OUTCOMES OF NON-SURGICAL RETREATMENT AND ENDODONTIC SURGERY: A REVIEW

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ABSTRACT

Clinicians are regularly confronted with different choices after failure of root canal treatment. In today's world, patients prefer to keep their natural teeth, so non-surgical retreatment should be the preferred treatment. In the field of implant dentistry, the new generation of endodontic instruments, magnification, materials, and technology, combined with the basic principles of endodontic retreatment, have assisted in the preservation of the patient's natural tooth structure to form and function, reducing the need for extensive and expensive prosthetic replacement. In clogged, calcified, or nonnegotiable canals, a surgical technique can be used. If conventional endodontic retreatment is not possible or is linked with dangers, endodontic surgery has become the standard of therapy for dental maintenance. However, depending on the amount and position of periapical or periradicular diseases, the outcome of endodontic surgery may be affected or unknown. This literature review sought to provide the reader with up-to-date information on outcomes of non surgical retreatment and endodontic surgery, including scientific evidence on postoperative management and healing outcomes.

Keywords: Non-surgical retreatment, endodontic surgery, outcomes

I. INTRODUCTION

Cleaning, shaping, obturation, iatrogenic events, and reinfection of the root canal system when the coronal seal is disrupted following root canal treatment are all reasons for endodontic failure. The most common causes of endodontic treatment failure are leakage and bacterial contamination. The goal of non-surgical endodontic retreatment is to eliminate microleakage. The goal of retreatment is to eliminate root canal irritants as a source of attachment discomfort. Many factors influence the ability of endodontic lesions to heal, including diagnosis, total access, canal identification, and the use of concepts and procedures.¹²

Endodontic retreatment differs from root canal treatment in a number of ways, and it necessitates a number of treatments, including coronal disassembly, post removal, and filling material removal within the canal, depending on the tooth's state. In addition, a large percentage of teeth that are candidates for retreatment have been restored, and retreatment must take this into account before proceeding. The post and core or the coronal repair can be removed or kept. Each of these options is linked to unique circumstances and has its own set of benefits and drawbacks. Root canal filling materials should be removed using suitable method and resources.³⁴
Retreatment guarantees that the whole root canal system, as well as any communication channels, are properly cleansed, and that a high-quality root filling is inserted in each canal under ideal asepsis. Damage to the root level walls should be addressed when evaluating the outcomes of endodontic retreatment. Consequences include a compromised crown-to-root ratio and mobility caused by chronic periodontitis. Retreatment should not be considered for external resorptive root deformities, vertical root fractures, or non-negotiable root canal space. If conservative therapy fails to heal the periapical lesion after a fair period of time, the periapical lesion has stayed unaltered. If periapical pathology persists and/or treatment through the orthograde route is impracticable or exhausted, the endodontic surgery is indicated.5,6

If conventional endodontic retreatment is not possible or is linked with dangers, endodontic surgery has become the standard of therapy for dental maintenance. However, depending on the amount and position of periapical or periradicular diseases, the outcome of endodontic surgery may be affected or unknown. Farrar & Brophy (1880) completed the first endodontic surgical report in the United States, performing an apicectomy (root removal). Since then, his technique has been improved, and this operation is now used by both general and speciality dentists.7,8

According to Torabinejad et al. (1995), if conservative therapy fails to heal the periapical lesion after a reasonable follow-up, the periapical lesion remained unchanged because the root canal was not adequately treated and filled. Endodontic surgery is needed if periapical disease persists and/or treatment via the orthograde route is unfeasible or exhausted. El Swiah and Walter (1996) studied the clinical factors that influence the choice to undergo an apicectomy and found that a combination of technical and biological factors account for 60% of apicectomies. Chronic symptoms, the existence of root lesions on a regular basis, and persistent exudate are the most common biological reasons (2 percent). As a result, these criteria must be considered while deciding whether or not to proceed with surgery.9,10

The European Society of Endodontics (ESE) (2006) recently updated the endodontic surgical indications, which now include the following:11,12

1. Apical periodontitis radiological findings and/or symptoms linked with a blocked canal (obstruction proved not to be removable, displacement did not seem feasible, or the risk of damage was very large).

2. Extruded material with apical periodontitis and/or chronic symptoms, as determined by clinical or radiographic evidence.

