

**ORIGINAL RESEARCH**

# Examining the Factors Contributing to Endodontic Failures in Various Study Cohorts

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**ABSTRACT**

**Background:**Endodontic therapy, commonly known as root canal therapy, is a systematic treatment approach aimed at addressing the infected pulp of a tooth. The goal is to eliminate the infection and safeguard the decontaminated tooth against potential microbial invasions in the future. This study was conducted to evaluate the factors contributing to failures in endodontic procedures within the study groups.**Methods:**This study involved the examination of 224 patients, encompassing a total of 320 teeth that had undergone root canal treatment. The evaluation focused on determining the presence or absence of periapical radiolucency, the quality of obturation, the identification of missed canals, and the assessment of issues such as dislodged or fractured restorations. Additionally, potential iatrogenic problems, including perforations, file separations, and ledges, were scrutinized using intraoral periapical radiographs.**Results:**Among the 224 patients, there were 120 males and 104 females, with males having 170 teeth and females having 150 teeth. The primary cause of endodontic failure varied between genders. In males, the most common reason was a missed canal, accounting for 30%, followed by inadequate obturation at 25% and fractured coronal obturation at 45%. Conversely, females exhibited a higher prevalence of a missed canal at 40%, with inadequate obturation at 10% and fractured coronal obturation at 50%. **Conclusion:**The author identified missed canals, inadequate obturation, and fractured coronal obturation as prevalent causes of root canal failures.

**Keywords:** coronal, obturation, Endodontic, restorations.

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**INTRODUCTION**

Endodontic therapy, commonly referred to as root canal therapy, constitutes a comprehensive treatment protocol designed to effectively manage and alleviate infections within the dental pulp of a tooth. This intricate procedure not only aims to eliminate existing infections but also endeavors to safeguard the treated tooth against potential microbial invasions in the future.<sup>1</sup> The versatility of endodontic therapy is notably demonstrated in its application to various dental conditions such as apical periodontitis, periapical abscess, granuloma, and cysts. The success and efficacy of endodontic treatment are contingent upon the scrupulous execution of each procedural step. The initial phase involves a precise access opening, enabling the dentist to reach and address the infected pulp. Subsequently, meticulous biomechanical preparation is undertaken to clean and shape the root canals thoroughly.<sup>2</sup> This step is crucial

in ensuring the removal of all infectious material, preventing any residual microbes from causing further complications. Once the cleaning and shaping are accomplished, the next crucial step is obturation, where the root canals are sealed to prevent the re-entry of bacteria or contaminants. The choice of appropriate filling materials and techniques is pivotal in achieving a hermetic seal and maintaining the long-term success of the procedure. Finally, the restoration phase focuses on rebuilding the tooth's structural integrity. This involves the application of a crown or other suitable restoration methods to fortify the tooth, ensuring its functionality and aesthetic appeal are restored. In essence, the comprehensive and meticulous nature of endodontic therapy underscores its significance in not only treating existing infections but also in preserving the overall health and functionality of the tooth over the long term.<sup>3</sup>

The crux of successful endodontic treatment lies in the meticulous removal of necrotic or infected pulp tissues, microorganisms, and the thorough sealing of the root canal space. This comprehensive approach is pivotal in preventing the persistence of infection and averting the risk of reinfection within the root canal system. Determining the success or failure of endodontic treatment involves assessing clinical signs, symptoms, and radiographic findings of the treated tooth. A myriad of factors contribute to endodontic treatment failure, as evident in the literature. These encompass residual necrotic pulp tissue, the presence of peri-radicular infection, underlying periodontal disease, root fractures, broken instruments, mechanical perforations, overfilling or underfilling of the root canal, and the oversight of missed or unfilled canals. An important factor contributing to treatment failure is the inability to locate and treat all canals within the root canal system. This deficiency on the part of the operator has been identified as a significant cause of root canal treatment failures. Studies indicate that in a majority of cases, general dental practitioners are accountable for instances of endodontic failures, emphasizing the importance of precision and thoroughness in canal localization and treatment to ensure the long-term success of the procedure.<sup>4</sup>

