size for this work which would allow meaningful statistical tests. The sample size used in any study should be large enough to have no less than an 80% probability of detecting an effect when there is an effect to be detected. The study, therefore, should have no more than a 20% probability of making a Type II error ( $\beta$ ) and thus yielding a power ( $1 - \beta$ ) of larger than 80% .<sup>(62)</sup>

The study by Bierenkrant et al.<sup>(58)</sup> yielded a figure of 74% for a satisfactory root canal filling. The corresponding figure from the pilot study carried out here was 82%. The smallest sample size for this study was calculated to be 219 (see details in Appendix III a). The actual sample size, as mentioned previously, was 298. This bigger sample size yields an enhanced power of 92% (see details Appendix III b)

## 2.4 Criteria for The Assessment of Root Canal Filling Quality

The technical quality of the root filling depends on two main parameters (i) homogeneity of the root filling and (ii) distance between the end of the filling and radiographic apex, (Table 3).

Table 3: Technical Quality of The Root Filling

Length of the root filling	Homogeneity of the root filling
Root filling terminating 0-2 mm from the radiographic apex (acceptable).	Homogeneous root filling, good condensation, no voids visible (acceptable).
Root filling terminating >2 mm from the radiographic apex (unacceptable).	Inhomogeneous root filling, poor condensation, voids visible (unacceptable).
Root filling extending beyond the radiographic apex (unacceptable).	N/A

A root canal with an acceptable filling length and a homogeneous root filling was defined as being good quality endodontic work (GQEW). A treated tooth was defined as having good quality endodontic work tooth (GQEW-T) when all its canals had a GQEW. Examples of quality of root canal fillings are show in Figure 13-17.

Figure 13: #25 Root Filling Terminating 0-2 mm from the Radiographic Apex  
(Acceptable) and Homogenous Root Filling



Figure 14: #46 Root Filling Terminating >2 mm from the Radiographic Apex  
(Unacceptable) and Homogeneous Root Filling

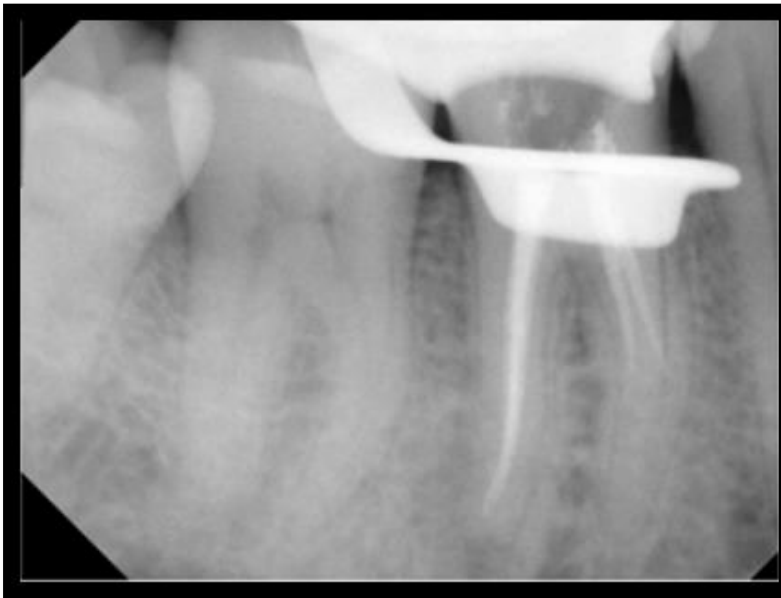




Figure 15: #36 Root Filling Extending Beyond the Radiographic Apex (Unacceptable)  
and Homogenous Root Filling

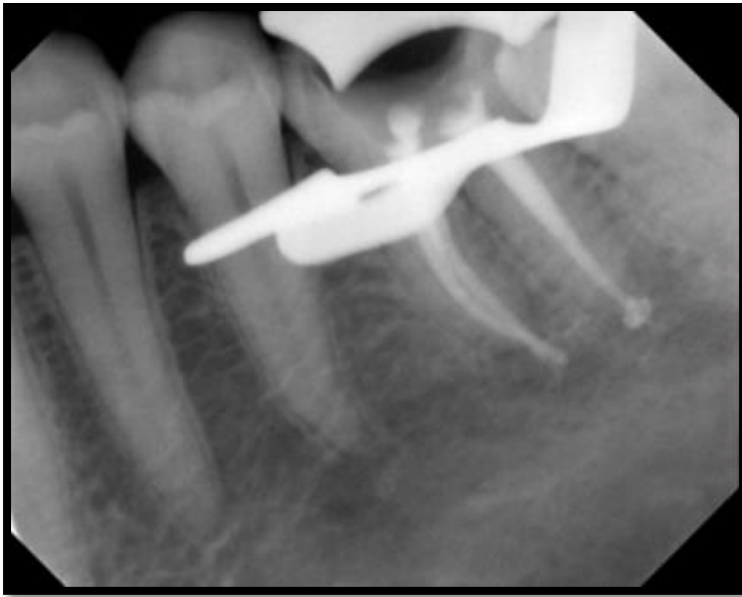


Figure 16: #16 Root Filling Terminating 0-2 mm from the Radiographic Apex  
(Acceptable) and Inhomogeneous Root Filling

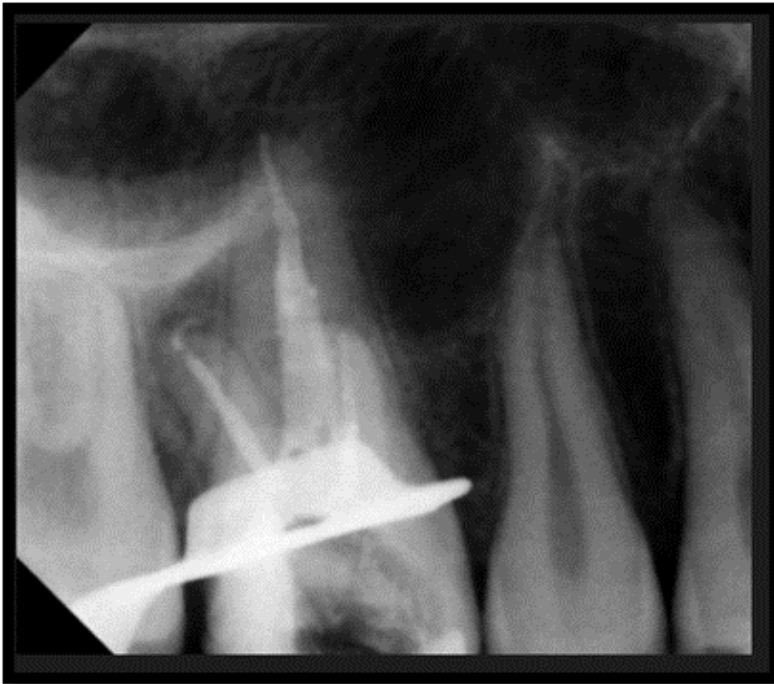
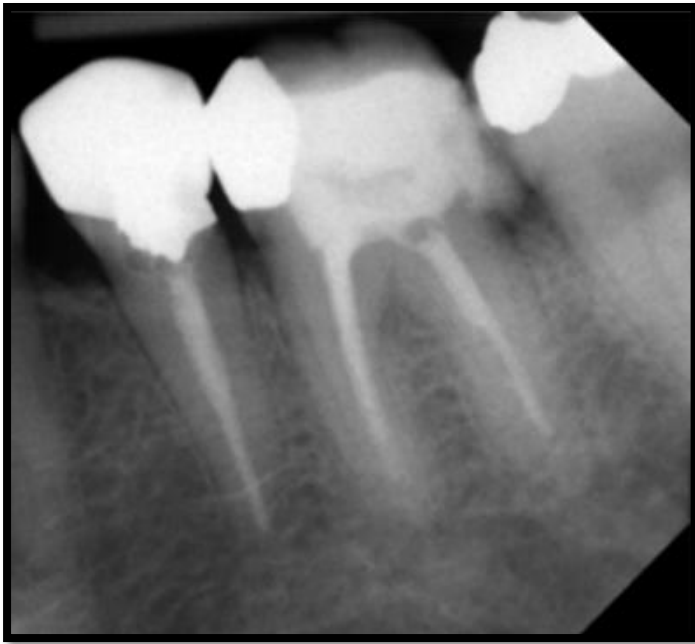


Figure 17: #36 Root Filling Terminating >2 mm from the Radiographic Apex  
(Unacceptable), and Inhomogeneous Root Filling



## **2.5 Statistical Test**

Chi square tests were applied to the data. Statistical Package for the Social Sciences (SPSS) version 20 was used to carry out the tests.

## **2.6 Ethical Approval**

Ethical approval for this study was obtained from the Ethical Committee in HBMCDM-MBRU on 9<sup>th</sup> September, 2015. (Appendix IV)

## **CHAPTER THREE**

### **RESULTS**

The raw data, exhibited in Table 4, show the average age of patients to be 41 with more male than female patients. The table also shows that of the 298 teeth, 143 teeth were molars.

The case mix of the sample presented was predominantly that of high difficulty followed by moderate difficulty and only 12% of minimal difficulty. These figures were judged to be significant to separately present in a pie chart (Figure 18). As mentioned earlier, the sample was categorised into the three difficulties using the AAE standards. The raw data were also analysed according to gender and jaw (Table 5). There was understandably, no association between gender and case difficulty ( $p=0.083$ ).

Surprisingly, however, significant differences in case difficulty between maxillary and mandibular teeth and it would appear that the differences are associated with minimal difficulty cases ( $p=0.017$ ). The technical outcome for the sample in terms of homogeneity and root filling length is displayed in the form of a pie chart (Figure 19). The overwhelming majority 84% were homogeneity acceptable and length acceptable, which demonstrated the high quality treatment outcomes achieved at MBRU. Some of these findings (shown in Tables 6, 7 and 8) were statistically significant ( $p<0.05$ ). In contrast, only around three cases (1%) were deemed unacceptable again in terms of homogeneity unacceptable and length terminating  $>2\text{mm}$  from the apex. There were no cases where homogeneity was unacceptable beyond the radiographic apex (0%) and thus could not be included in the pie chart.

