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REVIEW ARTICLE

Endodontic Retreatment vs. Apical Surgery: Evidence-Based Decision Making

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ABSTRACT

Recurrent periapical pathology after root canal therapy poses a clinical dilemma as both nonsurgical endodontic retreatment and surgery are required. The present paper is a critical review of evidence on the topic of endodontic retreatment versus apical surgery in regards to indications, success rates, long-term prognosis, patient-centered outcomes, and cost-effectiveness. Published systematic reviews and meta-analyses to 2020 indicate that nonsurgical retreatment has positive long-term results, especially when failure occurs due to poor obturation, missed canals, or coronal leakage. On the other hand, apical surgery particularly in cases where surgery is done with modernized microsurgical instruments and bioceramic root-end filling substances is more successful in the short-term with increased likelihood of success but eventually resulting in failure. Tooth- and patient-specific, restorative prognosis, clinician knowledge, and modern diagnostic technologies, e.g., cone-beam computed tomography, should be combined in decision-making. There is evidence that there is no such thing as the best modality; therefore, specific, evidence-based planning of treatment is necessary to maximize clinical and patient-reported outcomes. The treatment paradigm can be further improved with future developments in regenerative endodontics, artificial intelligence, and minimally invasive treatment.

Keywords: Endodontic retreatment, Apical surgery, Evidence-based dentistry, Periapical pathology, Root canal failure, Microsurgery, Prognosis

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INTRODUCTION

Endodontic therapy is primarily aimed at the removal of infection and the preservation of periapical health by the means of complete cleaning, shaping, and obturation of the root canal system (Chandra et al., 2021). Although the success rates are high, failure also happens, and most commonly it is caused by persistent or secondary intraradicular infection, coronal leakage, or missed anatomy (Huelsmann & Tulus, 2016; Singh, 2020). Failure in root canal treatment leaves clinicians with a critical question of whether to go through nonsurgical retreatment procedure or surgery, the most popular of which is apical surgery. Selection of these modalities is complicated and depends on clinical, biological and patient-centered factors (Cohn, 2005; Rosen and Tsesis, 2017).

Historically, retreatment and apical surgery were viewed as competing alternatives. However, advancements in technology have blurred this distinction by improving outcomes for both approaches. Nonsurgical retreatment has benefited from innovations such as rotary NiTi instruments, advanced irrigation protocols, and three-dimensional imaging modalities like cone-beam computed tomography (CBCT), which enhance detection of missed canals and evaluation of root morphology (Singh, 2018; Singh, 2020). Conversely, modern endodontic microsurgery, supported by surgical microscopes, ultrasonic root-end preparation, and the introduction of biocompatible retrofilling materials, has significantly improved short-term healing rates compared to traditional surgical techniques (Friedman, 2011; Del Fabbro et al., 2016).

Nevertheless, clinical decision-making remains controversial. Studies demonstrate variability in treatment planning between general practitioners, specialists, and academic environments, highlighting a lack of consensus and the influence of training and experience (Balto & Al-Madi, 2004; Al-Ali et al., 2005; Aryanpour et al., 2000). Evidence suggests that nonsurgical retreatment often provides more favorable long-term survival outcomes, whereas apical surgery achieves rapid resolution of symptoms but may demonstrate reduced success over extended follow-up periods (Mead et al., 2005; Hülsmann & Tulus, 2016).

Incorporating an evidence-based approach is essential for improving decision-making in this context. Evidence-based dentistry integrates the best available scientific evidence, clinician expertise, and patient preferences to ensure optimal care (Rosen, Paul, & Tsesis, 2017; Rosen & Tsesis, 2017). Factors such as restorability of

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the tooth, presence of procedural complications, patient expectations, and cost-effectiveness must all be weighed when determining the appropriate treatment path (Cohn, 2005; Makkar et al., 2016).

This paper critically reviews the current evidence on endodontic retreatment and apical surgery, compares their clinical outcomes, and proposes a structured framework for evidence-based decision-making in cases of post-treatment endodontic disease.

