Review Article

EVALUATION OF ENDODONTIC ERRORS CAUSES AND MANAGEMENT APPROACH: LITERATURE REVIEW

Rawan Waleed Alhussain[1], Yaqean Khaleal A Alhajimohammed[1], Rola Eid Almohammadi[1], Razan Waleed Alhussain[1], Asma'a Ayed Alruwili[1], Entesar Jaber Almalki[2], Asma Mohammed Shagagi[3], Hanin Mohammed Basheer[3], Salih Mohammed Aljasem[4], Abdullah Khaled Abdullah Albaz5, Hadeel Bahaa Kashkari[3]

[1] *Faculty of Dentistry Medicine, Alfarabi Medical College, Riyadh, KSA.*
[2] *Department of Dentistry, Evian Dental Center, Aseer, KSA.*
[3] *Faculty of Dentistry Medicine, King Abdulaziz University, Jeddah, KSA.*
[4] *Faculty of Dentistry Medicine, Imam Abdulrahman Bin Faisal University, Dammam, KSA.*
[5] *Dentistry Department, Prince Sultan Military Medical City, Riyadh, KSA.*

ABSTRACT

Background: Endodontic treatment (ET) is an operative dental procedure that aims at managing an infected tooth pulp. The tooth pulp contains the neurovascular bundle that is encapsulated within a hollow structure of the tooth termed root canal. One of the essential predictors of effective bacterial eradication and future dental protection is sedulous operative techniques.

Objectives: The occurrence of any of the aforementioned errors can result in devastating consequences, and thus, ET errors are of extreme importance and clinical relevance for practicing clinicians. Therefore, in this paper, we will review the proper literature discussing the causes and the available treatments of ET errors.

Methodology: We conducted the literature search within the PubMed database using the keywords: "Endodontic" and "Errors" and "Treatment" and "Failure" and "Root" and "Canal" and with dates from 1990 to 2020.

Review: A dentist might run into many unforeseen complications that might directly affect the o of the outcome of the disease. Appropriate knowledge and expertise of performing procedures in a standardized fashion is vital to prevent and/or overcome such complications should they arise

Conclusion: In conclusion, the current review has summarized the current state of the literature regarding the causes and treatments of endodontic errors. It has explained the various processes common endodontic errors occur during the multiple phases of endodontic management.

Key words: Endodontic; Errors; Treatment; Failure.

Introduction

Endodontic treatment (ET) is an operative dental procedure that aims at managing an infected tooth pulp. The tooth pulp contains the neurovascular bundle that is encapsulated within a hollow structure of the tooth termed root canal. The main objectives of ET are (1) infection eradication and (2) tooth protection. Despite the importance of all procedural steps in endodontic management, complete elimination of bacterial infection from the root canal system is the key step [1].

One of the essential predictors of effective bacterial eradication and future dental protection is sedulous operative techniques. For example, it is estimated that success rates approaching 100% could be achieved if such meticulous practice is followed [2, 3]. In contrast, a significant increase in failure rates is observed in a situation where poor effort is made to eliminate affected tissues [4].

ET errors can be classified into three main categories: (1) length errors, (2) cleaning errors, and (3) obturation quality errors. For example, length-related ET errors can manifest in over-filling or under-filling of the managed tooth. While cleaning-related ET errors can present in multiple ways, including: (1) ledge formation, (2) apical transportation, (3) perforations, and (4) instrument fracture. Lastly, voids, lack of uniformity, and lack of homogeneity can all result from poor quality of obturation. Having poor health care or any defect on the external surface of the teeth enamel makes the teeth prone to discoloration [5-8]. The criteria considered for assessing the radiographic quality of root filling (Table 1).

Parameter	Criteria	Definition
Length of the root canal filling	Adequate	Root canal filling is 0-2 mm from the radiographic apex
	Under -filled	When it is more than 2 mm from the radiographic apex
	Overfilled	Any extrusion beyond the

		radiographic apex.
Density	Adequate	Homogeneous with the absence of voids
	Inadequate	Not uniform homogeneity with the presence of voids.
Taper	Adequate	Consistent and uniform taper from the coronal to an apical area with a reflection of the original shape of the canal.
	Inadequate	Inconsistent taper
Procedural errors	Ledge	A root filling is at least 1 mm shorter than the working length and deviated from the original canal shape in teeth where root canal curvature occurred.
	Transportation	The filling material is located on the outside curve of the canal at the apical third
	Perforation	The obturation material is detected outside the canal walls

Source: *Evaluation of the Quality of Root Canal Treatments Performed by Dental Undergraduates: Is There a Need to Review Preclinical Endodontic Courses?.*

Table 1. Criteria used to assess the radiographic quality of root filling.

The occurrence of any of the aforementioned errors can result in devastating consequences, and thus, ET errors are of extreme importance and clinical relevance for practicing clinicians. Therefore, in this paper, we will review the proper literature discussing the causes and the available treatments of ET errors.