In order to show the relationship between case difficulty and technical outcomes, the results were exhibited in a master bar chart in (Figure 20). The main feature of this figure is the very high acceptable outcome (homogeneity and length) for all three difficulties. The results demonstrate a resounding success for the college and excellent treatment provided. At the other extreme of the chart, the unacceptability (homogeneity unacceptable filling length beyond the radiographic apex) is zero and about 2% for homogeneity unacceptable and filling length terminates  $>2\text{mm}$ .

The quality of endodontic treatment outcomes was also related to tooth type, radiographic appearance and endodontic treatment history (Table 9 a, b, c). There appeared to be significant statistical differences between a number of these variables and endodontic outcomes ( $p < 0.05$ ).

Table 4: Demographical Data

Items	No (%)
Gender	
Male	118 (55.9%)
Female	93 (44.1%)
Age	
Mean (SD)	41.12 (11.238)
Tooth type	
Anterior	54 (18.12%)
premolar	101 (33.89%)
Molar	143(47.98%)

Figure 18: Case Difficulty Distribution of the Sample

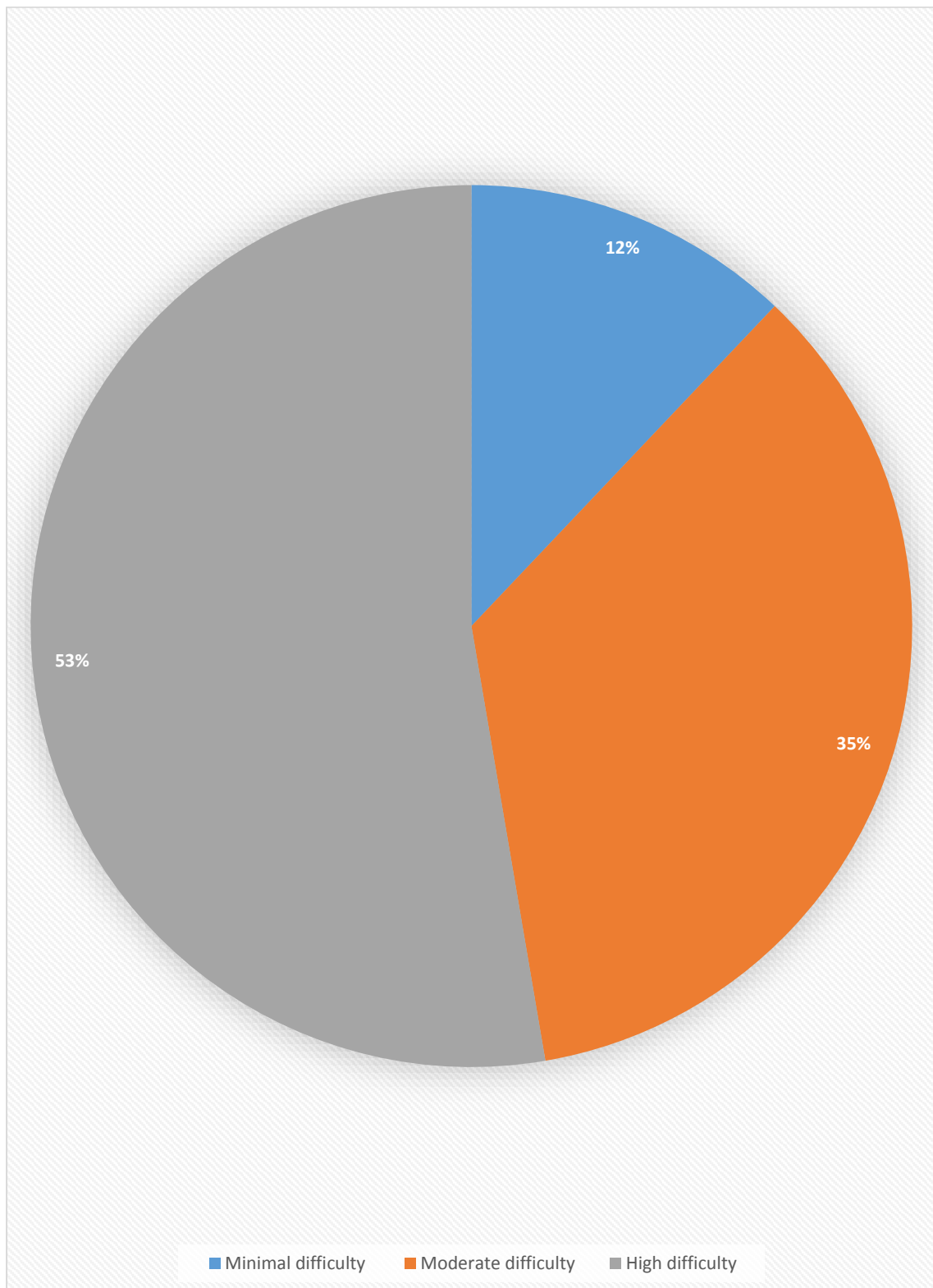


Table 5: Case Difficulty Distribution in Relation to Gender and Jaw

Items	Minimal difficulty	Moderate difficulty	High difficulty	P-value
Gender				
Male	27 (15.6%)	57 (32.9%)	89 (51.4%)	0.083
Female	9 (7.2%)	48 (38.4%)	68 (54.4%)	
Jaw				
Maxilla	26(72.2%)	60(57.1%)	74(47.1%)	0.017
Mandible	10(27.8%)	45(42.9%)	83(52.9%)	