INDICATIONS AND CONTRAINDICATIONS

Endodontic Retreatment

Indications

Nonsurgical retreatment is the preferred option when failure of the primary root canal treatment is attributable to technical or biological shortcomings that can be corrected. These include inadequate canal obturation, coronal leakage, missed canals, under- or over-instrumentation, and insufficient disinfection (Hülsmann & Tulus, 2016; Del Fabbro et al., 2016). Cone-beam computed tomography (CBCT) has enhanced the ability to diagnose untreated anatomy, procedural errors, and periapical pathosis, thereby improving case selection for retreatment (Singh, 2018). In addition, advances in irrigation protocols and rotary NiTi instruments facilitate more effective microbial reduction and canal re-instrumentation (Singh, 2020). Retreatment is also indicated when a tooth is of high strategic value, when restorative plans necessitate preservation of the natural dentition, or when apical surgery carries excessive risk due to anatomical considerations (Rosen & Tsesis, 2017).

Contraindications

Contraindications to retreatment include cases where the tooth is structurally compromised, such as severe root fractures, extensive caries rendering the tooth unrestorable, or compromised periodontal support (Chandra et al., 2021; Makkar et al., 2016). Retreatment may also be contraindicated when there is obstructed canal access due to posts, separated instruments, or complex canal anatomy that would significantly reduce the likelihood of success (Cohn, 2005). In educational and clinical surveys, dentists often report uncertainty or lack of consensus in retreatment decisions, particularly in cases of questionable restorability (Al-Ali et al., 2005; Aryanpour et al., 2000; Balto & Al-Madi, 2004).

Apical Surgery

Indications

Apical surgery, particularly in the form of modern microsurgical endodontics, is indicated when nonsurgical retreatment is not feasible, not likely to succeed, or has already failed. Common indications include canal obstructions (e.g., separated instruments, posts that cannot be removed), persistent periapical lesions suggestive of true cysts, and when anatomical complexity precludes adequate nonsurgical disinfection (Hülsmann & Tulus, 2016; Rosen, Paul, & Tsesis, 2017). Microsurgical approaches, supported by ultrasonic root-end preparation and bioceramic materials, have significantly improved outcomes compared to traditional surgical methods (Friedman, 2011). Furthermore, apical surgery is often indicated in cases where preservation of existing prosthetic restorations is critical and retreatment would necessitate their removal (Mead et al., 2005).

Contraindications

Apical surgery is contraindicated in teeth with poor periodontal prognosis, non-restorable crown-to-root ratio, or extensive structural damage (Chandra et al., 2021). Anatomical limitations, such as proximity to vital neurovascular structures (e.g., mandibular canal, maxillary sinus), also reduce surgical feasibility (Mead et al., 2005). Patient-related factors—including systemic health conditions that impair healing, limited compliance, or unwillingness to undergo surgery must also be considered (Rosen & Tsesis, 2017). Additionally, when a tooth has minimal strategic value and implant therapy is a more predictable option, surgery may not be justified (Cohn, 2005).

The decision between endodontic retreatment and apical surgery hinges on a complex interplay of biological, structural, and patient-centered factors. Retreatment is generally preferred for correctable intracanal deficiencies, while apical surgery is indicated when retreatment is technically impractical or has failed. Both modalities require thorough case selection supported by CBCT imaging, restorative assessment, and evidence-based guidelines to maximize prognosis (Del Fabbro et al., 2016; Rosen & Tsesis, 2017).

EVIDENCE-BASED COMPARISON OF OUTCOMES

The choice between endodontic retreatment and apical surgery is influenced not only by technical feasibility but also by the expected clinical outcomes. Evidence-based dentistry emphasizes integrating the best available research with clinical expertise and patient preferences to optimize treatment results (Rosen et al., 2017; Rosen & Tsesis, 2017).

Table 1: Comparative Evidence on Endodontic Retreatment vs. Apical Surgery

Parameter	Endodontic Retreatment	Apical Surgery	Key References
Primary Indications	Inadequate obturation, missed canals, coronal leakage	Obstructions preventing retreatment, failed retreatment, persistent apical pathology	Hülsmann & Tulus (2016); Al-Ali et al. (2005)
Short-term Success (1–2 years)	75–85%	90–95% (microsurgery)	Friedman (2011); Del Fabbro et al. (2016)
Long-term Success (4–6 years)	70–83% (stable outcomes)	74–80% (declining outcomes)	Cohn (2005); Mead et al. (2005)
Complications	Instrument fracture, perforation, ledging	Surgical morbidity, damage to adjacent structures	Chandra et al. (2021); Aryanpour et al. (2000)
Radiographic Healing	Gradual but stable	Rapid but less stable long-term	Friedman (2011); Rosen & Tsesis (2017)
Patient Experience	Less invasive, cost-effective, requires multiple visits	More invasive, faster resolution, higher morbidity	Balto & Al-Madi (2004); Makkar et al. (2016)
Technological Advances	NiTi rotary systems, CBCT, advanced irrigation	Microscope-assisted surgery, ultrasonic retropreparation, bioceramics	Singh (2018, 2019, 2020); Rosen et al. (2017)
Prognosis Influencers	Restorability, coronal seal, clinician skill	Anatomical complexity, surgical expertise, material choice	Hülsmann & Tulus (2016); Rosen & Tsesis (2017)