The classification of success or failure in endodontic procedures demands a precise and universally agreed-upon definition to ensure meaningful interpretation. However, consensus among endodontists regarding the criteria for failure following endodontic treatment remains elusive. The dental community, at times, tends to simplify success by narrowing it down to the absence of pain, offering a convenient yet limited measure. While the absence of pain is a tangible and easily observable outcome, it falls short of providing a comprehensive measure of good health or success in endodontic treatment. Health assessment in this context requires a more multifaceted approach, considering factors beyond mere pain relief.<sup>5,6</sup> A broader and more inclusive definition of success should encompass not only the alleviation of pain but also factors such as the absence of clinical symptoms, radiographic evidence of healing, and the preservation of the tooth's structural integrity. Establishing a standardized and comprehensive definition of success in endodontics is crucial for enhancing communication within the field and fostering a deeper understanding of treatment outcomes. This would ultimately contribute to the continual improvement of endodontic practices and the overall well-being of patients undergoing these procedures.

The evolving landscape of dental care, characterized by increased patient education and technological advancements, has significantly influenced the prevailing perspective that maintaining natural dentition is not only desirable but feasible throughout a person's lifetime.<sup>7</sup> This paradigm shift has spurred a notable upswing in the demand for conventional non-surgical root canal therapy, as individuals become

more proactive in seeking solutions to preserve their natural teeth. Patient education initiatives have played a pivotal role in empowering individuals with knowledge about oral health, fostering a sense of responsibility for the longevity of their dentition. Technological advancements have complemented this educational push, offering innovative tools and techniques that enhance the effectiveness and accessibility of various dental treatments. However, amid this positive trend, it is essential to acknowledge that endodontic treatments, including root canal therapy, are not immune to challenges and failure rates. Despite the best efforts of dental professionals and the utilization of advanced technologies, certain cases may exhibit complications or incomplete success. Factors contributing to such outcomes include the complexity of dental anatomy, variations in patient physiology, and the potential for unforeseen issues during the treatment process. As individuals increasingly recognize the importance of preserving their natural teeth, the demand for endodontic interventions is likely to continue its upward trajectory.<sup>8,9</sup> Consequently, the dental community must remain committed to ongoing research and advancements in endodontic techniques. This commitment ensures that practitioners are equipped with the knowledge and tools to navigate the intricacies of root canal therapy, ultimately improving success rates and contributing to the broader goal of achieving optimal oral health throughout individuals' lifetimes.

## MATERIALS AND METHODS

The current study, conducted within the Department of Endodontics, represents a comprehensive exploration involving a diverse group of 224 patients, with a collective of 320 root canal-treated teeth. This inclusive approach encompassed individuals of both genders, aiming to capture a representative sample of the population. Prior to their involvement, a paramount focus on ethical considerations was observed, with all participants receiving detailed information about the study's objectives, and explicit written consent was obtained from each individual. Furthermore, ethical clearance was diligently sought and secured before the initiation of the study, demonstrating a commitment to upholding ethical standards in research.

To establish a comprehensive understanding of the study population, meticulous recording of general information was carried out, including the name, age, and gender of each participant. This demographic data serves as a foundational backdrop, facilitating a nuanced analysis of the study's outcomes. The assessment of the root canal-treated teeth involved a thorough examination of various parameters. The presence or absence of periapical radiolucency, a crucial indicator of treatment success or complications, was scrutinized. Additionally, the quality of obturation, a key aspect of root canal

treatment, was evaluated to gauge the effectiveness of the procedure. The identification of missed canals, dislodged or fractured restorations, and iatrogenic problems such as perforations, file separations, and ledges were meticulously assessed. Intraoral periapical radiographs were instrumental in ensuring a precise and detailed examination of these factors. The collected data underwent rigorous statistical analysis, a crucial step in extracting meaningful insights from the study. The chosen criterion for statistical significance, a P value less than 0.05, adds a layer of

reliability to the interpretation of results, underscoring the commitment to a robust analytical process. In essence, this detailed and systematic approach not only ensures the scientific rigor of the study but also positions it as a valuable contribution to the field of endodontics. By shedding light on the intricacies of root canal treatments and their outcomes, the study provides a nuanced understanding that can inform and enhance dental practices, ultimately contributing to improved patient care and treatment efficacy.