Figure 19: Technical Quality Outcomes

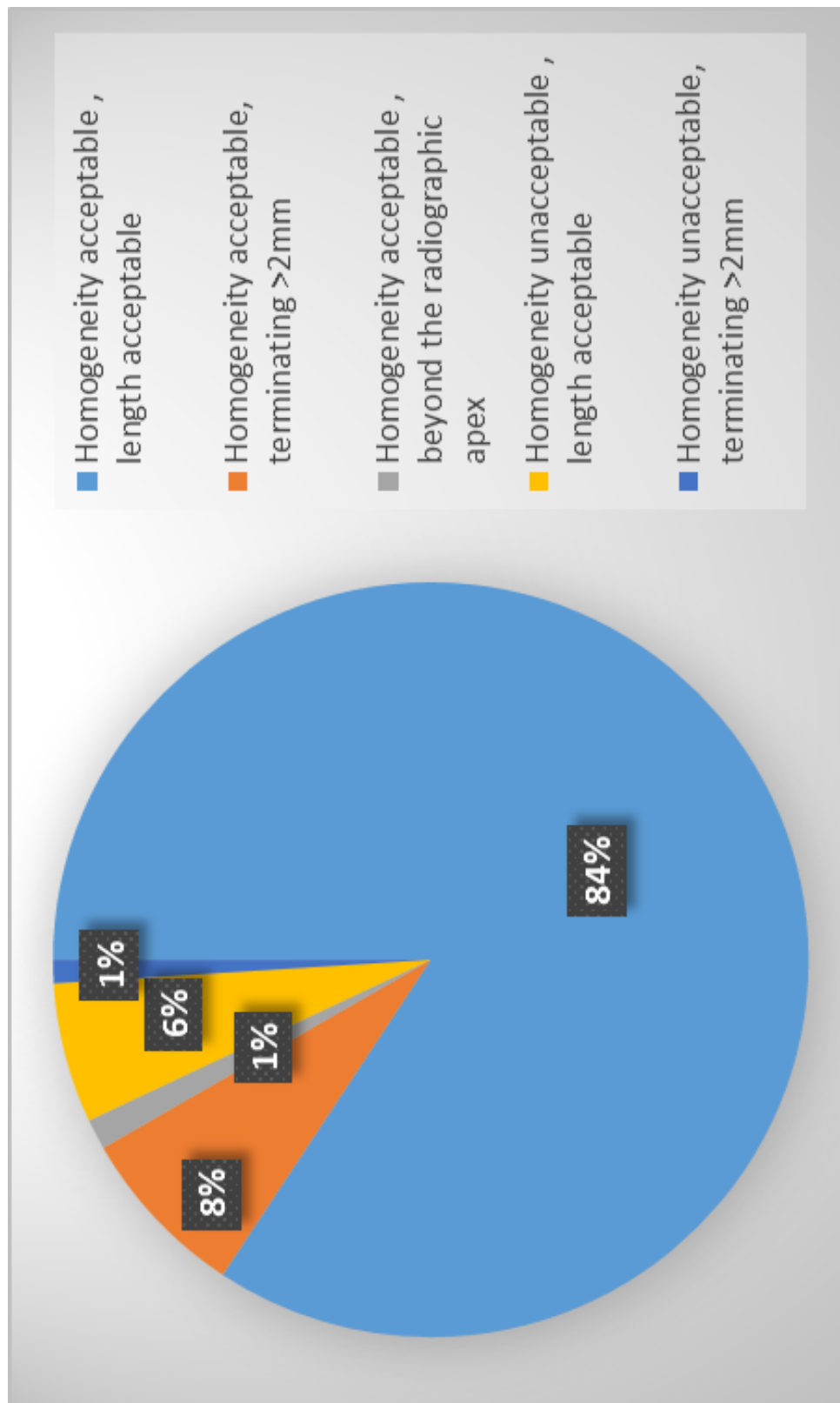




Figure 20: The Relation between Case Difficulty and Technical Outcomes

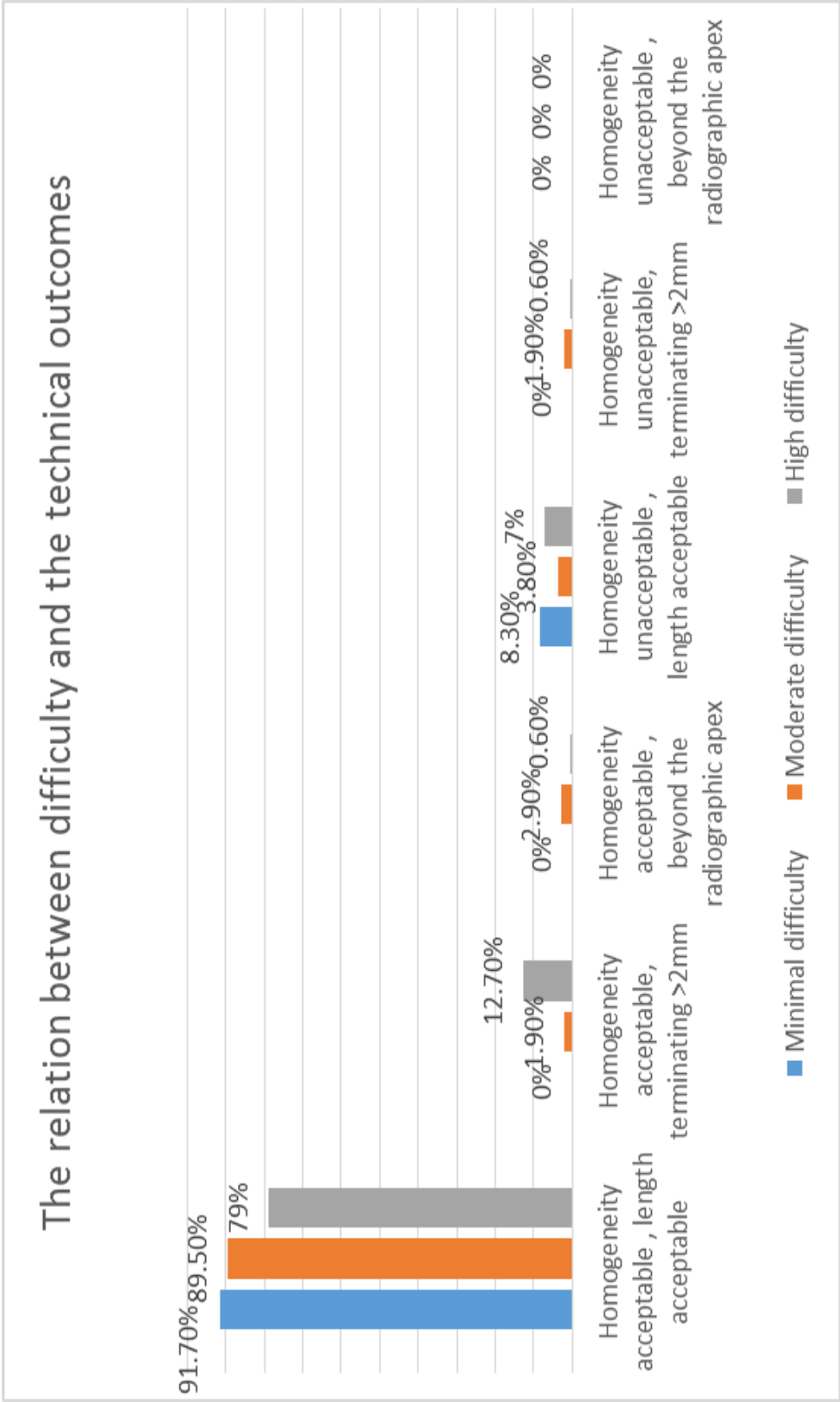


Table 6: Relation between Case Difficulty and Treatment Outcome

Items	Homogeneity acceptable , length acceptable	Others	P-value
Minimal difficulty	33(91.7)	3(8.3%)	0.031
Moderate difficulty	94(89.5%)	11(10.5%)	
High difficulty	124(79%)	33(21%)	

Table 7: Technical Outcomes in Relation to the Length of Obturation

Outcomes Difficulty	Adequate Length	Inadequate Length	P-value
Minimal difficulty	36(13.4%)	0	0.016
Moderate difficulty	98(36.4%)	7(24.1%)	
High difficulty	135(50.2%)	22(75.9%)	

Table 8: Technical Outcomes in Relation to Homogeneity

Outcomes Difficulty	Adequate Homogeneity	Inadequate Homogeneity	P-value
Minimal difficulty	33(11.9%)	3(14.3%)	0.794
Moderate difficulty	99 (35.7%)	6(28.6%)	
High difficulty	145(52.3%)	12(57.1%)	

Table 9: Relationship between Criteria of Case Difficulty and Treatment Outcome

a	Tooth Type	Good Quality	Improper Quality	p-value
	Anterior/premolar	89.7%	10.3%	.003
	1 <sup>st</sup> molar	72.2%	27.8%	
	2 <sup>nd</sup> molar	82.3%	17.7%	
b	Radiographic appearance of canal(s)	Good Quality	Improper Quality	p-value
	Visible canal	86.6%	13.4%	.006
	Reduce size of canal/pulp stone	76.4%	23.6%	
	Canal(s) not visible	54.5%	45.5%	
c	Endodontic Treatment History	Good Quality	Improper Quality	p-value
	No previous treatment	87.9%	12.1%	.050
	Previous access without complication	78.1%	21.9%	
	Previous access with complications/previous nonsurgical endodontic treatment completed	76.9%	23.1%	

## CHAPTER FOUR

### Discussion

Endodontic cases normally present in one of three categories; minimal difficulty, moderated or high difficulty. The AAE guidelines for endodontic case difficulty were applied to categorize the patient sample used in this study.

The minimal difficulty cases are often treated by General Dental Practitioners (GDPs). The medium and high difficulties cases are on the other hand often referred to secondary or tertiary referral centres such as (HBMCDM-MBRU). Centres such as HBMCDM provide not only the expertise /specialists needed to treat such cases but, also all the latest advanced instruments required for such treatments including for example, surgical microscopes, three dimensional imaging etc. which are essential for the successful outcome of complex endodontic cases.<sup>(63–65,67)</sup>

Clearly, therefore, it is important from the outset for the clinician to be able to determine the complexity of a particular case, there are a number of reasons for this. The treating dentist, for example, needs to be able to assess the complexity of the case so that a realistic outcome/prognosis can be given to the patient. It is well documented in the literature that successful endodontic outcomes are dependent on many factors <sup>(1)</sup> including root canal morphology and presence of iatrogenic factors due to previous attempts at endodontic treatment. The success rates in endodontics, reported in the literature range from as low as 74% to as high as 92%.<sup>(38)</sup> Patients need to be made aware of the prognosis in order that he or she may give their informed consent. The patient thus may consent to endodontic treatment the tooth or opt for extraction of the tooth and placement of an implant.<sup>(66)</sup> Many endodontists are using Cone Beam Computed

Tomography (CBCT) in order to assess cases before commencing endodontic treatment.<sup>(65,67)</sup> An initial screening and categorizing of the cases will help in determining which of the cases require further investigation with CBCT as such cases involve a relatively high dose of radiation exposure. To put the dosage into perspective, five periapicals are equivalent to 0.001mSv and one small volume CBCT (4cm x 4cm) is equivalent to 0.01 mSv, which is an order of magnitude higher.

The demographic data in Table 4 shows that there was no particular gender bias in the sample. The average age of the patients was 41 years. It is well known that endodontic treatment becomes progressively harder with increasing patient age due to many factors such as physiologic aging, pathology and reduction in the size of the pulp canal space due to production of secondary and tertiary dentine and cementum.<sup>(1)</sup> By the time patients reach their forties, the chances are that they are undergoing restorative maintenance including failure of restorations and endodontic retreatment not to mention the likelihood of associated complex medical histories. With average patient age of 41 years, the above reinforces the assertion that the patient sample available for the training programme were challenging. It is also interesting to note that only 18% of the sample were anterior teeth. That said, a number of these were trauma cases (around 2%) which have associated problems such as resorption and obliterated canals which automatically fall into the high difficulty case mix.<sup>(68)</sup>

Some centres such as UK, National Health Service (NHS) teaching hospital do not accept low difficulty cases, apart from a limited number for undergraduate student training, as they are overwhelmed with patient numbers and have lengthy waiting lists. Not to mention that many postgraduate teaching institutes in the UK restrict the training

programme to the moderate and high difficulty cases only. In this study, it was found that out of a sample of 298, 53% were of high difficulty and 35% of moderate difficulty leaving a mere 12% of minimal difficulty (see figure 18). This indicates that the training programme offered at MBRU is on a par with international standards /norms for Endodontic training.

Examining Figure 19 for technical outcome reveals that 84% are acceptable on both counts of homogeneity and root filling length, which is a very good outcome and this was statistically significant ( $P=0.031$ )(Table 6). At the other extreme where both homogeneity and length are unacceptable, the corresponding figure was only 1%. The above figures underscore the high quality of work carried out at MBRU. Further, (Table 7) shows that there is a statistically significant difference ( $P=0.016$ ) across the three difficulties. In contrast, there were no significant differences ( $P=0.794$ ) with regard to homogeneity (Table 8). During retreatment cases there are often previous endodontics mishaps such as blockage and ledges<sup>(40)</sup> which prevent instrumentation to full working length. There may also be damage to the apical constriction from previous shaping procedures, again contributing to an incorrect, usually in this situation, overextended obturation.<sup>(69)</sup>

It is clear that the clinical case difficulty classification system is sensitive to the index used in such classifications. With this in mind and to illustrate the matter further, a random sample of 30 were selected and classified using the RIOTN system and the results are shown in (Table 1). At a glance, a number of striking anomalies can be seen. Case numbers 22 and 30, for example, both of which classified high difficulty according to AAE are classified as complexity 1 according to the RIOTN. Investigating this

further, the differences occurred due to a history of complex signs and symptoms in case 22, and in case 30 due to position of the tooth, the presence of a multi surface restoration and the nature of the endodontic history. The chances are that such patients may be treated by GDPs in the UK whereas in America you would expect them to be referred to a specialist being classified as a high difficulty case with all the implications of such referrals. The percentage of satisfactory versus unsatisfactory treatments (Table 9a) was highest for anterior /premolar teeth followed by second molars. The differences were statistically significant ( $p=0.03$ ). That said, even in cases of first molars the percentage of satisfactory treatment were still above 70%. This again reflects the high standard of treatment being carried out by the postgraduate residents. With regard to radiographic assessment of the pulp space on the preoperative radiograph (Table 9b), understandably where canals were not visible would result in a substantial reduction in satisfactory success rate (87% when canals are visible versus 55% when canals are not visible). Again this was statistically significant ( $p=0.006$ ). In contrast to the above trends, there were not much differences in success rate ( $p=0.05$ ) between primary treatment and cases which had been accessed previously (88% versus 77% satisfactory outcome).