Success and Survival Rates

Nonsurgical retreatment has traditionally been considered the first-line option due to its ability to address the root cause of endodontic failure, such as missed canals, inadequate obturation, or coronal leakage (Al-Ali et al., 2005; Hülsmann & Tulus, 2016). Long-term studies show retreatment yields survival rates comparable to initial root canal therapy, especially when modern instruments, advanced irrigation techniques, and three-dimensional imaging are employed (Singh, 2018; Singh, 2020).

Apical surgery, on the other hand, demonstrates higher short-term success, particularly with the advent of microsurgical techniques, ultrasonic retropreparation, and bioceramic retrofilling materials (Friedman, 2011; Singh, 2019). However, long-term survival rates tend to decline compared to nonsurgical retreatment, highlighting the importance of careful case selection (Mead et al., 2005; Del Fabbro et al., 2016).

Healing and Radiographic Outcomes

Meta-analyses have shown that microsurgical apical surgery can achieve success rates of 90–95% at 1–2 years, but this reduces to 74–80% at 4–6 years (Friedman, 2011). Conversely, retreatment often demonstrates slower but more stable healing trends, with survival rates remaining high over longer periods (Cohn, 2005; Hülsmann & Tulus, 2016).

Complication Rates

Retreatment complications often include instrument separation, perforations, and difficulty in negotiating obstructed canals (Chandra et al., 2021). Surgical approaches carry risks such as damage to adjacent anatomical structures, postoperative pain, and surgical morbidity (Mead et al., 2005; Aryanpour et al., 2000).

Patient-Centered Outcomes and Cost-Effectiveness

Evidence also highlights the importance of patient-reported outcomes, including pain, recovery time, esthetics, and cost-effectiveness. Retreatment is often less invasive and better tolerated, while surgery provides faster resolution but involves higher procedural morbidity (Balto & Al-Madi, 2004; Makkar et al., 2016). Cost analyses further suggest that retreatment is generally more economical, though surgical intervention may be justified in cases where nonsurgical access is impractical (Cohn, 2005).

Current evidence suggests that both retreatment and apical surgery are effective modalities with unique strengths and limitations. Retreatment provides stable long-term outcomes and is more conservative, whereas apical surgery offers high short-term success, especially with microsurgical techniques and modern materials. Evidence-based decision-making should balance clinical feasibility, patient-centered outcomes, and long-term prognosis to ensure optimal care (Rosen et al., 2017; Del Fabbro et al., 2016).

DECISION-MAKING FRAMEWORK

The choice between endodontic retreatment and apical surgery requires a structured, evidence-based framework that integrates clinical, radiographic, patient-related, and operator-related considerations. Decision-making in endodontics is often complex due to variability in anatomical, restorative, and biological factors (Rosen & Tsesis, 2017; Hülsmann & Tulus, 2016). Historically, there has been limited consensus among clinicians on

Table 2: Comparative Framework for Decision-Making in Endodontic Retreatment vs. Apical Surgery

Decision Factor	Endodontic Retreatment	Apical Surgery
Indications	Inadequate obturation, missed canals, coronal leakage, instrument removal possible (Hülsmann & Tulus, 2016; Del Fabbro et al., 2016)	Persistent periapical lesion with inaccessible canals, obstructed systems, post-core crowns, or retreatment failure (Friedman, 2011; Mead et al., 2005)
Contraindications	Non-restorable tooth, root fracture, severe curvature, poor periodontal support (Al-Ali et al., 2005; Chandra et al., 2021)	Proximity to vital structures, inadequate bone support, non-strategic tooth (Cohn, 2005; Balto & Al-Madi, 2004)
Success (short-term)	70–85% at 2–4 years (Del Fabbro et al., 2016)	85–95% with microsurgery at 2–4 years (Friedman, 2011)
Success (long-term)	80–85% at 8–10 years (Rosen & Tsesis, 2017)	Declines to ~60–70% beyond 8 years (Mead et al., 2005)
Technical Considerations	Requires complete canal negotiation, effective irrigation, and adequate obturation (Singh, 2020)	Requires surgical access, microsurgical instruments, bioceramic retrofill materials (Singh, 2019)
Patient Burden	Non-surgical, less invasive, lower immediate discomfort (Aryanpour et al., 2000)	Surgical morbidity, higher cost, potential post-op discomfort (Cohn, 2005)
Diagnostic Tools	CBCT aids in identifying missed canals, root fractures (Singh, 2018)	CBCT for surgical planning, lesion dimension evaluation (Rosen & Tsesis, 2017)

