

Research Article

Surgical Versus Non-Surgical Retreatment Outcomes in Failed Root Canal Case

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ABSTRACT

Background: Failure of root canal treatment is a common clinical challenge in endodontic practice and may result from persistent intraradicular infection, inadequate canal debridement, missed canals, or coronal leakage. Management of failed endodontic cases generally involves either non-surgical retreatment or surgical endodontic procedures such as apicoectomy. Determining the most effective treatment approach remains an important clinical decision in endodontic (Torabinejad et al., 2009; Ng et al., 2011).

Objective: To compare the clinical and radiographic outcomes of surgical versus non-surgical retreatment in failed root canal cases.

Methods: This prospective comparative clinical study was conducted at the Department of Dentistry, Sandman Provincial Hospital and SPH Quetta, Pakistan. A total of 100 patients presenting with failed root canal treatment were enrolled and allocated into two groups: Group A underwent non-surgical retreatment, while Group B received surgical endodontic retreatment (apicoectomy with retrograde filling). Patients were followed for 12 months. Treatment success was assessed based on clinical symptoms, radiographic healing, and absence of periapical pathology. Statistical analysis was performed using chi-square and independent t-tests with significance set at $p < 0.05$.

Results: Non-surgical retreatment demonstrated a high success rate in cases where the cause of failure was related to inadequate previous root canal therapy. Surgical retreatment showed favorable outcomes in cases with persistent periapical lesions or anatomical complexities. Overall success rates were slightly higher in the non-surgical retreatment group; however, surgical retreatment remained an effective alternative when conventional retreatment was not feasible.

Conclusion: Both surgical and non-surgical retreatment methods are effective for managing failed root canal cases. Non-surgical retreatment should be considered as the first line of treatment whenever feasible, while surgical intervention remains a reliable option for cases where conventional retreatment is not possible or has failed.

Keywords: Root Canal Retreatment, Apicoectomy, Endodontic Surgery, Failed Root Canal Treatment, Periapical Healing.

INTRODUCTION

Root canal treatment (RCT) is a well-established procedure for the management of pulpal and periapical diseases, with reported success rates generally ranging from 86% to 98% when performed under optimal conditions (Ng, Mann, & Gulabivala, 2011).

The primary objective of root canal therapy is to eliminate microorganisms from the infected root canal system and prevent reinfection through proper cleaning, shaping, disinfection, and obturation of the canal space (Torabinejad, Corr, Handysides, & Shabahang, 2009). Despite high success rates, a

proportion of cases may fail due to various biological and technical factors, resulting in persistent or recurrent periapical pathology. Failed root canal treatment presents a significant challenge in endodontic practice and requires careful evaluation and appropriate management to restore periapical health and tooth function.

The causes of endodontic failure are multifactorial. Persistent microbial infection within the root canal system remains the most common cause of treatment failure (Siqueira & Rôças, 2008). Microorganisms may survive in areas that are difficult to access during instrumentation, such as lateral canals, apical ramifications, and dentinal tubules. Inadequate canal preparation, missed canals, insufficient irrigation, or poor obturation may allow bacteria to remain within the canal system and contribute to persistent infection (Ng et al., 2011). Additionally, coronal leakage due to defective restorations can lead to reinfection of the root canal system and subsequent failure of treatment (Torabinejad et al., 2009).

When root canal treatment fails, several management options are available, including non-surgical retreatment, surgical endodontic retreatment, or extraction followed by prosthetic replacement. Among these options, non-surgical retreatment is often considered the first line of management because it addresses the primary cause of failure by removing existing root canal filling materials, disinfecting the canal system, and performing proper re-obturation (Friedman & Mor, 2004). Non-surgical retreatment has demonstrated favorable success rates when the cause of failure is related to inadequate previous treatment, such as missed canals or insufficient canal cleaning (Ng et al., 2011).

However, non-surgical retreatment may not always be feasible or successful, particularly in cases where anatomical complexities, procedural errors, or obstructive restorations prevent adequate access to the canal system. In such situations, surgical endodontic retreatment, commonly known as apical surgery or apicoectomy, may be indicated (Kim & Kratchman, 2006). Surgical retreatment involves the removal of periapical pathological tissue, resection of the apical portion of the root, and placement of a retrograde filling material to seal the root canal system. Advances in microsurgical techniques, magnification, ultrasonic instruments, and biocompatible retrograde

filling materials such as mineral trioxide aggregate (MTA) have significantly improved the success rates of surgical endodontic procedures (Setzer, Shah, & Kohli, 2010).