## **CHAPTER FIVE**

### **Conclusions**

The cases examined in this study were predominantly high followed by moderate difficulty cases. This indicates that HBMCDM-Endodontic Department is considered a centre for secondary and tertiary endodontic referrals, and meets the criteria for an accredited training centre. It is also clear from the results that a robust guideline should be used to categorise complexity cases as case difficulty determination is very sensitive to the guidelines used that will ultimately determine the care pathway for the patient. Guidelines need to be evidence based which can be easily verified using appraisal tools such as the one used in this study.

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## Appendices

### Appendix I: Excel Sheet- Raw Data of 298 Cases

NO	Pt ID	Tooth NO	Medical History	Anastesia	Pt Disposition	Open Mouth	Gag Reflex	Emergency	Diagnosis
1	ALHBA001	12	1	1	1	1	1	1	1
2	ALMAL008	21	1	1	1	1	1	1	1
3	ALMSH007	25	1	1	1	1	1	1	1
4	DUPEL000	22	1	1	1	1	1	1	1
5	KAUBI000	24	1	1	1	1	1	1	1
6	ALSRO002	14	1	1	1	1	1	1	1
7	BALAH000	11	1	1	1	1	1	1	1
8	GANEL000	13	1	1	1	1	1	1	1
9	KAMJO000	14	1	1	1	1	1	1	1
10	KHIAB000	35	1	1	1	1	1	1	1
11	ALAMA011	25	1	1	1	1	1	1	1
12	AZIFO000	44	1	1	1	1	1	1	1
13	BRIAB000	34	1	1	1	1	1	1	1
14	DUPCH000	14	1	1	1	1	1	1	1
15	HOSCH000	45	1	1	1	1	1	1	1
16	IBRKH002	13	1	1	1	1	1	1	1
17	ALISA000	45	1	1	1	1	1	1	1
18	ABUAL001	35	1	1	1	1	1	1	1
19	AIZEM000	14	1	1	1	1	1	2	1
20	MUSAK000	35	1	1	1	1	1	1	1
21	ALGBA000	12	1	1	1	1	1	1	1
22	PICMA000	24	1	1	1	1	1	1	1
23	ADEKH000	13	1	1	1	1	1	1	1
24	ATTJI000	44	1	1	1	1	1	1	1
25	PARSA001	14	1	1	1	1	1	1	1
26	THIKA000	25	1	1	1	1	1	1	1
27	ALSMO016	25	1	1	1	1	1	1	1
28	ALSMO016	14	1	1	1	1	1	1	1
29	BIHMO000	24	1	1	1	1	1	1	1
30	WADWI000	15	1	1	1	1	1	1	1
31	WADWI000	14	1	1	1	1	1	1	1
32	OLAES000	25	1	1	1	1	1	1	1
33	ALMAI002	35	1	1	1	1	1	1	1
34	IQBZA000	35	1	1	1	1	1	1	1
35	MATAB000	45	1	1	1	1	1	1	1
36	MALMA003	22	1	1	1	1	1	1	1
37	ABDMA012	26	2	1	1	1	1	1	1
38	ALREN000	36	1	1	1	1	1	1	1
39	ELAKH000	14	1	1	1	1	1	2	1
40	ELHOS000	24	1	1	1	1	1	1	1
41	HAMSA005	45	1	1	1	1	1	1	1
42	HAMSA005	16	1	1	1	1	1	1	1
43	HAMSA005	11	1	1	1	1	1	1	1
44	HAMSA005	21	1	1	1	1	1	1	1
45	MANRE000	11	1	1	1	1	1	1	1
46	RAHAS000	26	1	1	1	1	1	1	1
47	SHAZA000	25	2	1	1	1	1	1	2
48	SINSU001	45	1	1	1	1	1	1	1
49	ZAIAD000	46	2	1	1	1	1	1	1
50	ADDCH000	35	2	1	1	1	1	2	1

NO	Radiographic Difficulties	Position	Tooth Isolation	Morphological Crown	Canal and Root morphology	Radiographic Appearance of Canal
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	1	1	1	1	1	1
14	1	1	1	1	1	1
15	1	1	1	1	1	1
16	1	1	1	1	1	1
17	1	1	1	1	1	1
18	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	1	1	1	1	1	1
22	1	1	1	1	1	1
23	1	1	1	1	1	1
24	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	1	1	1	1	1	1
29	1	1	1	1	1	1
30	1	1	1	1	1	1
31	1	1	1	1	1	1
32	1	1	1	1	1	1
33	1	1	1	1	1	1
34	1	1	1	1	1	1
35	1	1	1	1	1	1
36	1	1	1	1	1	1
37	1	2	1	1	1	2
38	1	2	1	1	1	2
39	1	1	1	2	1	1
40	1	1	1	2	1	2
41	1	1	1	1	2	2
42	1	2	1	1	1	2
43	1	1	1	2	1	1
44	1	1	1	2	1	1
45	1	1	1	2	1	1
46	1	2	1	1	1	2
47	1	1	1	1	1	1
48	1	1	1	2	1	1
49	1	2	1	1	1	1
50	1	1	1	2	1	1



NO	Resorption	Trauma	Endo-Peri	Endodontic History	Complexity	Outcome
1	1	0	1	1	1	1
2	1	0	1	1	1	1
3	1	0	1	1	1	1
4	1	0	1	1	1	1
5	1	0	1	1	1	1
6	1	0	1	1	1	1
7	1	0	1	1	1	4
8	1	0	1	1	1	1
9	1	0	1	1	1	1
10	1	0	1	1	1	4
11	1	0	1	1	1	1
12	1	0	1	1	1	1
13	1	0	1	1	1	1
14	1	0	1	1	1	1
15	1	0	1	1	1	1
16	1	0	1	1	1	1
17	1	0	1	1	1	1
18	1	0	1	1	1	1
19	1	0	1	1	1	1
20	1	0	1	1	1	1
21	1	0	1	1	1	1
22	1	0	1	1	1	4
23	1	0	1	1	1	1
24	1	0	1	1	1	1
25	1	0	1	1	1	1
26	1	0	1	1	1	1
27	1	0	1	1	1	1
28	1	0	1	1	1	1
29	1	0	1	1	1	1
30	1	0	1	1	1	1
31	1	0	1	1	1	1
32	1	0	1	1	1	1
33	1	0	1	1	1	1
34	1	0	1	1	1	1
35	1	0	1	1	1	1
36	1	0	1	1	1	1
37	1	0	1	1	2	1
38	2	0	1	1	2	3
39	1	0	1	1	2	1
40	1	0	1	1	2	1
41	1	0	1	1	2	1
42	1	0	1	1	2	1
43	2	0	1	1	2	1
44	1	0	1	1	2	1
45	1	0	2	1	2	1
46	1	0	1	2	2	1
47	2	0	1	1	2	1
48	1	0	1	2	2	3
49	2	0	1	2	2	1
50	1	0	1	1	2	4

NO	Pt ID	Tooth NO	Medical History	Anesthesia	Pt Disposition	Open Mouth	Gag Reflex	Emergency	Diagnosis
51	ALDAB004	45	1	1	1	1	1	1	1
52	ALDHI001	36	1	1	1	1	1	1	1
53	ALMAH009	33	1	1	1	1	1	1	1
54	ALRAM000	25	1	1	1	1	1	1	1
55	BLAST000	45	1	1	1	1	2	1	1
56	BONJA000	35	1	1	1	1	1	2	1
57	BOUTA000	45	1	1	1	1	1	1	1
58	DURER000	16	2	1	1	1	1	1	1
59	HAMRE000	16	2	1	1	1	1	1	1
60	KIMMY000	26	1	1	1	1	1	2	1
61	MELCE000	11	1	1	1	1	1	2	1
62	MUSRA001	26	1	1	1	1	1	2	1
63	RAFLE000	46	2	1	1	1	1	1	1
64	RASJA000	25	2	1	1	1	1	1	1
65	RAYSA000	46	1	1	1	1	1	1	1
66	SHAAM002	15	2	1	1	1	1	2	1
67	TAJLA000	15	1	1	1	1	1	2	1
68	ALARA003	46	2	1	1	1	1	1	1
69	ALDSA004	26	1	1	1	1	1	2	1
70	ABUSA002	26	1	1	1	1	1	2	1
71	AHMAL007	46	1	1	1	1	1	1	1
72	AHMBAA001	46	1	1	1	1	1	1	1
73	ALIAK000	36	1	1	1	1	1	2	1
74	ALIDA000	46	1	1	1	1	1	2	1
75	ALISA000	16	1	1	1	1	1	1	1
76	ALKMO011	16	1	1	1	1	1	2	1
77	ALZAZ000	24	1	1	1	1	1	1	1
78	ARERI000	12	1	1	1	1	1	1	1
79	SHUCA000	26	1	1	1	1	1	2	1
80	BABNE000	25	2	1	1	1	1	1	1
81	BALSA000	26	1	1	1	1	1	2	1
82	BELMO002	16	1	1	1	1	1	1	1
83	BRIAB000	15	1	1	1	1	1	2	1
84	HOSCH000	46	1	1	1	1	1	1	1
85	IMAA000	14	1	1	1	1	1	2	1
86	KARMO000	46	1	1	1	1	1	2	1
87	LATKA000	46	1	1	1	1	1	2	1
88	MAHMA002	36	1	1	1	1	1	2	1
89	MOUCA000	46	1	1	1	1	1	1	1
90	OBINA000	26	1	1	1	1	1	2	1
91	RAHMO000	26	1	1	1	1	1	2	1
92	RAJNI000	16	1	1	1	1	1	1	1
93	RASMO000	46	1	1	1	1	1	1	1
94	RUKMU000	25	1	1	1	1	1	2	1
95	SAMOS000	22	2	1	1	1	1	1	1
96	WASFA000	22	1	1	1	1	1	2	1
97	ABUSA002	16	1	1	1	1	1	1	1
98	REGKA000	16	1	1	1	1	1	2	1
99	ALAMO017	36	1	1	1	1	1	2	1
100	IBRAH003	16	1	1	1	1	1	1	1