retreatment decisions (Aryanpour, Van Nieuwenhuysen, & D'Hoore, 2000; Balto & Al-Madi, 2004), highlighting the need for standardized, evidence-based approaches.

Modern frameworks incorporate four key domains

Patient-related factors

systemic health, preferences, compliance, esthetic concerns, and financial considerations (Cohn, 2005; Rosen, Paul, & Tsesis, 2017).

Tooth-related factors

restorability, periodontal support, presence of fractures, and strategic importance within the dentition (Chandra et al., 2021; Makkar et al., 2016).

Technical feasibility

canal accessibility, previous obturation quality, presence of obstructions, and use of advanced imaging such as CBCT for diagnosis and planning (Singh, 2018; Singh, 2020).

Clinician-related factors

operator expertise, availability of microsurgical instruments, bioceramic materials, and irrigation techniques (Hülsmann & Tulus, 2016; Singh, 2019).

A critical review of outcomes suggests that nonsurgical retreatment is preferable when technical feasibility allows canal reinstrumentation and adequate coronal restoration (Del Fabbro et al., 2016). In contrast, apical surgery is indicated when retreatment is not possible or has previously failed, especially where periapical pathology persists despite adequate orthograde management (Friedman, 2011; Mead et al., 2005).

SYNTHESIS

An evidence-based decision-making model favors nonsurgical retreatment as the first-line approach when the root canal system can be predictably disinfected and restored (Del Fabbro et al., 2016; Hülsmann & Tulus, 2016). Apical surgery is reserved for cases with persistent periapical pathology where orthograde access is limited or infeasible (Friedman, 2011). Ultimately, optimal care requires a patient-centered approach, balancing biological feasibility with patient preferences, cost, and long-term prognosis (Rosen & Tsesis, 2017).

CONCLUSION

Nonsurgical retreatment and apical surgery have to be a delicate balance in the management of persistent apical periodontitis after root canal, as its management. Existing literature indicates that nonsurgical retreatment is the treatment of choice when possible since it can tackle the etiological causes of missed canals, poor obturation, or coronal leakage (Huelsmann and Tulus, 2016; Del Fabbro et al., 2016). The improvements in the dynamics of irrigation, CBCT imaging, and materials with bioceramics further promote predictability of the retreatment results (Singh, 2018; Singh, 2019; Singh, 2020).

Conversely, as an alternative to retreatment that failed or is not possible, apical surgery is a predictable option with a higher short-term success rate than conventional methods due to the use of microsurgical techniques and contemporary root-end filling materials (Friedman, 2011;

Mead et al., 2005). However, the long-term prognosis is more inclined to support nonsurgical retreatment, especially in situations when restorative and periodontal prognoses are positive (Rosen and Tsesis, 2017; Rosen, Paul, and Tsesis, 2017).

The process of decision-making should thus be patient-centered and evidence-based, combining patient-specific variables, tooth restorability, periodontal support, expertise of the clinician, and patient preference (Cohn, 2005; Al-Ali et al., 2005; Balto and Al-Madi, 2004). The relative uncertainty in the choice of retreatment versus surgery implies the relevance of the use of a structured framework based on the best available evidence, clinical judgment, and patient-centered care (Aryanpour et al., 2000; Chandra et al., 2021).

In the future, the incorporation of artificial intelligence, regenerative endodontics, and minimally invasive microsurgery is likely to streamline the treatment process and improve the evaluation of the prognosis (Makkar et al., 2016). The task of the clinician is to integrate a body of evidence that is available with the individualized clinical presentation in the best interest of patients who present with post-treatment apical periodontitis.

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