**RESULTS**

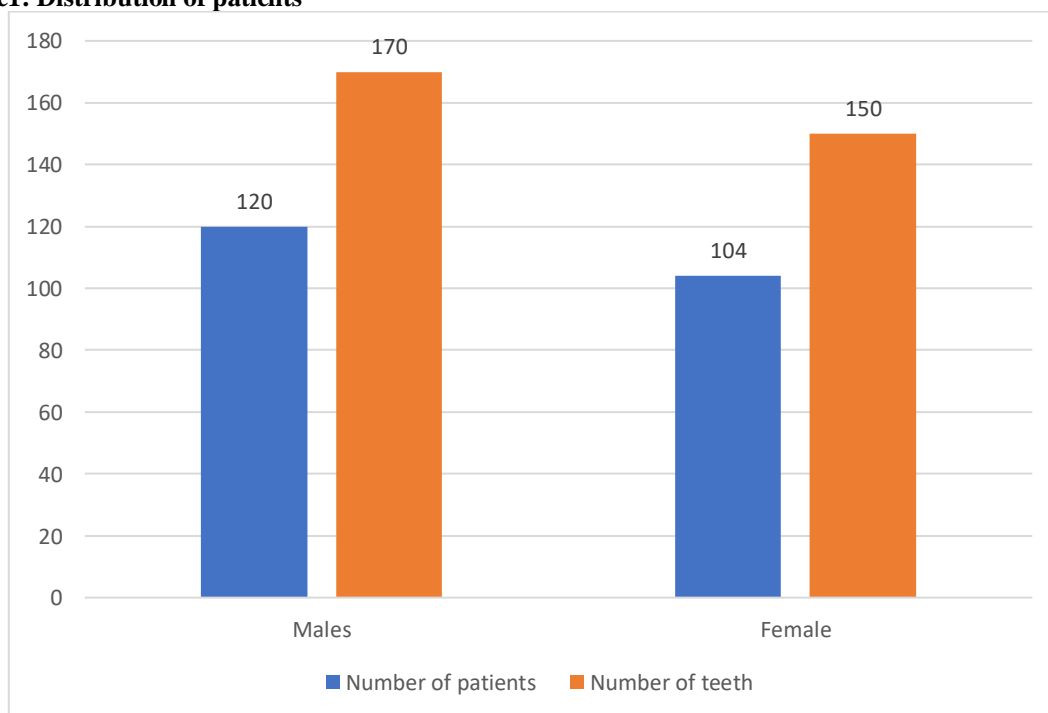
**Table I: Distribution of patients**

Gender	Males	Female
Number of patients	120	104
Number of teeth	170	150

Table I presents a comprehensive overview of the demographic distribution within the study cohort. Among the 224 patients included in the study, 120 were identified as male, while 104 were female. This gender distribution provides insight into the representation of both males and females in the sample population. Furthermore, the table highlights the distribution of teeth among the male and female participants. In the male group, a total of 170 teeth were accounted for, emphasizing the prevalence of dental issues requiring root canal treatment in this

subset. Conversely, the female group exhibited a total of 150 teeth that underwent root canal treatment. These gender-specific breakdowns not only offer a snapshot of the demographic composition of the study but also provide a foundation for further analysis. By delineating the distribution of patients and treated teeth based on gender, the study can explore potential patterns, variations, or correlations in the outcomes of root canal treatments, adding depth to the understanding of how these treatments manifest in different demographic groups.

