ORIGINAL ARTICLE

EVALUATING THE CAUSES OF ROOT CANAL TREATMENT FAILURE IN SOUTHERN PUNJAB, PAKISTAN

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ABSTRACT

Background: Numerous significant factors have been associated with root canal failure. Notably, the presence of bacteria within the root canal system constitutes a primary causative factor for the failure of root canal treatment.

Objective: The objective of this study is to determine the most common cause for root canal failure in the public and private sectors of South Punjab, Pakistan.

Methods: This cross-sectional study was carried out at the Endodontic Department of Multan Medical and Dental College in Pakistan from October 2022 to April 2023, examined 104 teeth with failed root canal treatments from patients seeking retreatment, and divided them into public and private sector treated groups to identify the main cause of failure through clinical and radiographic examination.

Results: Among 104 participants, 65.3% (n=68) were identified as male, whereas 34.6% (n=36) were identified as female. The primary cause of root canal failure among patients treated in the public sector was identified as broken instruments, accounting for 6.7% of cases. Conversely, patients treated in the private sector experienced root canal failure primarily due to poor coronal seal, which accounted for 23.0% of cases. Pain is the predominant manifestation of root canal failure, with a prevalence rate of 70%.

Conclusion: The mandibular first molar had the greatest endodontic treatment failure rate. Poor coronal seal and under-filled root canal caused most root canal failures. These events were more common in male patients and private sector hospitals than in public ones.

Keywords: Root canal treatment failure, Government sector, Private sector.

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INTRODUCTION

Root canal treatment, also known as endodontic treatment, involves shaping and cleaning the root canal system before filling the pulpal area with a sterile substance.[1] One of the most frequently procedures performed in dentistry is endodontic therapy. The primary objective of endodontic therapy is to preserve the functional capacity of the tooth within the oral cavity by effectively eliminating any residual infection or necrotic pulp.[2] Improper adherence to established principles of root canal treatment results in an increased incidence of periapical radiolucency and symptom recurrence, thereby affecting the overall success rates of the procedure, which

typically range from 85% to 96%. A return of clinical symptoms and the appearance of periapical radiolucency are considered signs of endodontic failure. Therefore, the treated tooth's clinical symptoms and radiographic findings are used to assess endodontic failure.[1]

Empirical data suggests a positive correlation between the efficacy of root canal sealing and the favorable outcome of endodontic therapy on the respective tooth, in terms of preventing bacterial infiltration.[3] As a result, bacteria and necrotic tissue may be present in an unprepared section of a root canal system, which could result in treatment failure.[4] Once the canal has undergone appropriate chemo-mechanical preparation, the necessity for achieving adequate root canal obturation becomes evident.[5] Obturation failure, on the other hand, frequently precedes endodontic failure in the long run.[6]

Re-treatment is advised for symptoms including fistulation, swelling, pain, percussion, tenderness, and discomfort while chewing. The goals of non-surgical endodontic retreatment encompass the thorough removal of all contents within the root canal space.[7] Moreover, based on the condition of the canal(s), placement of an intra-canal medication for a specified duration.[8] When endodontic treatment is performed incorrectly, it frequently fails. However, there are some instances where failure can still occur despite adhering to the correct protocol and maintaining the highest levels of treatment quality.

In general, a clinical and radiographic follow-up should be performed following every root canal therapy, ideally one year after the treatment has been completed and at the very least after six months.[9] Therefore, the treated tooth's clinical symptoms and radiographic findings are used to assess endodontic failure.[1] There are numerous significant factors have been associated with root canal failure.[10] Common contributors to endodontic failure encompass under-filled root canals resulting from insufficient cleaning and obturation, overextensions of root filling materials, inadequate coronal seal leading to microleakage, and untreated canals including both primary and accessory canals. Notably, the presence of bacteria within the root canal system constitutes a primary causative factor for the failure of endodontic procedures.[11] The main cause of the continuation of symptoms is these localized bacteria.[12] Clinical failure is indicated if there are chronic symptoms including oedema, sinus tract pain, pain on percussion, and pain on probing in the apical region. The lack of these symptoms, however, denotes clinical success. The radiographic assessment provides valuable indicators to determine the outcomes of endodontic treatment.[13]

This study aims to highlight the importance of taking significant measures to improve the quality of endodontic treatment in dentistry. Specifically, it focuses on identifying the factors that play a significant role in causing endodontic treatment failures. The primary objective of this investigation was to determine the specific factor that contributes to the failure of endodontic treatment among patients undergoing re-treatment at a tertiary care facility in South Punjab, Pakistan.