NO	Radiographic Difficulties	Position	Tooth Isolation	Morphological Crown	Canal and Root morphology	Radiographic Appearance of Canal
51	1	1	1	2	1	1
52	1	2	1	1	1	1
53	1	1	1	1	2	1
54	1	1	1	2	1	2
55	2	1	1	2	1	1
56	1	1	1	1	1	1
57	1	1	1	2	1	1
58	1	2	1	2	1	1
59	1	2	1	1	1	1
60	1	2	1	2	1	1
61	1	1	1	1	1	1
62	1	2	1	2	1	1
63	1	2	1	1	1	1
64	1	1	1	1	1	1
65	1	2	1	1	1	1
66	1	1	1	1	1	1
67	1	1	1	1	2	1
68	1	2	2	2	1	2
69	1	2	1	2	1	1
70	1	2	1	2	1	1
71	2	1	1	1	1	1
72	2	1	1	2	1	1
73	1	2	1	2	1	1
74	1	2	1	2	1	1
75	1	2	1	2	1	1
76	1	2	1	2	1	1
77	1	2	1	2	1	2
78	1	1	1	2	1	1
79	1	2	1	2	1	1
80	1	1	1	1	2	1
81	1	2	1	2	1	1
82	1	2	1	1	1	1
83	1	1	1	2	2	2
84	1	2	1	2	1	1
85	1	1	1	2	1	1
86	1	2	1	2	2	1
87	1	2	1	1	1	1
88	1	2	1	2	1	1
89	1	2	1	2	1	1
90	1	2	1	2	1	2
91	1	2	1	1	2	1
92	1	2	1	1	1	1
93	1	2	1	1	1	1
94	1	1	1	2	1	1
95	1	1	2	2	1	1
96	1	1	1	2	2	1
97	1	2	1	1	1	1
98	1	2	1	1	2	2
99	1	2	1	1	1	2
100	1	2	1	1	2	2

NO	Resorption	Trauma	Endo-Peri	Endodontic History	Complexity	Outcome
51	2	0	1	2	2	1
52	1	0	1	2	2	5
53	1	0	1	2	2	1
54	1	0	1	2	2	1
55	1	0	1	1	2	1
56	2	0	2	1	2	1
57	1	0	1	2	2	1
58	1	0	1	1	2	1
59	1	0	1	2	2	1
60	1	0	1	1	2	1
61	1	2	1	1	2	1
62	1	0	1	1	2	1
63	2	0	1	1	2	1
64	1	0	1	2	2	1
65	2	0	1	1	2	1
66	1	0	1	1	2	1
67	1	0	1	1	2	1
68	1	0	1	1	2	1
69	1	0	2	1	2	1
70	1	0	1	1	2	1
71	2	0	1	1	2	1
72	1	0	1	1	2	4
73	1	0	2	2	2	1
74	1	0	2	1	2	1
75	1	0	1	1	2	1
76	1	0	1	1	2	4
77	2	0	1	1	2	3
78	2	0	2	2	2	1
79	1	0	1	1	2	1
80	1	0	1	1	2	1
81	1	0	2	1	2	1
82	1	0	1	1	2	1
83	1	0	1	1	2	1
84	2	0	1	1	2	1
85	1	0	1	1	2	1
86	1	0	1	1	2	1
87	2	0	1	1	2	1
88	1	0	1	1	2	1
89	1	0	2	1	2	1
90	1	0	1	1	2	1
91	1	0	1	1	2	1
92	1	0	1	1	2	1
93	1	0	1	1	2	1
94	1	0	1	1	2	1
95	2	0	1	1	2	1
96	1	0	1	1	2	1
97	1	0	1	2	2	2
98	1	0	1	1	2	1
99	1	0	2	1	2	1
100	1	0	1	2	2	1

NO	Pt ID	Tooth NO	Medical History	Anastesia	Pt Disposition	Open Mouth	Gag Reflex	Emergency	Diagnosis
101	KINAB000	36	1	1	1	1	1	2	1
102	KHARA004	46	1	1	1	1	1	1	1
103	AIZEM000	26	1	1	1	1	1	2	1
104	AIZEM000	15	1	1	1	1	1	2	1
105	YOUMU000	16	1	1	1	1	1	1	1
106	ALMSH009	36	1	1	1	1	1	1	1
107	MOHTA002	46	2	1	1	1	1	1	1
108	YOUWI000	16	1	1	1	1	1	2	1
109	ADEKH000	14	1	1	1	1	1	2	1
110	KUNNA000	36	1	1	1	1	1	1	1
111	ALRAZ000	41	1	1	1	1	1	1	1
112	ALRAZ000	31	1	1	1	1	1	1	1
113	TURMA001	36	1	1	1	1	1	1	1
114	ABDFA009	45	2	1	1	1	1	1	1
115	ABUSA002	35	1	1	1	1	1	1	1
116	ALGRA000	15	1	1	1	1	1	2	1
117	AMACA000	13	1	1	1	1	1	1	1
118	AMAMO000	35	1	1	1	1	1	1	1
119	BONMA000	12	1	1	1	1	1	2	1
120	HMESA000	23	1	1	1	1	1	1	1
121	MOHMA009	44	2	1	1	1	1	1	1
122	QASSA000	25	1	1	1	1	1	1	1
123	WILJE000	23	1	1	1	1	1	1	1
124	YUSMO000	25	1	1	1	1	1	2	1
125	BALSA000	23	1	1	1	1	1	2	1
126	RUKMU000	34	1	1	1	1	1	2	1
127	HOSCH000	25	1	1	1	1	1	1	1
128	ABDAL007	13	1	1	1	1	1	1	1
129	BASFA000	24	1	1	1	1	1	2	1
130	KASBA000	21	1	1	1	1	1	1	1
131	YOUMU000	43	1	1	1	1	1	2	1
132	ALGBA000	24	1	1	1	1	1	1	1
133	ASLMU002	44	1	1	1	1	1	1	1
134	RAMME000	11	2	1	1	1	1	1	1
135	BOYMU000	25	1	1	1	1	1	2	1
136	KIMRA000	15	2	1	1	1	1	2	1
137	HOUEF000	45	2	1	1	1	1	1	1
138	SAEMA002	36	1	1	1	1	1	2	1
139	SAMOS000	46	2	1	1	1	1	2	1
140	BYRPA000	46	2	1	1	1	1	2	1
141	KASFA001	36	1	1	1	1	1	1	1
142	ABDAM000	47	1	1	1	1	1	1	1
143	ABDAS001	46	1	1	1	1	1	1	1
144	ABDSA002	25	1	1	1	1	1	1	1
145	ABUMA003	26	1	1	1	1	1	1	1
146	ABUMA003	45	1	1	1	1	1	1	1
147	ALDFA001	37	1	1	1	1	1	1	1
148	ALHBA001	11	1	1	1	1	1	1	1
149	ALHBA001	21	1	1	1	1	1	1	1
150	ALHBA001	23	1	1	1	1	1	1	1

NO	Radiographic Difficulties	Position	Tooth Isolation	Morphological Crown	Canal and Root morphology	Radiographic Appearance of Canal
101	1	2	1	1	2	1
102	1	2	1	2	2	1
103	1	2	1	1	2	1
104	1	1	1	1	1	1
105	1	2	1	1	2	1
106	1	2	1	2	1	1
107	1	2	1	2	2	1
108	1	2	1	1	2	1
109	1	1	1	2	1	2
110	1	2	1	1	1	2
111	1	1	1	2	1	1
112	1	1	1	2	1	1
113	1	2	1	2	1	1
114	1	1	1	2	1	1
115	1	1	1	1	1	1
116	1	1	1	2	1	1
117	1	1	1	2	1	1
118	1	1	1	2	1	1
119	1	1	1	1	1	1
120	1	1	1	1	2	1
121	1	1	1	2	1	1
122	1	1	1	2	1	1
123	1	1	1	2	1	1
124	1	1	1	1	1	1
125	1	1	1	2	1	1
126	1	1	1	2	1	1
127	1	1	1	2	1	1
128	1	1	1	2	1	1
129	1	1	1	2	1	1
130	1	1	2	2	1	1
131	1	1	1	2	1	1
132	1	1	1	2	1	1
133	1	1	1	2	1	1
134	1	1	1	1	1	1
135	1	1	1	1	1	1
136	1	1	1	1	1	1
137	1	1	1	1	1	1
138	1	2	1	1	2	1
139	1	2	1	2	1	2
140		1	1	1	2	1
141	1	2	1	2	1	1
142	1	3	1	2	2	2
143	1	2	1	2	2	3
144	1	1	1	2	1	1
145	1	2	1	2	1	1
146	1	1	1	3	2	1
147	1	3	1	2	2	2
148	1	1	1	2	1	1
149	1	1	1	2	1	1
150	1	1	1	1	2	1