**Figure1: Distribution of patients**



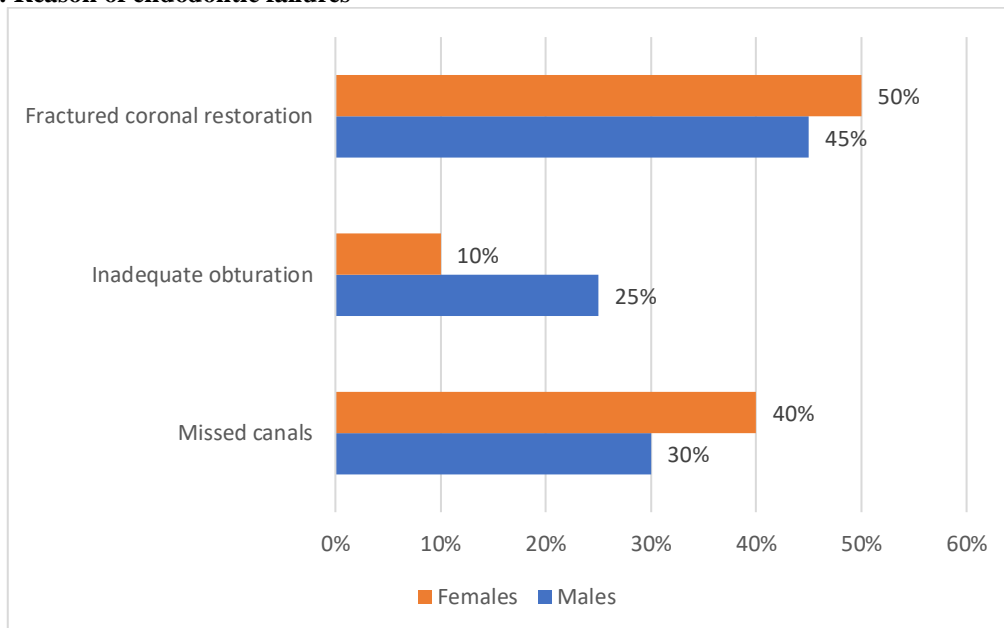
**Figure2: Reason of endodontic failures**

Figure II presents a detailed breakdown of the common reasons for endodontic failure, highlighting notable differences between males and females in the study cohort. The data underscores the significance of these variations, with a statistical difference observed ( $P < 0.05$ ). The predominant cause of endodontic failure among both genders was identified as a missed canal. Notably, this issue was reported in 30% of males and 40% of females, indicating a higher prevalence in the female subset. This finding suggests a gender-specific difference in the identification or treatment of root canal anatomy, emphasizing the importance of thorough examination and precision in canal localization for both male and female patients. In terms of inadequate obturation, 25% of males experienced this issue compared to 10% of females. This discrepancy suggests a potential variation in the quality of root canal filling between the two genders, with a higher incidence of inadequate obturation in the male group. This highlights the importance of meticulous attention to obturation techniques, particularly in male patients, to enhance treatment success. Fractured coronal obturation emerged as a significant factor contributing to endodontic failure. The data indicates that 45% of males and 50% of females experienced this complication, showcasing a relatively balanced gender distribution in this particular aspect of treatment failure. The statistical significance ( $P < 0.05$ ) of these differences emphasizes the importance of considering gender-specific factors in assessing and addressing the reasons for endodontic failure. This nuanced analysis contributes valuable insights to the field, facilitating a more tailored approach to endodontic treatment based on gender-specific considerations.