Methodology:

We conducted the literature search within the PubMed database using the keywords: “Endodontic” and “Errors” and “Treatment” and “Failure” and “Root” and “Canal” and with dates from 1990 to 2020. We also used the Google Scholar database for additional literature search. After reading the abstracts, we manually selected the relevant papers for this review. In regards to the inclusion criteria, the articles were selected based on the inclusion of one of the following topics; endodontic treatment failure and management of endodontic treatment failure. Exclusion criteria were all other articles that did not have one of these topics as their primary endpoint.

Review:

A dentist might run into many unforeseen complications that might directly affect the o of the outcome of the disease. Appropriate knowledge and expertise of performing procedures in a standardized fashion is vital to prevent and/or overcome such complications should they arise [9].

- **Length Errors:**

Among all types of ET errors encountered during root canal treatment, some errors pose the most significant adverse effects on the outcome. For example, over- and under-fill have been shown to significantly decrease success rates [2, 10]. Table 2 shows the characteristics of clinical and imaging outcomes in RCT.

Outcomes	Clinical features	Imaging aspects
Success	Absence of pain	Absence of periapical radiolucency
	Tooth with definitive restoration	
	Tooth in masticatory function	
Failure	Presence of pain	Presence or regression of periapical radiolucency
	Tooth with definitive restoration	
	Tooth with a temporary restoration	
	Presence of swelling, sinus tract	
Doubt	Absence/presence of pain	Presence of periapical radiolucency/ Absence of periapical radiolucency
	Presence of sporadic pain	
	Presence of discomfort	
	Presence of swelling	
	Presence of sinus tract	

RCT: Root Canal Treatment. Source: *Common Operative Procedural Errors and Clinical Factors Associated with Root Canal Treatment.*

Table 2. Characteristics of clinical and imaging outcomes in RCT.

It has been shown that during the management of root canal disease, filling material should no extend into periapical tissues. Despite careful attention in avoiding any extension, erroneous over-extension of such materials may take place. Tissue demise or post-operative pain are among the most commonly reported complications associated with overfilling errors [11, 12].

Management of length related errors can be accomplished with surgical removal of dental material from the affected canal. This has been shown to significantly improves symptoms of paraesthesia and anesthesia resulting from over-filling [12, 13].

- **Cleaning and Preparation Errors:**

A deviation from the original canal curvature without coming in contact with the periodontal ligament is known Ledge formation is defined. This error can be caused by using small files that do not reach the full length of the canal [14].

Ideally, ledges should not occur in the first place, and thus, the best approach to manage them is by preventing their occurrence. The dentist's experience plays an important role and thus learning from the previous misencounter is essential as it has been shown that treatment evaluation and critical analysis of one's work can help prevent future occurrences [15]. Additionally, the usage of appropriate pre-operative and imaging during the procedure to determine the length of the root canal will significantly improve outcomes and prevent ledge formation [16].

Root perforation (RP) is a serious ET error that can occur during root canal treatment [10]. If encountered, RP can seriously affect the treatment outcome and can persist as a significant postoperative complication if not managed. They mainly occur during the preparation phase of root canal treatment [17].

Concerning the management of RP, numerous materials can be used, such as (1) Indium foil, (2) Amalgam, (3) Plaster of Paris, (4) Zinc Oxide Eugenol, and (5) Gutta Percha. Table 3 shows the ideal requirements of root repair material. Table 4 shows various materials used for perforation repair.

Requirements of root repair material
It should provide an adequate seal.
It should be biocompatible.
It should have the ability to produce osteogenesis and cemento-genesis.
It should be bacteriostatic, and radiopaque.
It should also be beneficial to use a resorbable matrix in which a sealing material can be condensed.
It should be relatively inexpensive.
It should be non-toxic, non-cariogenic, and easy to place.

Source: *Hartwell GR, England MC. Healing of furcation perforation in primate teeth after repair with decalcified freeze-dried bone: a longitudinal study. J Endod. 1993;19:357–61.*

Table 3. Ideal requirements of root repair material.

Material	
Indium foil	Cavit
Amalgam	Glass Ionomer Cement
Plaster of Paris	Metal-Modified Glass Ionomer Cement
Zinc Oxide Eugenol	Composite
Super EBA	Dentin chips
IRM (Intermediate Restorative Material)	Decalcified Freezed Dried Bone
Gutta Percha	Calcium Phosphate Cement

Table 4. Various materials are used for perforation repair.

- **Cavity Access Errors:**

Furcal perforation is one of many feared complications that might occur during ET [18]. Burs and inadequate direction while performing pulp chamber ceiling removal can result in this type of accident [17, 19]. The prognosis of such errors is unfavorable [20]. The management of furcal perforation is similar to that of apical perforation; however, favorable outcomes were obtained using calcium hydroxide [17, 21].

