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REVIEWS

# THE MOST COMMON CAUSES OF ENDODONTIC FAILURE

**Tsvetelina Borisova-Papancheva, Ana-Mariya Miteva**

*Department of Conservative Dentistry and Oral Pathology, Faculty of Dental Medicine, Medical University of Varna, Bulgaria*

## ABSTRACT

**Endodontic treatment continues to focus on chemomechanical preparation and the removal of diseased tissues in order to eradicate bacteria and avoid subsequent pathologies.**

**In addition to creating space for obturation, mechanical preparation of the canals also makes it easier to sanitize the root canal system using irrigation solutions.**

**The presence of iatrogenic errors occurring during treatment, such as missed diagnosis, poor access cavity shape, coronal leakage, improper mechanical debridement or irrigation, untreated canals, perforations, separated instruments, poor canal obturation, and persistence of bacteria, are all linked to less effective endodontic outcome and clinical failure.**

**Even though endodontic treatment has a high success rate, failures do happen frequently and are typically caused by the aforementioned factors.**

**Keywords:** *post-treatment healing, failure, perforation, separated instruments, obturation, bacteria*

## INTRODUCTION

Nowadays, nonsurgical endodontic therapy has become a standard procedure. Due to technological and scientific advancements, millions of teeth have been saved. With documented success rates of up to 86–98%, endodontic therapy is generally predictable (1). However, not all treatments provide optimal outcome. Failure is defined by many authors as a lack of post-treatment healing process and reappearance of clinical symptoms (2). Many are the causes leading to poor post-endodontic outcome. The aim of this article is to identify the most common mistakes resulting in endodontic failure. Among them are:

- persistent infection;
- missed or inaccurate diagnosis;
- untreated or missed canals;
- iatrogenic procedural mistakes (improper cavity access, separated instruments, perforations);
- coronal leakage;
- poor quality of the endodontic obturation.

### *Persistent Infection*

Infection brought on by the presence of bacteria and their byproducts, either inside or outside the root canals, is the main cause of endodontic failure (3,4,5). Apical periodontitis develops when microorganisms or their byproducts infect the endodontium and manage to contact the periradicular tissues. If the primary therapy does not eliminate the pathogenic microorganisms, if temporary or definitive obturation does not seal the endodontium or the procedure is done without proper isolation such as rubber dam, the risk of bacteria reentering the canal space is real and most commonly post-treatment disease does occur. While the primary bacterial flora is polymicrobial, mostly anaerobic species, the sec-

**Address for correspondence:**
*Ana-Mariya Miteva*
*Faculty of Dental Medicine*
*Medical University of Varna*
*84 Tzar Osvoboditel Blvd*
*9002 Varna, Bulgaria*
*e-mail: anamariya@abv.bg*

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ondary flora is primarily gram positive and not anaerobic, with *Enterococcus faecalis* (6,7) being a commonly isolated species that has been demonstrated to be resistant to canal irrigation solutions (8,9). Bacterial cells can also penetrate the periradicular space through direct dissemination of root canal infectants by preparation with infected endodontic instruments, extrusion of infected elements through the apex, or through deep periodontal pockets. Several researches demonstrate the ability of *Actinomyces israelii* and *Propionibacterium propionicum* to survive and inhibit the healing process periapically after endodontic therapy (10,11,12).

### *Missed or Inaccurate Diagnosis*

The correct diagnosis is most likely the most crucial aspect of any endodontic procedure. It goes without saying that if a problem's definition is incomplete or inaccurate, no suitable solution can be developed or applied (13). Indeed, missed or inaccurate diagnoses are rather common in the medical field. Patients, clinicians, and researchers would all benefit greatly from reducing these diagnostic errors. Having a complete list of diagnoses, and remembering the required questions and tests during examination, makes the process of establishing a diagnosis simpler. The clinician then looks for a specific sign or symptoms that would validate a certain diagnosis or reduce the alternatives to two or three options (14,15,16). Pulp testing, single deep periodontal probing, different angled x-rays, cone-beam computed tomography (CBCT), percussion, palpation, all have a specific applicability to one or more of the possible diagnosis (17,18). Problem solving requires analyzing the timing and duration of the symptoms, the endodontic anatomy and expected variations, the requirements of the treatment, and the expected prognosis of the tooth.