## DISCUSSION

The reality of countless individuals living pain-free with some underlying dental conditions post-endodontic treatment is a testament to the apparent success of such interventions in specific cases, despite the complexities involved.<sup>10</sup> This success can, in part, be attributed to the remarkable capacity of the body's natural defense mechanisms to manage infections and enhance overall survival. While it may seem that endodontic treatment succeeds effortlessly in certain instances, it is imperative for practicing endodontists to acknowledge that the absence of pain is not the sole criterion for gauging success. Despite their best efforts, establishing universally accepted criteria for success or failure remains a challenging task. Endodontic failures persist for various reasons, and practitioners should be cognizant of the fact that the lack of clinical signs or symptoms alone is not a sufficient indicator of a successful outcome. Radiographic evidence of periapical bone destruction becomes a crucial parameter in assessing the need for re-intervention. The first and foremost step in addressing endodontic failure involves a meticulous determination of its underlying cause. Etiologic factors contributing to endodontic failure can typically be categorized into four groups: (1) Persistent or Reintroduced Intra-radicular Microorganisms: Despite initial treatment efforts, the presence of microorganisms within the root canal system can persist or be reintroduced, contributing to treatment failure. (2) Extra-radicular Infection: In some cases, infections may extend beyond the confines of the root canal, leading to extra-radicular complications that can compromise treatment success. (3) Foreign Body Reaction: The body's response to foreign materials within the root canal can result in complications, contributing to the failure of endodontic treatment. (4) True Cysts: The formation of true cysts

in response to unresolved issues within the root canal can represent a distinct etiological factor contributing to treatment failure. The present study aims to contribute to the understanding of the causes of endodontic failures within specific study groups. By delving into the intricacies of these factors, the research seeks to provide valuable insights that can inform future practices and enhance the success rates of endodontic interventions.

In this comprehensive study, a diverse cohort of 224 patients participated, with the demographic breakdown revealing 120 males and 104 females. The extensive sample allowed for a thorough examination of various aspects related to root canal treatments. Within this population, males presented a total of 170 teeth undergoing root canal procedures, while females accounted for 150 treated teeth, offering a detailed insight into the distribution of cases across genders. The focus of the study extended beyond demographic data to encompass the challenges encountered during root canal treatments, particularly concerning instrument breakage, such as dental files. These instruments, essential for the cleaning and shaping of root canals, may occasionally break, leading to the inadvertent retention of a file segment. This scenario is often managed pragmatically, with the decision to leave the fragment in place if its removal poses a potential risk to the integrity of the tooth.<sup>11</sup> The notion of having foreign materials, such as metal fragments, within a tooth was explored in the context of patient perception. Although patients might find the idea disconcerting, it was emphasized that the presence of metal components within teeth is a common occurrence in various dental procedures. Examples include metal posts, amalgam fillings, gold crowns, and porcelain-fused-to-metal crowns. This insight into patient concerns and expectations contributes to a more holistic understanding of the impact of endodontic procedures on patient experiences. Furthermore, the study delved into the factors influencing instrument breakage, elucidating that the occurrence of file separation is proportional to the narrowness, curvature, length, calcification, and the number of roots in the tooth being treated. This nuanced understanding enables endodontists to anticipate challenges and adopt tailored approaches to manage cases more effectively. In essence, the study not only provided a comprehensive demographic overview but also delved into the intricacies of root canal treatments, addressing challenges and patient perceptions. This multifaceted exploration contributes valuable insights to the field of endodontics, aiding practitioners in navigating the complexities of their clinical practice and enhancing patient care.

The insightful study conducted by Chugal and colleagues sheds light on a critical aspect of endodontic treatment outcomes. Their findings underscore the pivotal relationship between the loss of 1 mm in working length and a substantial 14% increase in the likelihood of treatment failure,