METHODS

Following the approval from the ethical committee of Multan Medical and Dental College (IRB # C-52-1008). This cross-sectional study was conducted seeking re-treatment. The study took place from 1st October 2022 to 20th April 2023, and the participants were individuals who had received treatment from either the public or private healthcare sectors in the South Punjab region. They were divided into two distinct groups. After obtaining written informed consent, a total of 104 teeth displaying post-endodontic complaints were carefully selected as the subjects of the study. The inclusion criteria for this study encompassed patients who met the following characteristics: persistent indications of swelling, presence of a sinus tract, tenderness to percussion, and pain on palpation in the apical region. Additionally, the subjects have fully developed permanent dentition, maintained adequate oral hygiene and demonstrated complete root formation of their teeth. To maintain the integrity of the research, precise exclusionary criteria were implemented. The study excluded patients who exhibited periodontal disease, vertical root fracture, split crown, involvement of third molars, mental or physical handicaps, and those with an unidentified cause of previous treatment. These criteria aimed to create a homogeneous and focused sample, suitable for the comprehensive analysis of the research objectives.

The coronal restorations underwent a clinical and radiographic evaluation to assess their quality. Two periapical radiographs were obtained to assess the condition of the root canal filling and peri-radicular region. One radiograph was taken using a parallel technique with 900 X-ray beams directed towards the tooth and film, while the second radiograph was taken using a SLOB technique. The fundamental parameters utilized for identifying the reasons behind the failure were as follows; inadequate filling, defined as filling less than two mm from the root apex, overfilling, defined as filling beyond the root apex, insufficient filling, defined as the presence of voids or radiolucency within the root filling, additional factors such as ledges, perforations, and broke instruments were also documented.

Subsequently, the individuals were directed to an endodontic specialist to receive retreatment.

STATISTICAL ANALYSIS

A descriptive analysis was conducted utilizing Statistical Package for Social Sciences (SPSS) version 25 to analyse the data. The analysis involved calculating percentages to provide an overview of the data distribution.

RESULTS

Out of the 104 patients included in the study, 68 (65.3%) were male, while 36 (34.6%) were female. The majority of individuals belonged to the age group of 20 to 30 years, accounting for 32.4% of the sample as shown in **Table 1**. The study revealed that broken instruments were the leading cause of root canal failure in patients receiving treatment within the public healthcare sector, while poor coronal seals followed by under-filled root canals were identified as the most common causes of root canal treatment failure in the private sector, as evidenced by the data presented in **Table 2**. **Table 3** presents the prevalence of symptoms reported by participants, with pain being the most frequently reported symptom, followed by loss of restoration, swelling, and formation of the sinus tract.

Causes of Root Canal Treatment Failure	Public sector Treated		Private Sector Treated	
	Freq	(%)	Freq	(%)
Poor Coronal Seal	05	4.8	24	23.0
Underfilled	04	3.8	22	21.1
Broken Instrument	07	6.7	13	12.1
Ledge/ Calcification	06	5.7	7	6.7
Missed Canal	02	1.9	02	1.9
Non-Resorbable Periapical Lesion	04	3.8	04	3.8
Periodontal Lesion	00	0	04	3.8

Table 1: Age of the Patients

Age of Patients	No of Patients	Percentage
Below 20 years	5	4.8
20-30 years	34	32.4
30-40 years	28	26.9
40-50 years	19	18.3
50-60	13	12.5
60 years and above	4	3.8
Total	104	100

Table 2: Causes of Root Canal Treatment Failure

Symptoms	No of Patients	Percentage
Pain	75	72.1
Swelling	8	7.7
Sinus Tract Formation	7	6.7
Loss of Restoration	14	13.5
Total	104	100

Table 3: Symptoms of Root Canal Treatment Failure

DISCUSSION

The primary goal of root canal treatment is to eliminate or reduce bacterial colonization to prevent potential re-infection. Endodontic treatment failure is often attributed to substandard treatment procedures.[11] The decision to perform a root canal treatment is contingent upon four key factors which include accessibility, restorability, the strategic significance of the tooth, and the patient's overall resistance. These factors are crucial in achieving a successful outcome.[14] The failure of endodontic treatment is determined by the presence of symptoms in a tooth that has undergone root canal treatment, as well as an abnormal soft tissue response upon manual examination. The radiographic alterations that signify the failure of endodontic treatment encompass inadequate healing of the peri-apical lesion and the perpetuation or enlargement of the pre-existing lesion.[15]