Not following the proper examination protocol can lead to inadequate treatment plan, unnecessary procedures, iatrogenic procedural mistakes, such as perforations, separated instrument, poor cavity access, steps, or more; all associated with lack of a post-treatment healing process and endodontic failure (19).

### *Untreated or Missed Canals*

Missed root canals are the main reason for post-treatment apical periodontitis and prolonged intraradicular infection. Missing a canal during endodontic treatment is a typical occurrence, most commonly noticed in molar teeth. This is due to the fact that the "one root, one canal" rule is overruled by the bigger quantity of canals than roots. A poor access visibility also makes it challenging for the clinician to identify all the root canals. One of the factors contributing to endodontic failure is the inability to treat all the canals (20). One study on 5616 retracted molars demonstrated the correlation between missed MB2 canals and lowering the rates of a good post-treatment outcome (21). In another study, conducted by Hoen and Pink (22), the error of missed canals was observed in 42% of all 1100 therapeutically failed teeth.

It has been shown that missed canals account for about 40% of retreatment with chronic apical periodontitis or symptomatic apical periodontitis. In 2016, Karabucak et al. determined that the overall incidence of missed canals in treated teeth was 23.04%, with maxillary first molars having a rate of 41 to 46%. Teeth with missed canals were 4.38 times more likely to have a periapical lesion (23). Because of the high frequency of the missed MB2 canal and the difficulty in locating it in most cases, the focus remains on maxillary molars (21).Witherspoon et al. (2013) discovered that in mandibular first molars 86% of the missed canals were detected in the distal root and 14%—in the mesial root (23).

The root canal anatomy of mandibular incisors and canines varies. For the purpose of reducing the cases with missed canals is essential to be aware of these changes. The majority of mandibular incisor endodontic treatment failures are brought on by missing canals, particularly the lingual (24,25,26).

Most of the time, untreated spaces and pulp tissue remnants result in root canal failure. The prognosis will be good, resulting in healing and a successful conclusion, once the entire root canal tissue has been removed and cleaning has been completed.

### *Iatrogenic Procedural Mistakes*

*The access cavity preparation* is the initial critical stage during root canal therapy. Inadequate access cavity design and lack of direct access to the canals are typically the reasons for difficulties experienced during the instrumentation of a root canal (27,28). Poor access cavity preparation can lead to numerous complications through the subsequent

treatment, such as deficient removal of carious tissue or remaining underlying and softened hard teeth structures. Due to the absence of direct access to the root canal system, a ledge formation or a radicular perforation may occur, especially in a root canal with complicated anatomy (29). In order to provide a complete view of the endodontic inside without jeopardizing the integrity of the tooth, it is crucial to plan the outline form and size of the access cavity with a thorough understanding of the possible endodontic anatomy variations (30).

*Instrument separation* is commonly found in endodontic therapy. The possibility of separation or breaking within the canals is prevalent when using rotary files (31,32). In most clinical cases, the tool breaks at the apical third of canal length, making removal of the broken piece difficult or impossible (33,34). Even more procedural mistakes, including perforation, may occur during removal attempts. The fragment that is left behind prevents effective cleaning, shape, and sealing of the endodontium. Although removing the broken fragment is possible, many separated instruments cannot be evacuated using conservative methods. The majority of research studies on the impact of broken instruments have shown that they have very little effect on treatment success (35,36,37). The prognosis may vary, depending on the stage at which the instrument fails. It becomes challenging to clean, shape, and seal the portion of the canal beyond the broken tool, which could result in a persistent infection there (37). Yet the separated instrument has no significant effect on failure because most of the time, success is only jeopardized when an infection is present. There are two main reasons resulting in instrument breakage. One is the excessive apical pressure used in preparing the proper canal shape, the other is the plastic deformation that occurs in files due to overuse. Knowing and avoiding these factors will benefit the positive treatment outcome.