particularly in cases where pre-existing apical periodontitis is present. This correlation underscores the importance of meticulous attention to working length during root canal procedures, emphasizing its direct impact on treatment success.<sup>12</sup> The primary driver of peri-radicular tissue irritation, as identified in this study, lies in the persistence of necrotic and infected pulp tissues within inadequately instrumented and incompletely filled canals. This elucidates the profound significance of thorough cleaning and shaping of the root canal system and emphasizes the critical role of comprehensive obturation to seal the canal effectively. In essence, the study highlights the imperative of achieving an optimal treatment environment to mitigate the risk of persistent infection and enhance treatment outcomes. Unfilled canals emerged as the second most common factor contributing to endodontic treatment failure. The study underscores that these canals may be overlooked during root canal filling, elude detection during exploration, or pose challenges to operators in terms of location and negotiation during the root canal exploration and chemomechanical preparation phases. This emphasizes the intricate nature of the root canal system and the potential risks associated with incomplete treatment, necessitating a heightened awareness and meticulous approach to canal exploration and management. These findings resonate with similar studies, collectively emphasizing the complexity of root canal anatomy and the potential for missed intricacies during treatment.<sup>13</sup> The inherent challenges posed by the complicated root canal system necessitate a thorough and precise approach by practitioners. This includes not only an acute awareness of potential anatomical variations but also a commitment to employing advanced techniques and technologies to enhance the precision of root canal procedures. In doing so, practitioners can strive to minimize the risk of treatment failure and optimize the overall success of endodontic interventions. The presence of denticles within the root canal poses a considerable challenge in the context of endodontic therapy. Particularly when located in the apical third of the root canal, denticles heighten the risk of barbed broach breakage, especially if there is a defect in the steel. It is crucial to exercise caution, ensuring that barbed broaches are not introduced into tight canals and are not used for canal enlargement. Instead, their primary purpose should be to engage pulp tissue for efficient removal. The potential complications associated with denticles emphasize the importance of adopting precise and meticulous techniques during endodontic procedures. In cases where barbed broaches break within the canal, commercially available retrieval kits offer a viable solution for the removal of broken instruments. These kits provide specialized tools designed to navigate the intricacies of the root canal system and safely extract fragmented or broken instruments. This approach ensures the completion of the endodontic procedure without

leaving remnants that may compromise treatment outcomes.<sup>14</sup>The presence of infected and necrotic pulp tissue within the root canal serves as a continuous irritant to periapical tissues, necessitating thorough debridement of the root canal. The removal of such tissues is critical for the success of endodontic therapy, as persistent infection can lead to treatment failure and further complications. Achieving a clean and disinfected root canal is fundamental to promoting healing and preventing the recurrence of infection. Ostrander E. C.'s assertion that some endodontic cases may fail due to a lack of strictly aseptic technique underscores the importance of maintaining a sterile environment during root canal procedures. The introduction of new microorganisms into the root canal during treatment can compromise the overall success of the procedure. This highlights the need for practitioners to adhere diligently to aseptic protocols, ensuring the highest standards of infection control throughout the entirety of the endodontic therapy. In summary, addressing the challenges posed by denticles, employing specialized retrieval kits, and prioritizing aseptic techniques are essential considerations in the pursuit of successful endodontic therapy. These practices contribute to minimizing risks, promoting thorough debridement, and fostering an environment conducive to optimal healing within the root canal system.

## CONCLUSION

The author's findings highlight prevalent reasons for root canal failures, emphasizing the significance of missed canals, inadequate obturation, and fractured coronal obturation. The complexity of root canal anatomy contributes to the challenge of consistently identifying and treating all canals, potentially leading to persistent infection and treatment failure. Inadequate obturation, characterized by incomplete filling of the root canal, poses a risk of bacterial infiltration, underscoring the importance of precise techniques and materials in achieving effective seals. The fracture of coronal obturation materials, such as restorations or crowns, not only compromises the structural integrity of the tooth but also creates a potential pathway for bacterial re-entry, further jeopardizing treatment success. Addressing these factors through meticulous exploration, precise instrumentation, and thorough obturation is crucial for enhancing the overall efficacy of endodontic treatments. Ongoing advancements in endodontic techniques and materials contribute to continuous improvements, offering potential avenues for

optimizing the long-term success of root canal procedures.

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