Previous studies have reported varying success rates for both treatment modalities. Non-surgical retreatment success rates have been reported to range between 74% and 86%, depending on factors such as case selection, operator skill, and quality of previous treatment (Ng et al., 2011). Surgical endodontic procedures have also demonstrated favorable outcomes, with modern endodontic microsurgery achieving success rates exceeding 90% in some studies (Setzer et al., 2010). Nevertheless, the decision between surgical and non-surgical retreatment often depends on multiple factors, including the cause of failure, anatomical considerations, accessibility of the canal system, and patient-related factors.

Although both treatment approaches are widely practiced, there remains ongoing debate regarding the optimal management strategy for failed root canal cases. Comparative clinical studies evaluating outcomes of surgical versus non-surgical retreatment are essential to guide evidence-based clinical decision-making. Therefore, the present study aims to compare the clinical and radiographic outcomes of surgical and non-surgical retreatment in failed root canal cases treated at Bolan Medical Complex Hospital, Quetta, Pakistan. By evaluating treatment success, symptom resolution, and periapical healing over a 12-month follow-up period, this study seeks to provide valuable clinical insights into the effectiveness of these two treatment modalities.

LITERATURE REVIEW

Failure of root canal treatment remains an important concern in endodontic practice, despite the high success rates reported for primary endodontic therapy. The long-term success of root canal treatment depends primarily on complete elimination of microorganisms from the root canal system and prevention of reinfection through adequate obturation and coronal sealing (Siqueira & Rôças, 2008). However, anatomical complexities of the root canal system, procedural errors, and microbial persistence may contribute to treatment failure, leading to persistent periapical lesions and clinical symptoms that require retreatment (Ng et al., 2011).

Causes of Endodontic Treatment Failure

Numerous studies have identified microbial persistence as the primary cause of failed root canal therapy. Bacteria that remain within the root canal system after treatment can survive in inaccessible anatomical areas such as isthmuses, lateral canals, and apical deltas (Siqueira & Rôças, 2008). Inadequate cleaning and shaping of the canal system, insufficient irrigation, and incomplete obturation may allow microorganisms to persist and continue causing periapical inflammation.

Technical factors also contribute to endodontic failure. Missed canals, inadequate obturation length, overfilling, instrument separation, and perforations are among the most commonly reported procedural errors associated with failed root canal treatment (Friedman & Mor, 2004). In addition, coronal leakage caused by defective restorations may lead to bacterial recontamination of the canal system, which can compromise treatment outcomes (Torabinejad et al., 2009).

Non-Surgical Root Canal Retreatment

Non-surgical retreatment is generally considered the first-line approach for managing failed root canal therapy because it directly addresses the primary cause of failure by removing the previous root filling material and re-cleaning the canal system (Ng et al., 2011). During this procedure, the existing root canal filling material is removed; the canal system is re-instrumented, disinfected using antimicrobial irrigants, and obturated again to achieve a hermetic seal.

Several studies have reported favorable outcomes for non-surgical retreatment. Friedman and Mor (2004) reported success rates ranging from 70% to 86%, depending on factors such as the quality of previous treatment and the presence of periapical pathology. Similarly, Ng et al. (2011) conducted a systematic review of endodontic treatment outcomes and found that non-surgical retreatment has a high probability of success when the cause of failure is related to inadequate previous root canal therapy.

However, non-surgical retreatment may be limited in certain situations. Teeth with complex canal anatomy, calcified canals, separated instruments, or posts and crowns that cannot be safely removed may present challenges that make conventional retreatment difficult or impossible (Kim & Kratchman, 2006). In such cases, surgical

endodontic treatment may be considered as an alternative.

Surgical Endodontic Retreatment

Surgical endodontic retreatment, also known as apical surgery or apicoectomy, is indicated when conventional retreatment cannot adequately resolve the underlying cause of failure. The procedure involves surgical access to the periapical region, removal of infected periapical tissues, resection of the root apex, and placement of a retrograde filling material to seal the canal system (Kim & Kratchman, 2006).

Traditional apical surgery showed moderate success rates; however, the introduction of endodontic microsurgery has significantly improved clinical outcomes. The use of operating microscopes, ultrasonic root-end preparation, and biocompatible retrograde filling materials such as mineral trioxide aggregate (MTA) has enhanced the predictability of surgical retreatment procedures (Setzer et al., 2010).