*Perforation* of the pulp chamber walls or floor, or root walls during root canal instrumentation exposes tooth structures to bacterial infection and frequently results in tooth loss (38). There are many articles describing the different types of perforations, their causes and risk factors as well as advices on prevention and post-perforation steps of treatment. However, there are very few studies on the frequency of these unforeseen events. A study shows that the presence of perforations as a main risk factor accounts for 10% of all unsuccessful treatment plans (39). The estimations may differ due to the type of tooth and perforation. There are fewer cases of excessive failure, resulting in official complaints and possibly lawsuits. A study conducted in Italy found that 15 teeth (13%) out of 117 failed cases had perforation, which resulted in the extraction of 13 (87%) of them (40). Root perforations were calculated as 10% of technical problems in Denmark according to a study of 482 endodontic claims from 1995 to 2002 (41). If a perforation occurs, it should be repaired as soon as possible because the prognosis worsens as the time between the perforation and the repair increases. It is responsibility of the clinician to evaluate the current status of the tooth, the further prognosis, and the need of endodontic treatment (42).

### *Coronal Leakage*

Following three-dimensional canal obturation, a properly sealed coronal restoration is necessary to prevent the invasion of any pathogens from the surrounding environment (43). Ray and Trope's work pointed out the significance of high-quality coronal restoration (44). Another retrospective research on 1001 endodontically treated teeth later produced similar results (45). The findings of the study revealed that the success rates in teeth with hermetic canal obturation and proper coronal restoration are higher than in those with poor quality of the root canal and coronal obturation.

### *Poor Quality of the Canal Obturation*

Endodontic therapy success is determined by the proper obturation of the root canal with gutta-percha and sealers designed to encapsulate the whole root canal. The hermetic seal avoids microleakage and reinfection. Sealers and gutta-percha have become the conventional method for obturation of root canals over time. In a study of 1001 endodontically treated teeth, the quality of root canal obturation was found to be the single-most important determinant in endodontic treatment outcome (46). Periapical radiographs of 200 patients were analyzed in a study by Saira Dar and M Bader Munir to determine the risk factor for failure of the initial root canal therapy. A total of 45.5% of the canals were un-

derobturated, 26% had inadequate obturation, 14.5% had missed canals, 5% had overobturation, and 9% had iatrogenic mistakes leading to poor end result. In conclusion, underobturation of root canals was found to be the most common cause of primary endodontic treatment failure, followed by poor obturation, missing canals, overobturation, and iatrogenic mistakes (47,48,49).

## DISCUSSION

Nowadays, the positive outcome of endodontic treatment has been increasing significantly due to the research breakthroughs in the 21st century. Post-treatment success is described by the lack of pain, exudation or any symptoms at all, and presence of coronal and apical sealing and post-endodontic cavity restoration (50,51). The absence of these clinical criteria is categorized as a failure (50,3). The best success rates are reported in upper central incisors with minimal iatrogenic mistakes due to their large, straight, rounded root canal shape (53). Tooth anatomy variations have influence over the good post-endodontic outcome. Iatrogenic mistakes such as underfilling, overfilling, or instrument separation reduce the success rates by 68%, 76%, and 14%, respectively (9,13,15,54,55). To eliminate these mistakes as failure factors and accomplish the necessary sterile environment, a precise endodontic treatment technique is required. Following the critical criteria determined as success factors, has led to good post-treatment outcome in 94% of the cases (56,57).

## CONCLUSION

The most common endodontic treatment mistakes correlate with decreased treatment success and potential failure of treating apical periodontitis. The successful end result of endodontic therapy may increase with correct preparation, cleaning of root canal systems, and responsible evaluation of these iatrogenic procedural mistakes by clinicians.

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