NO	Resorption	Trauma	Endo-Peri	Endodontic History	Complexity	Outcome
101	1	0	1	1	2	1
102	1	0	1	1	2	4
103	1	0	1	1	2	1
104	1	0	1	1	2	1
105	1	0	1	1	2	1
106	2	0	1	1	2	1
107	1	0	2	1	2	5
108	1	0	1	1	2	1
109	2	0	1	1	2	1
110	1	0	1	1	2	1
111	2	0	2	1	2	1
112	2	0	2	1	2	1
113	1	0	1	1	2	1
114	1	0	1	1	2	1
115	1	0	1	2	2	1
116	1	0	1	1	2	1
117	1	0	1	2	2	1
118	1	0	1	2	2	1
119	2	0	1	1	2	1
120	1	0	1	1	2	1
121	1	0	1	1	2	1
122	1	0	1	2	2	1
123	1	0	1	1	2	1
124	1	0	1	1	2	1
125	1	0	2	2	2	1
126	1	0	1	1	2	1
127	1	0	2	1	2	1
128	1	0	1	1	2	1
129	1	0	1	1	2	1
130	2	2	1	1	2	1
131	2	0	1	1	2	1
132	1	0	1	1	2	1
133	1	0	1	1	2	2
134	1	0	1	1	2	1
135	1	0	2	1	2	2
136	1	0	1	1	2	1
137	1	0	1	1	2	1
138	1	0	2	1	2	1
139	1	0	2	1	2	1
140	1	0	2	1	2	1
141	1	0	1	2	2	1
142	1	0	1	1	3	1
143	1	0	1	1	3	1
144	1	0	1	3	3	1
145	1	0	1	3	3	1
146	1	0	1	3	3	1
147	1	0	1	1	3	1
148	1	0	1	3	3	1
149	1	0	1	3	3	1
150	1	0	1	3	3	1

NO	Pt ID	Tooth NO	Medical History	Anastesia	Pt Disposition	Open Mouth	Gag Reflex	Emergency	Diagnosis
151	ALHBA001	45	1	1	1	1	1	1	1
152	ALIMA001	37	1	1	1	1	1	1	1
153	ALKFA007	36	2	1	1	1	1	2	1
154	ELHOS000	27	1	1	1	1	1	1	1
155	ELHOS000	26	1	1	1	1	1	1	1
156	HAMSA005	44	1	1	1	1	1	1	1
157	HAMSA005	36	1	1	1	1	1	1	1
158	JABSA000	34	1	1	1	1	1	1	1
159	MANRE000	12	1	1	1	1	1	1	1
160	MANRE000	21	1	1	1	1	1	1	1
161	MANRE000	22	1	1	1	1	1	1	1
162	MANRE000	41	1	1	1	1	1	1	1
163	MOHAM004	16	1	1	1	1	1	1	1
164	RATMA000	45	1	1	1	1	1	1	1
165	ABDAZ000	43	1	2	1	1	1	1	1
166	ABDAZ000	42	1	2	1	1	1	1	1
167	ABDAZ000	32	1	2	1	1	1	1	1
168	AHMMWI000	47	1	1	1	1	1	2	1
169	ALAAB004	17	1	1	1	1	1	1	1
170	ALMHA007	37	1	1	1	1	1	1	1
171	ALRAM000	17	1	1	1	1	1	1	1
172	ALSKH005	26	1	1	1	1	1	1	1
173	ALSKH007	46	2	1	1	1	1	1	1
174	ALSRO002	26	1	1	1	1	1	1	1
175	BASMI000	47	2	2	1	1	1	1	1
176	BONJA000	34	1	1	1	1	1	2	2
177	ELSRA001	37	1	1	1	1	1	1	1
178	FORTO000	41	1	1	1	1	1	1	1
179	GARDA000	37	1	1	1	1	1	1	1
180	HULDA000	46	2	2	1	1	1	1	1
181	IBRYO000	46	2	2	1	1	1	1	1
182	JACJU000	23	2	1	1	1	1	1	1
183	JOSAN000	45	1	1	1	1	1	1	1
184	JOSAN000	24	1	1	1	1	1	1	1
185	KAYHA000	47	1	1	1	2	2	1	1
186	KHAME000	17	1	1	1	1	1	3	1
187	MGHTA000	47	1	1	1	1	1	1	1
188	PARSU000	46	1	1	1	1	1	1	1
189	UGUFE000	44	1	1	1	1	1	2	1
190	ABDNA003	47	1	1	1	1	1	1	1
191	ABDAB015	47	1	1	1	1	1	1	1
192	ABDAM004	17	1	1	1	2	2	1	1
193	AHMBAA001	27	1	1	1	1	1	1	1
194	ALAHA007	37	1	1	1	1	1	3	1
195	ALCRO000	46	1	1	1	1	1	1	1
196	ALCRO000	37	1	1	1	1	1	1	1
197	ALIDA000	27	1	1	1	1	1	1	1
198	ALZAZ000	47	1	1	1	1	1	1	1
199	ALZAZ000	36	1	1	1	1	1	1	1
200	APUMA000	37	1	1	2	2	1	2	1



NO	Radiographic Difficulties	Position	Tooth Isolation	Morphological Crown	Canal and Root morphology	Radiographic Appearance of Canal
151	1	1	1	1	1	1
152	1	3	1	2	1	1
153	1	2	1	2	1	3
154	1	3	1	2	2	2
155	1	2	1	2	2	1
156	1	1	1	2	1	1
157	1	2	1	1	1	2
158	1	1	1	2	1	1
159	1	1	1	2	1	1
160	1	1	1	2	2	1
161	1	1	1	2	2	1
162	1	1	1	2	1	1
163	1	2	1	2	3	1
164	1	1	1	1	1	1
165	1	1	1	1	1	1
166	1	1	1	1	1	1
167	1	1	1	1	1	1
168	1	3	1	2	2	1
169	1	3	1	2	2	1
170	1	3	1	2	2	1
171	1	3	1	2	1	1
172	1	2	1	1	1	1
173	1	2	1	1	1	3
174	1	2	1	2	2	1
175	1	3	1	1	1	1
176	1	1	1	2	1	1
177	1	3	1	1	3	2
178	1	1	1	1	3	3
179	1	3	1	1	1	2
180	1	2	1	2	1	1
181	1	2	1	2	2	2
182	1	1	1	1	2	1
183	1	1	1	2	1	1
184	1	1	1	2	1	1
185	1	3	1	1	1	1
186	1	3	1	1	1	1
187	1	3	1	2	2	1
188	1	2	1	2	2	1
189	1	1	1	1	3	1
190	1	3	2	2	2	1
191	1	3	1	1	2	1
192	2	3	1	1	1	1
193	3	3	1	2	2	1
194	1	3	1	2	2	1
195	1	2	1	2	2	2
196	1	3	1	2	2	1
197	1	3	2	2	2	2
198	1	3	1	1	2	1
199	1	2	1	2	1	2
200	1	3	1	2	1	1

NO	Resorption	Trauma	Endo-Peri	Endodontic History	Complexity	Outcome
151	1	0	1	3	3	1
152	1	0	1	1	3	1
153	2	0	2	1	3	2
154	1	0	1	1	3	1
155	2	0	1	3	3	1
156	3	0	1	1	3	1
157	1	0	1	3	3	1
158	1	0	1	3	3	1
159	1	0	1	3	3	1
160	2	0	1	3	3	1
161	2	0	1	3	3	3
162	2	0	2	3	3	1
163	1	0	1	1	3	2
164	3	1	1	1	3	5
165	1	0	2	3	3	1
166	1	0	2	3	3	1
167	1	0	2	3	3	1
168	1	0	1	2	3	1
169	1	0	1	2	3	1
170	1	0	1	1	3	1
171	1	0	1	3	3	1
172	1	0	1	3	3	4
173	1	0	1	3	3	2
174	1	0	1	3	3	1
175	2	0	1	1	3	1
176	1	0	1	3	3	1
177	1	0	1	1	3	1
178	1	0	1	2	3	1
179	2	0	1	1	3	4
180	2	0	3	1	3	1
181	1	0	1	3	3	1
182	1	0	1	3	3	2
183	1	0	1	3	3	1
184	1	0	1	3	3	1
185	1	0	1	2	3	4
186	1	0	1	1	3	1
187	1	0	1	2	3	4
188	2	0	1	3	3	4
189	1	0	1	1	3	1
190	2	0	1	3	3	1
191	1	0	1	1	3	1
192	1	0	1	2	3	4
193	1	0	1	1	3	1
194	1	0	2	1	3	1
195	1	0	1	3	3	1
196	1	0	1	3	3	1
197	1	0	2	1	3	1
198	1	0	1	3	3	1
199	2	0	1	3	3	2
200	1	0	1	1	3	1

NO	Pt ID	Tooth NO	Medical History	Anastesia	Pt Disposition	Open Mouth	Gag Reflex	Emergency	Diagnosis
201	ARERI000	21	1	1	1	1	1	1	1
202	ARZFA000	35	1	1	1	1	1	1	2
203	BASZA000	17	2	1	1	1	1	1	1
204	BELJA000	26	1	1	1	1	1	1	1
205	BOTRE000	46	1	1	1	1	1	1	1
206	BRIAB000	17	1	1	1	1	1	2	1
207	BUSRI000	12	2	1	1	1	1	1	1
208	CCARO000	16	2	1	1	1	1	1	1
209	CCARO000	44	2	1	1	1	1	1	1
210	CHELI000	17	1	1	1	1	1	2	1
211	CRULU000	14	1	1	1	1	1	1	1
212	CRULU000	16	1	1	1	1	1	1	1
213	DAHRE000	22	1	1	1	1	1	1	1
214	DECSA000	46	1	1	1	1	1	1	1
215	DILMU000	37	1	1	1	1	1	1	1
216	DUPCH000	27	1	1	1	1	1	1	1
217	GULIS000	24	1	1	1	1	1	1	1
218	IBRKH002	37	1	1	1	1	1	2	1
219	ISMYA000	27	1	1	1	1	1	1	1
220	KAMJO000	17	1	1	1	1	1	3	1
221	KANMO000	15	1	1	1	1	1	1	1
222	LAHFA000	45	1	1	1	1	1	1	1
223	MAHMA002	14	1	1	1	1	1	2	2
224	MAHMA002	16	1	1	1	1	1	1	1
225	MOLGE000	37	1	1	1	1	1	3	1
226	MOLGE000	45	1	1	1	1	1	1	1
227	MOSMO000	17	1	1	1	1	1	1	1
228	MOUCA000	37	1	1	1	1	1	1	1
229	NOUMU000	25	2	1	1	1	1	2	1
230	NOUMU000	45	2	1	1	1	1	1	1
231	QADEL000	16	1	1	1	1	1	2	1
232	RADGH000	37	1	1	1	1	1	1	1
233	RAJNI000	33	1	1	1	1	1	1	1
234	RASSA001	46	1	1	1	1	1	1	1
235	SABSO000	37	1	1	1	1	1	2	1
236	SAMOS000	21	2	1	1	1	1	1	1
237	SHAAB005	47	1	1	1	1	1	2	1
238	STEJA000	13	2	1	1	1	1	1	1
239	VIDFE000	27	1	1	1	1	1	1	1
240	WASFA000	27	1	1	1	1	1	1	1
241	WITRE000	27	1	1	1	1	1	1	1
242	YOULA000	15	1	1	1	1	1	1	1
243	ZAKAY000	27	1	1	1	1	1	2	1
244	BUSRI000	45	2	1	1	1	1	1	1
245	ALCRO000	47	1	1	1	1	1	1	1
246	ALCRO000	34	1	1	1	1	1	1	1
247	ALZAZ000	46	1	1	1	1	1	1	1
248	ATTJI000	37	1	1	1	1	1	1	1
249	ATTJI000	14	1	1	1	1	1	1	1
250	BUSRI000	24	2	1	1	1	1	1	1