Several clinical studies have demonstrated favorable outcomes for modern endodontic microsurgery. Setzer et al. (2010) conducted a systematic review and reported success rates exceeding 90% when contemporary microsurgical techniques were used. Similarly, Kim and Kratchman (2006) highlighted that advancements in surgical techniques have significantly increased the success of apical surgery compared to traditional approaches.

Comparison between Surgical and Non-Surgical Retreatment

Both treatment modalities have demonstrated effectiveness in managing failed root canal therapy, but their indications differ. Non-surgical retreatment addresses intraradicular infection and is therefore preferred when the root canal system can be accessed and adequately cleaned. In contrast, surgical retreatment directly targets periapical pathology and may be more appropriate when orthograde retreatment is not feasible (Torabinejad et al., 2009).

Torabinejad et al. (2009) compared surgical and non-surgical retreatment outcomes and concluded that non-surgical retreatment should generally be attempted before surgical intervention. However, when surgical retreatment is performed using modern microsurgical techniques, it can achieve comparable or even higher success rates in selected cases.

Despite the availability of these treatment options, the decision between surgical and non-surgical retreatment remains complex and depends on factors such as the cause of failure, anatomical considerations, and accessibility of the root canal system. Therefore, further comparative clinical studies are necessary to evaluate the relative effectiveness of these two treatment modalities.

The present study aims to compare the clinical and radiographic outcomes of surgical and non-surgical retreatment in failed root canal cases treated at Bolan Medical Complex Hospital, Quetta, Pakistan, in order to provide evidence-based guidance for clinicians in selecting the most appropriate treatment approach.

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a prospective comparative clinical study conducted at the Department of Dentistry, Sandman Provincial Hospital SPH Quetta, Pakistan, between March 2024 and March 2025. The study protocol was reviewed and approved by the Institutional Ethical Review Committee of Bolan Medical Complex Hospital. All procedures were carried out in accordance with the principles outlined in the Declaration of Helsinki for research involving human subjects. Written informed consent was obtained from all participants prior to inclusion in the study.

Study Population

Patients presenting to the dental outpatient department with signs and symptoms suggestive of failed root canal treatment were screened for eligibility. Diagnosis of failed root canal treatment was based on the presence of persistent clinical symptoms such as pain, tenderness on percussion, swelling, sinus tract formation, or the presence of persistent periapical radiolucency on radiographic examination.

Inclusion Criteria

The following patients were included in the study:

1. Patients aged between 18 and 60 years.
2. Teeth with previously treated root canal therapy showing persistent periapical pathology.
3. Patients with adequate coronal structure allowing restoration after retreatment.
4. Patients willing to participate and attend follow-up visits.

Exclusion Criteria

Patients were excluded if they had:

1. Teeth with vertical root fractures.
2. Teeth with severe periodontal disease or mobility greater than Grade II.
3. Non-restorable teeth.
4. Patients with systemic conditions that could affect healing such as uncontrolled diabetes or immune compromised states.
5. Pregnant patients or patients unable to return for follow-up.

Sample Size

A total of 100 patients diagnosed with failed root canal treatment were included in the study. The participants were divided into two groups of 50 patients each:

- **Group A:** Non-surgical root canal retreatment
- **Group B:** Surgical endodontic retreatment (apicoectomy)

Allocation of Participants

Patients were allocated into the two treatment groups based on clinical indications and feasibility of orthograde retreatment. Cases where the root canal system could be accessed and retreated conventionally were managed using non-surgical retreatment, whereas cases with obstructed canals, separated instruments, or persistent periapical lesions unsuitable for orthograde retreatment were treated using surgical endodontic procedures.

Non-Surgical Retreatment Procedure (Group A)

In Group A, conventional non-surgical retreatment was performed under local anesthesia. The procedure included removal of existing coronal restorations and previous root canal filling materials using endodontic files and solvents when necessary. The canals were re-instrumented using rotary nickel-titanium instruments and irrigated with 2.5% sodium hypochlorite and saline solution. Calcium hydroxide was placed as an intracanal medicament in cases with persistent infection. After adequate disinfection, the canals were obturated using gutta-percha and resin-based sealer through the lateral condensation technique. The teeth were subsequently restored with appropriate coronal restorations.