The results of this study indicate that root canal failure is observed in both public and private healthcare sectors, although with differences in the primary underlying factors. While certain reasons hold greater significance in the public sector, others are found to be more prevalent in the private sector. The findings of this study indicate that poor coronal seal was the predominant cause of root canal failure in the private sector. The results obtained are in line with the findings of the meta-analysis conducted by Ng et al. in 2011, which established that teeth with adequate coronal restorations exhibited a greater success rate compared to those with substandard coronal restorations.[16] The results of this study exhibit a discrepancy with a study that determined the primary determinant of root canal success to be the quality of the root canal filling, rather than the quality of the coronal restoration.[17] This study supports the findings of research conducted by Swanson K et al, which demonstrated the substantial impact of coronal leakage on the success of root canal therapy.[18] Furthermore, the importance of proper coronal restoration in their further reinforces the findings of this study.[19]

The current study observed a higher occurrence of failures in molar teeth compared to anterior teeth, which aligns with previous research findings. Notably, mandibular molars were identified as the most commonly affected teeth. Moreover, our investigation identified the under-filling of the root canal as a predominant cause of endodontic complications, accounting for 24.8% of cases in both the public and private sectors. Interestingly, this finding contrasts with the factors proposed in a study conducted by Akbar I in 2015.[20] The present study was carried out in the densely populated southern region of Punjab, Pakistan which is characterized by a limited number of dental hospitals in the public and private

sectors. Dental hospitals with high patient turnover often experience instances where patients who have been relieved of pain either postpone or completely neglect their coronal restoration scheduled appointments. The postponement of root canal treatment may result in a higher incidence of coronal seal inadequacy, which is a prevalent cause of root canal treatment failure in the public sector.

The appropriate density of the filling substance inside the root canal is a crucial factor in determining the sustained efficacy of root canal treatment. Inadequate filling of the root canal may result in microleakage along the canal walls, which can ultimately fail the root canal.[21] The results of present study revealed that under-filled root canal fillings constituted the second most prevalent cause of root canal failure in the private sector, accounting for approximately 21% of cases. The present study findings are in agreement with the 2019 study conducted by Aslam S et al. in Southern Punjab, Pakistan. Aslam S et al. found that under-filling was the primary cause of root canal failure in the private sector. Conversely, their study highlighted a poor coronal seal as the most prevalent factor leading to root canal failure in the public sector. In contrast, the present study identified broken instruments as the primary contributing factor to root canal failure specifically within the public sector. These findings provide further support for the differential causes of root canal failure between the private and public sectors.[21]

Existing research indicates that a significant proportion of poor root canal treatments are provided by general dentists working in private clinics. This problem could emerge as a result of a failure to follow recognised procedures and fundamental principles of root canal therapy, which are normally taught and enforced in dental teaching institutes.[22] Private dental practitioners specialising in endodontics could benefit from additional postgraduate qualifications and continuous training to improve their clinical performance.[23, 24] Compared to non-specialist practitioners, it is suggested that endodontists with specialized training and expertise have a lower likelihood of committing procedural errors that can compromise the effectiveness of endodontic treatment, such as inadequate root canal fillings. [20]

One potential limitation of this study was relying solely on periapical radiographs. Periapical radiographs provide a two-dimensional representation of a three-dimensional object, which introduces challenges in interpretation owing to the superimposition of adjacent structures. Additionally, it is important to note that this study would have benefited from the inclusion of a greater number of hospitals. By increasing the sample size, a more comprehensive representation of healthcare hospitals could have been obtained, allowing for a better-generalized statement on the outcome of the study. The present study is expected to contribute to the improvement of current practical approaches to endodontic treatment. Consequently, it is strongly recommended to exercise careful case selection to achieve optimal outcomes in root canal treatment. In cases involving complex anatomical considerations and those requiring re-treatment, it is advised to refer the patients to an endodontic specialist.

CONCLUSION

The findings of the current investigation revealed that the mandibular first molar exhibited the highest incidence of endodontic treatment failure among the affected teeth. The predominant factors contributing to root canal failure were identified as under-filled of the root canals. These occurrences were more common in male patients than females and were observed with greater frequency in private-sector hospitals compared to public-sector hospital.

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AUTHOR'S CONTRIBUTIONS

MA: Conceptualization, Writing - Original Draft, Writing - Review & Editing, Data Collection
SS: Conceptualization, Data Collection
BK: Review & Supervision
UA: Manuscript Preparation & Data interpretation
MI: Data collection
MAM: Conceptualization, Writing - Original Draft Editing, Supervision, Manuscript Preparation