NO	Radiographic Difficulties	Position	Tooth Isolaion	Morphological Crown	Canal and Root morphology	Radiographic Apperance of Canal
201	1	1	1	2	2	1
202	1	1	1	2	1	1
203	1	3	1	2	2	2
204	1	2	1	2	1	2
205	1	2	1	2	2	3
206	1	3	1	1	2	1
207	1	1	1	2	1	1
208	1	2	1	2	2	3
209	1	1	1	2	1	3
210	1	3	1	2	1	1
211	1	1	2	2	1	1
212	1	2	1	2	2	2
213	1	1	1	1	2	1
214	1	2	1	2	2	2
215	1	3	1	2	1	1
216	1	3	1	2	2	1
217	1	1	1	2	1	1
218	1	3	1	2	1	1
219	1	3	1	2	1	2
220	1	3	1	2	1	2
221	1	1	1	2	2	1
222	1	1	1	2	1	1
223	1	1	1	2	1	1
224	1	2	1	2	3	1
225	1	3	1	3	3	2
226	1	1	1	2	1	2
227	1	3	1	2	2	1
228	1	3	1	2	1	1
229	1	1	1	2	1	1
230	1	1	1	2	1	2
231	1	2	1	1	2	1
232	1	3	1	2	1	1
233	1	1	1	2	3	1
234	1	2	1	2	2	1
235	1	3	1	2	1	1
236	1	1	1	2	1	1
237	1	3	1	1	2	1
238	1	1	1	2	1	2
239	1	3	1	2	1	2
240	1	3	1	2	2	2
241	1	3	1	1	2	1
242	1	1	1	1	1	1
243	1	3	1	2	1	2
244	1	1	1	2	1	1
245	1	3	1	2	2	2
246	1	1	1	2	2	3
247	1	2	1	1	1	3
248	1	3	1	2	1	1
249	1	1	1	2	2	1
250	1	1	1	2	1	3

NO	Resorption	Trauma	Endo-Peri	Endodontic History	Complexity	Outcome
201	2	0	1	3	3	1
202	1	0	2	3	3	1
203	1	0	1	3	3	1
204	1	0	2	3	3	1
205	1	0	2	1	3	1
206	1	0	1	1	3	1
207	1	0	1	3	3	4
208	1	0	1	1	3	2
209	1	0	1	3	3	1
210	1	0	1	1	3	1
211	1	0	1	3	3	1
212	2	0	1	3	3	2
213	1	0	1	3	3	1
214	1	0	2	3	3	2
215	1	0	1	3	3	1
216	1	0	1	1	3	1
217	1	0	1	3	3	4
218	2	0	2	1	3	1
219	1	0	1	3	3	1
220	1	0	2	1	3	1
221	1	0	1	3	3	1
222	1	0	1	3	3	1
223	2	0	1	3	3	1
224	1	0	1	3	3	1
225	1	0	2	1	3	1
226	1	0	2	3	3	1
227	1	0	1	1	3	1
228	1	0	3	2	3	1
229	1	0	1	3	3	1
230	1	0	1	3	3	1
231	1	0	1	3	3	1
232	1	0	1	1	3	1
233	1	0	1	3	3	1
234	1	0	1	3	3	4
235	1	0	1	1	3	2
236	1	0	1	3	3	1
237	1	0	1	1	3	4
238	1	0	1	3	3	1
239	1	0	1	1	3	1
240	1	0	1	1	3	1
241	1	0	1	1	3	1
242	1	0	1	3	3	1
243	1	0	1	1	3	1
244	1	0	1	3	3	1
245	1	0	1	3	3	1
246	1	0	1	2	3	1
247	1	0	1	3	3	2
248	1	0	1	3	3	1
249	3	0	1	3	3	1
250	1	0	1	1	3	1

NO	Pt ID	Tooth NO	Medical History	Anastesia	Pt Disposition	Open Mouth	Gag Reflex	Emergency	Diagnosis
251	DECSA000	37	1	1	1	1	1	3	1
252	IBRKH002	45	1	1	1	1	1	1	1
253	MOLGE000	46	1	1	1	1	1	1	1
254	SAMOS000	15	2	1	1	1	1	1	1
255	SAMOS000	17	2	1	1	1	1	1	1
256	SAMOS000	11	2	1	1	1	1	1	1
257	SAMOS000	12	2	1	1	1	1	1	1
258	ABDSA012	27	1	1	1	1	1	3	1
259	PATMI001	27	1	1	1	1	1	3	1
260	IVANI000	26	1	1	1	1	1	1	1
261	ELHZA001	27	1	1	2	2	1	3	1
262	EIHZA001	16	1	1	2	2	1	1	1
263	EIKTA000	25	1	1	2	1	1	1	1
264	EIKTA000	26	1	1	2	1	1	1	1
265	EIKTA000	27	1	1	2	1	1	3	1
266	MAZSH000	47	1	1	1	1	1	3	1
267	KHASA012	46	1	1	1	1	1	1	1
268	KINAB000	47	1	1	1	1	1	1	1
269	MUTMU000	27	2	1	1	1	1	1	1
270	GIRMI000	27	1	1	1	1	1	1	1
271	AIZEM000	45	1	1	1	1	1	1	1
272	ZARSA001	47	1	1	1	1	1	2	1
273	ALMSH009	37	1	1	1	1	1	1	1
274	GUELI000	13	1	1	1	1	1	1	1
275	OSMOS000	27	1	1	1	1	1	1	1
276	ALGBA000	17	1	1	1	1	1	1	1
277	ALGBA000	15	1	1	1	1	1	1	1
278	FULAN000	37	1	1	1	1	1	1	1
279	AKHSH001	36	2	1	1	1	1	1	1
280	ALHKH004	47	1	1	1	1	1	1	1
281	JABJU000	47	1	1	1	1	1	1	1
282	ELSMO003	25	1	1	1	1	1	1	1
283	ALISA002	37	1	1	1	1	1	1	1
284	MALMA003	37	1	1	1	1	1	1	1
285	RAHSH000	31	1	1	1	1	1	1	1
286	RAHSH000	41	1	1	1	1	1	1	1
287	ALSKA000	35	1	1	1	1	1	1	1
288	YASMN000	16	1	1	1	1	1	1	1
289	YASMN000	45	1	1	1	1	1	1	1
290	ELMAM000	45	1	1	1	1	1	1	1
291	ALNEM000	15	1	1	1	1	1	3	1
292	ABDAT001	45	1	1	1	1	1	1	1
293	ABDSA009	24	1	1	1	1	1	3	1
294	ALIHO000	22	1	1	1	1	1	1	1
295	AMIMO000	21	1	1	1	1	1	1	1
296	ATTJI000	45	1	1	1	1	1	1	1
297	ALCRO000	36	1	1	1	1	1	1	1
298	IBRKH002	11	1	1	1	1	1	1	1

NO	Radiographic Difficulties	Position	Tooth Isolaion	Morphological Crown	Canal and Root morphology	Radiographic Apperance of Canal
251	1	3	1	2	2	1
252	1	1	1	2	2	2
253	1	2	1	2	1	2
254	1	1	1	2	1	1
255	1	3	1	2	2	3
256	1	1	1	2	1	1
257	1	1	1	2	1	1
258	1	3	1	2	2	1
259	1	3	1	2	1	2
260	1	2	1	2	2	2
261	1	3	1	1	1	1
262	1	2	1	1	2	2
263	1	1	1	2	2	2
264	1	2	1	2	2	2
265	1	3	1	2	2	2
266	1	3	1	1	1	1
267	1	2	1	2	2	2
268	1	3	1	1	2	1
269	1	3	1	2	2	1
270	1	3	1	1	2	1
271	1	1	1	2	1	1
272	1	3	1	2	1	1
273	1	3	1	2	2	2
274	1	1	1	2	1	1
275	1	3	1	2	1	2
276	1	3	1	2	1	1
277	1	1	1	2	1	2
278	1	3	1	3	1	1
279	1	2	1	2	1	2
280	1	3	1	1	2	2
281	1	3	1	2	2	1
282	1	1	1	1	1	1
283	1	3	1	1	2	1
284	1	3	1	2	1	1
285	1	1	1	1	2	1
286	1	1	1	1	2	1
287	1	1	1	1	1	1
288	1	2	1	1	2	1
289	1	1	1	2	2	1
290	1	1	1	2	1	1
291	1	1	1	1	1	1
292	1	1	1	2	2	1
293	1	1	1	1	2	1
294	1	1	2	2	1	1
295	1	1	1	1	3	1
296	1	1	1	2	2	1
297	1	2	1	1	2	1
298	1	1	1	1	2	1