Conclusion:

In conclusion, the current review has summarized the current state of the literature regarding the causes and treatments of endodontic errors. It has explained the various processes common endodontic errors occur during the multiple phases of endodontic management. It is evident by those errors the vital role of clinicians to maintain the accuracy of the working throughout the procedure, especially the length as it is by far the most common error. Additional care must be directed towards community awareness programs that explain the importance of preventing caries, as caries can progress to endodontic treatment.

References

1. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. International endodontic journal. 1997;30(5):297-306.
2. Imura N, Pinheiro ET, Gomes BP, Zaia AA, Ferraz CC, Souza-Filho FJ. The outcome of endodontic treatment: a retrospective study of 2000 cases performed by a specialist. Journal of endodontics. 2007;33(11):1278-82.
3. Lazarski MP, Walker WA, 3rd, Flores CM, Schindler WG, Hargreaves KM. Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. Journal of endodontics. 2001;27(12):791-6.
4. Chugal NM, Clive JM, Spångberg LS. Endodontic infection: some biological and treatment factors

associated with outcome. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics. 2003;96(1):81-90.
5. Asgari I, Soltani S, Sadeghi SM. Effects of Iron Products on Decay, Tooth Microhardness, and Dental Discoloration: A Systematic Review. Arch. Pharm. Pract. 2020;11(1):60-82.
6. Jahanimoghadam F, Gisour EF, Askari R, Rad M. Attitude Regarding Dental Stem Cells among Dental Practitioners in Kerman, Iran. Arch. Pharm. Pract. 2018;9(3):10-3.
7. Kharalampos M, Put V A, Tarasenko S V, Reshetov I V. Comprehensive patient rehabilitation while performing immediate dental implant placement with the use of information-wave therapy (literature overview). J. Adv. Pharm. Educ. Res. 2020;10(2):1-6.
8. Bulgakova AI, Vasilyeva NA, Vasilyev EA. The clinical and immunological rationale for the use of prolonged action dental ointment in periodontology. J. Adv. Pharm. Educ. Res. 2019;9(4):65-69.
9. Walton RE, Vertucci FJ. Internal anatomy. Torabinejad M, Walton RE. Endodontics principles and practice. Saunders. Elsevier: Philadelphia; 2009.
10. Nicholls E. Treatment of traumatic perforations of the pulp cavity. Oral surgery, oral medicine, and oral pathology. 1962;15:603-12.
11. Gatot A, Peist M, Mozes M. Endodontic overextension produced by injected thermoplasticized gutta-percha. Journal of endodontics. 1989;15(6):273-4.
12. Neaverth EJ. Disabling complications following inadvertent overextension of a root canal filling material. Journal of endodontics. 1989;15(3):135-9.
13. Köseogˇlu BG, Tanrıkulu Ş, Sübay RK, Sencer S. Anesthesia following overfilling of a root canal sealer into the mandibular canal: a case report. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2006;101(6):803-6.
14. Nagy CD, Bartha K, Bernáth M, Verdes E, Szabó J. The effect of root canal morphology on canal shape following instrumentation using different techniques. International endodontic journal. 1997;30(2):133-40.
15. Gowgiel JM. The position and course of the mandibular canal. The Journal of oral implantology. 1992;18(4):383-5.
16. Franklin S. Weine, Robert F.Kelly, Peter J. Lio. The effect of preparation procedures on original canal shape and on apical foramen shape. Journal of Endodontics. 1975; 1 (8):255-262
17. Bryan EB, Woollard G, Mitchell WC. Nonsurgical repair of furcal perforations: a literature review. General dentistry. 1999;47(3):274-8; quiz 9-80.
18. Keine KC, Kuga MC, Pereira KF, Diniz AC, Tonetto MR, Galoza MO, Magro MG, de Barros YB, Bandéca MC, de Andrade MF. Differential Diagnosis and Treatment Proposal for Acute Endodontic Infection. The journal of contemporary dental practice. 2015;16(12):977-83.
19. Silveira CM, Sánchez-Ayala A, Lagravère MO, Pilatti GL, Gomes OM. Repair of furcal perforation with mineral trioxide aggregate: long-term follow-up of 2 cases. Journal (Canadian Dental Association). 2008;74(8):729-33.
20. Ramazani N, Sadeghi P. Bacterial Leakage of Mineral Trioxide Aggregate, Calcium-Enriched Mixture, and Biodentine as Furcation Perforation Repair Materials in Primary Molars. Iranian endodontic journal. 2016;11(3):214-8.
21. Holland R, Bisco Ferreira L, de Souza V, Otoboni Filho JA, Murata SS, Dezan E, Jr. Reaction of the lateral periodontium of dogs' teeth to contaminated and non-contaminated perforations filled with mineral trioxide aggregate. Journal of endodontics. 2007;33(10):1192-7.

Corresponding Author

Entesar Jaber Almalki

Department of Dentistry, Evian Dental Center, Aseer, KSA.

Email: entealmalki @ hotmail.com