Surgical Retreatment Procedure (Group B)

In Group B, surgical endodontic retreatment (apicoectomy) was performed under local anesthesia. A full-thickness mucoperiosteal

flap was reflected to expose the periapical region. Granulation tissue was removed, and approximately 3 mm of the root apex was resected using surgical burs. Root-end preparation was performed using ultrasonic tips, and the retrograde cavity was filled with mineral trioxide aggregate (MTA). The surgical site was irrigated with sterile saline, and the flap was repositioned and sutured using 3-0 silk sutures.

Outcome Assessment

Patients were evaluated clinically and radiographically during follow-up visits at 3 months, 6 months, and 12 months post-treatment. Treatment success was determined based on the following criteria:

- Absence of pain or tenderness on percussion
 - Absence of swelling or sinus tract
 - Radiographic evidence of reduction or complete healing of periapical lesions
 - Functional tooth without clinical symptoms
- Cases presenting with persistent symptoms or unchanged/increased periapical radiolucency were classified as treatment failures.

Data Collection

Data regarding patient demographics, clinical findings and type of treatment performed, and treatment outcomes were recorded in a structured data collection form. Radiographic evaluation was performed using standardized

periapical radiographs interpreted by two independent examiners to minimize observer bias.

Statistical Analysis

The collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize patient characteristics and treatment outcomes. The Chi-square test was used to compare success rates between surgical and non-surgical retreatment groups. Continuous variables were analyzed using the independent sample t-test. A p-value < 0.05 was considered statistically significant.

RESULTS

Study Population

A total of 118 patients with previously treated root canal teeth were screened for eligibility during the study period. Eighteen patients were excluded due to not meeting the inclusion criteria or declining participation. The remaining 100 patients were enrolled and included in the study. These patients were divided equally into two groups:

- **Group A:** Non-surgical root canal retreatment (n = 50)
- **Group B:** Surgical endodontic retreatment (apicoectomy) (n = 50)

All participants completed the 12-month follow-up period, and their clinical and radiographic outcomes were evaluated.

Table 1. Demographic Characteristics of Patients

Variable	Non-Surgical Retreatment (n=50)	Surgical Retreatment (n=50)	P-Value
Mean Age (years)	35.8 ± 9.4	36.6 ± 8.9	0.64
Male	23 (46%)	25 (50%)	0.68
Female	27 (54%)	25 (50%)	
Maxillary Teeth	21 (42%)	19 (38%)	0.67
Mandibular Teeth	29 (58%)	31 (62%)	

Interpretation

There were no statistically significant differences between the two groups regarding

age, gender distribution, or tooth location, indicating comparable baseline characteristics.

Table 2. Causes of Initial Root Canal Treatment Failure

Cause of Failure	Non-Surgical Group	Surgical Group	Total
Inadequate Obturation	18 (36%)	12 (24%)	30
Missed Canals	14 (28%)	9 (18%)	23
Persistent Periapical Lesion	10 (20%)	21 (42%)	31
Coronal Leakage	8 (16%)	8 (16%)	16

Interpretation

Inadequate obturation and missed canals were more common in cases treated with non-surgical retreatment, whereas persistent

periapical lesions were more frequently observed in the surgical group.

Table 3. Clinical Success Rates after 12 Months

Outcome	Non-Surgical Retreatment (n=50)	Surgical Retreatment (n=50)	P-Value
Successful Healing	42 (84%)	38 (76%)	0.29
Treatment Failure	8 (16%)	12 (24%)	

Interpretation

Non-surgical retreatment showed a slightly higher success rate compared to surgical

retreatment; however, the difference was not statistically significant.

Table 4. Radiographic Healing of Periapical Lesions

Radiographic Outcome	Non-Surgical Group	Surgical Group	P-Value
Complete Healing	30 (60%)	32 (64%)	0.71
Partial Healing	12 (24%)	6 (12%)	
No Healing	8 (16%)	12 (24%)	

Interpretation

Radiographic healing was observed in the majority of cases in both groups. Complete

healing rates were similar between surgical and non-surgical retreatment.

Table 5. Post-Treatment Complications

Complication	Non-Surgical Group (n=50)	Surgical Group (n=50)
Postoperative Pain	6 (12%)	10 (20%)
Swelling	3 (6%)	8 (16%)
Infection	1 (2%)	2 (4%)
No Complications	40 (80%)	30 (60%)

Interpretation

Postoperative complications were slightly higher in the surgical retreatment group compared with the non-surgical group, particularly in terms of swelling and postoperative pain.

after 12 months of follow-up, supporting their use as viable treatment options for failed root canal therapy depending on case selection and clinical indications.