NO	Resorption	Trauma	Endo-Peri	Endodontic History	Complexity	Outcome
251	1	0	1	3	3	1
252	1	0	1	3	3	2
253	2	0	2	3	3	2
254	2	0	1	3	3	1
255	1	0	1	3	3	2
256	1	0	1	3	3	1
257	1	0	1	3	3	1
258	1	0	1	1	3	1
259	1	0	1	1	3	1
260	1	0	1	3	3	2
261	1	0	1	1	3	1
262	1	0	1	3	3	1
263	1	0	1	3	3	2
264	1	0	1	3	3	2
265	1	0	1	1	3	1
266	1	0	1	1	3	1
267	1	0	1	3	3	1
268	1	0	1	1	3	4
269	1	0	1	1	3	1
270	1	0	1	2	3	4
271	1	0	1	3	3	1
272	1	0	1	1	3	1
273	1	0	1	3	3	2
274	1	0	1	3	3	1
275	1	0	1	1	3	1
276	2	0	1	3	3	1
277	1	0	1	3	3	2
278	1	0	1	3	3	1
279	1	0	1	3	3	1
280	1	0	1	1	3	1
281	1	0	1	1	3	1
282	1	0	1	3	3	1
283	1	0	1	1	3	2
284	1	0	1	1	3	1
285	2	2	3	1	3	1
286	2	2	3	1	3	1
287	1	0	1	3	3	1
288	1	0	1	3	3	2
289	1	0	1	3	3	1
290	1	0	1	3	3	1
291	1	0	1	2	3	1
292	1	0	1	3	3	1
293	1	0	1	2	3	1
294	2	0	1	3	3	1
295	2	0	1	3	3	1
296	3	0	1	2	3	1
297	1	0	1	3	3	1
298	3	0	1	1	3	1



## Appendix II: Agree II Tool for Assessment of AAE and RIOTN Guidelines

DOMAIN 1. SCOPE AND PURPOSE						
1. The overall objective(s) of the guideline is (are) specifically described						
1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						
2. The health question(s) covered by the guideline is (are) specifically described						
1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						
3. The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described						
1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						
DOMAIN 2. STAKEHOLDER INVOLVEMENT						

4. The guideline development group includes individuals from all relevant professional groups.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments American Association of Endodontic Guidelines are developed by specialist Endodontists although General Dental Practitioners may also use them						

5. The views and preferences of the target population (patients, public, etc.) have been sought

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments Does not apply to these guidelines						

6. The target users of the guideline are clearly defined

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 3. RIGOUR OF DEVELOPMENT

7. Systematic methods were used to search for evidence

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

8. The criteria for selecting the evidence are clearly described

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

9. The strengths and limitations of the body of evidence are clearly described

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 3. RIGOUR OF DEVELOPMENT continued

10. The methods for formulating the recommendations are clearly described

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

11. The health benefits, side effects, and risks have been considered in formulating the recommendations

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

12. There is an explicit link between the recommendations and the supporting evidence

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 3. RIGOUR OF DEVELOPMENT continued

13. The guideline has been externally reviewed by experts prior to its publication

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

14. A procedure for updating the guideline is provided

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 4. CLARITY OF PRESENTATION

15. The recommendations are specific and unambiguous

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments Sometimes difficult to differentiate between a moderate and high difficulty case						

16. The different options for management of the condition or health issue are clearly presented

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

17. Key recommendations are easily identifiable.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 5. APPLICABILITY

18. The guideline describes facilitators and barriers to its application

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

19. The guideline provides advice and/or tools on how the recommendations can be put into practice

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

20. The potential resource implications of applying the recommendations have been considered.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 5. APPLICABILITY continued

21. The guideline presents monitoring and/or auditing criteria

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 6. EDITORIAL INDEPENDENCE

22. The views of the funding body have not influenced the content of the guideline.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

23. Competing interests of guideline development group members have been recorded and addressed

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						



## **OVERALL GUIDELINE ASSESSMENT**

For each question, please choose the response which best characterizes the guideline assessed:

1. Rate the overall quality of this guideline.

1						7
Strongly Disagree	2	3	4	5	6	Strongly Agree

2. I would recommend this guideline for use. (AAE)

Yes	
Yes, with modification	
NO	

Notes

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DOMAIN 1. SCOPE AND PURPOSE						
1.The overall objective(s) of the guideline is (are) specifically described						
1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						
2.The health question(s) covered by the guideline is (are) specifically described						
1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						
3.The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described						
1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						
DOMAIN 2. STAKEHOLDER INVOLVEMENT						

4. The guideline development group includes individuals from all relevant professional groups.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

5. The views and preferences of the target population (patients, public, etc.) have been sought

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

6. The target users of the guideline are clearly defined

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 3. RIGOUR OF DEVELOPMENT

7. Systematic methods were used to search for evidence

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

8. The criteria for selecting the evidence are clearly described

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

9. The strengths and limitations of the body of evidence are clearly described

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 3. RIGOUR OF DEVELOPMENT continued

10. The methods for formulating the recommendations are clearly described

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

11. The health benefits, side effects, and risks have been considered in formulating the recommendations

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

12. There is an explicit link between the recommendations and the supporting evidence

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 3. RIGOUR OF DEVELOPMENT continued

13. The guideline has been externally reviewed by experts prior to its publication

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

14. A procedure for updating the guideline is provided

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 4. CLARITY OF PRESENTATION

15. The recommendations are specific and unambiguous

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

16. The different options for management of the condition or health issue are clearly presented

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

17. Key recommendations are easily identifiable.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 5. APPLICABILITY

18. The guideline describes facilitators and barriers to its application

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

19. The guideline provides advice and/or tools on how the recommendations can be put into practice

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

20. The potential resource implications of applying the recommendations have been considered.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						



DOMAIN 5. APPLICABILITY continued

21. The guideline presents monitoring and/or auditing criteria

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

DOMAIN 6. EDITORIAL INDEPENDENCE

22. The views of the funding body have not influenced the content of the guideline.

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

23. Competing interests of guideline development group members have been recorded and addressed

1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Comments						

## OVERALL GUIDELINE ASSESSMENT

For each question, please choose the response which best characterizes the guideline assessed:

1. Rate the overall quality of this guideline.

1						7
Strongly Disagree	2	3	4	5	6	Strongly Agree

2. I would recommend this guideline for use. (RIOTN)

Yes	
Yes, with modification	
NO	

Notes

Needs more detail to incorporate other clinical factors .It would appear that the guidelines are based on logic rather than evidence  
Could be used as an initial screening tool but, at specialist level more in depth analysis is needed.

### Inference for a single Proportion: Comparing to a Known Proportion

(To use this page, your browser must recognize JavaScript.)

Choose which calculation you desire, enter the relevant values (as decimal fractions) for  $p_0$  (known value) and  $p_1$  (proportion in the population to be sampled) and, if calculating power, a sample size. You may also modify  $\alpha$  (type I error rate) and the power, if relevant. After making your entries, hit the **calculate** button at the bottom.

- ☒ Calculate Sample Size (for specified Power)
- ☐ Calculate Power (for specified Sample Size)

Enter a value for  $p_0$ :

Enter a value for  $p_1$ :

- ☐ 1 Sided Test
- ☒ 2 Sided Test

Enter a value for  $\alpha$  (default is .05):

Enter a value for desired power (default is .80):

The sample size is:

Reference: The calculations are the customary ones based on the normal approximation to the binomial distribution. See for example *Hypothesis Testing: One-Sample Inference for a Binomial Proportion* in Bernard Rosner's **Fundamentals of Biostatistics**

## Power Calculation-Screen Shoot (b)

### Inference for a single Proportion: Comparing to a Known Proportion

(To use this page, your browser must recognize JavaScript.)

Choose which calculation you desire, enter the relevant values (as decimal fractions) for  $p_0$  (known value) and  $p_1$  (proportion in the population to be sampled) and, if calculating power, a sample size. You may also modify  $\alpha$  (type I error rate) and the power, if relevant. After making your entries, hit the **calculate** button at the bottom.

- ☐ Calculate Sample Size (for specified Power)
- ☒ Calculate Power (for specified Sample Size)

Enter a value for  $p_0$ :  Enter a value for  $p_1$ :

Enter a value for  $\alpha$  (default is .05):

Enter a value for desired power (default is .80):

The sample size is:

Reference: The calculations are the customary ones based on the normal approximation to the binomial distribution. See for example *Hypothesis Testing: One-Sample Inference for a Binomial Proportion* in Bernard Rosner's **Fundamentals of Biostatistics**

## Appendix IV: Ethical Approval

Hamdan Bin Mohammed  
College of Dental Medicine  
Mohammed Bin Rashid UMMS

كلية حمدان بن محمد  
لطب الأسنان  
جامعة محمد بن راشد للعلوم الصحية

**Athanasios E. Athanasiou, D.D.S., M.S.D., Dr. Dent.**  
Acting Dean  
Professor & Program Director in Orthodontics  
Hamdan Bin Mohammed College of Dental Medicine

Ref: HBMCDM/EC/2023  
Date: September 10, 2015

Dr. Hessa Mohammad Fezai  
Resident, Endodontics Department  
Hamdan Bin Mohammed College of Dental Medicine  
PO Box 505097  
Dubai Healthcare City  
Dubai

**Title of project:** The Relationship between Endodontic Case Complexity and Treatment Outcome  
**Reference:** EC0815-004


Dear Dr. Hessa,


Thank you for submission of your proposal for approval to the Ethics Committee.

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion, effective 9<sup>th</sup> September, 2015, on the basis described in the application form.

The favourable opinion is given provided that all data used for the study and that are archived are anonymous. There should not be any patient identifiers on the study casts.

Yours sincerely,

  
Professor Athanasios E. Athanasiou  
Chairman, Research & Ethics Committee

  
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