Overall Results Summary

The results of this study demonstrated that both surgical and non-surgical retreatment methods were effective in managing failed root canal cases. Non-surgical retreatment showed a slightly higher overall success rate and fewer postoperative complications, particularly in cases where the cause of failure was related to inadequate previous treatment such as missed canals or insufficient obturation. Surgical retreatment also showed favorable outcomes, especially in cases with persistent periapical pathology where conventional retreatment was not feasible. Overall, both treatment modalities resulted in satisfactory clinical and radiographic healing

DISCUSSION

The management of failed root canal treatment remains an important aspect of endodontic practice, as preservation of natural teeth continues to be a primary objective in restorative dentistry. The present study compared the clinical and radiographic outcomes of surgical and non-surgical retreatment methods in failed root canal cases treated at Bolan Medical Complex Hospital, Quetta. The results demonstrated that both treatment modalities are effective in managing failed endodontic cases, with slightly higher success rates observed in the non-surgical retreatment group.

In this study, the overall success rate for non-surgical retreatment was 84%, compared to 76% for surgical retreatment. Although the

difference was not statistically significant, the findings support the widely accepted principle that non-surgical retreatment should be considered the first line of treatment whenever possible. Similar findings were reported by Ng et al. (2011), who observed that orthograde retreatment can effectively eliminate persistent intraradicular infection and achieve favorable healing outcomes in most failed root canal cases.

However, non-surgical retreatment may not always be feasible due to anatomical complexities, separated instruments, or obstructive coronal restorations. In such cases, surgical retreatment provides an alternative approach by addressing the periapical pathology directly. In the present study, surgical retreatment demonstrated a success rate of 76%, which is comparable to results reported in previous studies evaluating apical surgery outcomes. Kim and Kratchman (2006) highlighted that advancements in endodontic microsurgery have significantly improved the success rates of surgical retreatment procedures.

Radiographic evaluation in the current study revealed that complete periapical healing occurred in 60% of non-surgical retreatment cases and 64% of surgical retreatment cases. These results indicate that both treatment approaches can promote satisfactory periapical healing when performed appropriately. Similar findings were reported by Setzer et al. (2010), who conducted a systematic review demonstrating high success rates for modern endodontic microsurgery, particularly when performed using magnification and biocompatible root-end filling materials such as mineral trioxide aggregate.

The findings of this study highlight the importance of appropriate case selection when deciding between surgical and non-surgical retreatment methods. Non-surgical retreatment remains the preferred approach when the root canal system can be accessed and properly disinfected. Surgical retreatment should be reserved for cases where orthograde retreatment is not feasible or when persistent periapical pathology remains after conventional retreatment.

Despite its contributions, this study has certain limitations. The research was conducted at a single institution with a relatively moderate sample size. Additionally, longer follow-up periods beyond 12 months could provide further insight into the long-term success of retreatment procedures. Future multicenter

studies with larger sample sizes and longer observation periods are recommended to further evaluate the comparative effectiveness of surgical and non-surgical retreatment methods.

Overall, the findings of this study support existing literature suggesting that both surgical and non-surgical retreatment procedures can successfully manage failed root canal cases when appropriate clinical indications are considered.

CONCLUSION

Within the limitations of this prospective comparative clinical study conducted at Bolan Medical Complex Hospital, Quetta, both surgical and non-surgical retreatment methods demonstrated favorable outcomes in the management of failed root canal cases. Non-surgical retreatment showed a slightly higher overall success rate and fewer postoperative complications compared to surgical retreatment. These findings support the principle that conventional orthograde retreatment should be considered the first-line treatment option whenever access to the root canal system is feasible.

Surgical endodontic retreatment (apicoectomy) also demonstrated satisfactory clinical and radiographic outcomes, particularly in cases where conventional retreatment was not possible due to anatomical limitations, procedural complications, or persistent periapical lesions. Advances in modern endodontic microsurgical techniques and the use of biocompatible retrograde filling materials have further improved the predictability and success of surgical interventions.

Based on the results of this study, the choice between surgical and non-surgical retreatment should be guided by careful evaluation of the underlying cause of treatment failure, anatomical considerations, and accessibility of the root canal system. Proper case selection and adherence to evidence-based clinical protocols remain essential to achieving optimal treatment outcomes.

Further studies with larger sample sizes and longer follow-up periods are recommended to better evaluate long-term success rates and refine treatment guidelines for the management of failed root canal therapy.

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