3. When root canal retreatment is insufficient, persistent or developing illness occurs following root canal treatment.

4. Perforation of the root or pulp chamber floor in cases where the pulp cavity cannot be treated.

In some circumstances, Kim and Kratchman (2006) believe that surgery is more conservative than non-surgical treatment. A tooth with satisfactory endodontics and a fresh restoration with root retainer and crown, but a persistent or larger periapical disease, is a common example. A root microsurgical method would be more dramatic, longer, more expensive, and less predictable than breaking or disassembling the crown, removing the retainer, and retracting the channels. This review has been conducted to analyse the outcomes of non surgical retreatment and endodontic surgery.13,14

CAUSES OF ENDOdontic FAILURES

Some of the most prevalent causes of failure include improper mechanical debridement, the persistence of germs in the canals and apex, poor obturation quality, over and under extension of the root canal filling, and coronal leaking. Despite the high success rate of endodontic treatment, failures do occur in a significant number of cases, the majority of which can be attributable to the explanations already mentioned. With an ever-increasing number of endodontic procedures performed each day, it's become more important than ever to avoid or minimise the most basic causes of endodontic failure.15,16

Endodontic therapy is very predictable, with success rates ranging from 86 to 98 percent. However, there hasn't been a uniform definition of "success" criterion for endodontic treatment in the literature. Similarly, the term "failure" has many different definitions. A return of clinical symptoms combined with the presence of a periapical radiolucency has been defined in some investigations.17,18 For root canal treatment to be regarded
effective, an endodontically treated tooth should be assessed clinically as well as radiographically. Follow-up appointments should be made for the patient to ensure that the treatment was successful and that the tooth in question is functional. Endodontic treatment failure has been linked to a variety of variables. The following are the most common causes of endodontic failure:17,18

• Bacterial persistence (intra-canal and extra-canal)
• Inadequate canal filling (canals that are poorly cleaned and obturated)
• Improper coronal seal (leakage) • Untreated canals • Overextensions of root filling materials (both major and accessory)
• Instrumentation complications
• Iatrogenic procedural errors such as inappropriate access cavity design (ledges, perforations, or separated instruments).

Persistence of Bacteria
Persistent microbiological infection is one of the leading causes of endodontic failure. The involvement of bacteria in periapical infection has been extensively documented in the literature, and endodontic therapy will be more likely to fail if microorganisms remain in the canals after root canal obturation. Bacteria can survive disinfection in root canal locations such isthmuses, dentinal tubules, and ramifications. Lin et al. discovered a link between bacterial infection in the canals and periapical rarefaction in endodontic failures in a study of 236 cases of endodontic treatment failures.19,20

Inadequate or overextended root filling
Apart from adequate canal disinfection and debridement, the quality of obturation is also critical. In a study of 1001 endodontically treated teeth, the quality of root canal obturation was found to be the most critical factor in treatment outcome. Another study found that 65 percent of teeth with endodontic failures had low quality obturation, while 42 percent of the teeth had some canals that were left untreated. Obturations that are under or overextended have poorer success rates, whereas those that end flush or within 2 mm of the apex have the highest. According to a study, overextended obturation is 4 times more likely to fail than under obturated canals.21,22

Improper Coronal Seal
After obturation, a well-sealing coronal repair is required to avoid the invasion of any microorganisms that may be present in the surrounding environment. In their investigation, Swanson and Madison stressed the need of considering coronal leakage as a possible cause of endodontic failure. Ray and Trope underlined the importance of a good quality coronal restoration in their investigation, and their findings were later confirmed by a retrospective study on 1001 endodontically treated teeth. The findings revealed that teeth with poor quality coronal restorations had lower success rates than teeth with good coronal restorations.23,24

Complications of Instrumentation
When either the laws of access cavity preparation or the instructions for the use of rotary instruments are not followed, rotary instruments have a tendency to fracture in the canals. The access to the apical section of the root canal is reduced as a result of fracture, which could have a negative impact on canal disinfection and, eventually, obturation. The majority of investigations on the effect of shattered instruments have found that they have a minor impact on treatment success rates. The prognosis is affected by the stage of instrumentation at which the instrument fails.25,26

Untreated Canals
Missing a canal during endodontic treatment is not rare, especially in molar teeth, where the one root, one canal formula is usually overruled by the fact that the number of canals exceeds the number of roots. Furthermore, a small access aperture makes finding the supplemental canals harder for the primary dentist. One of the causes of endodontic failure is the inability to treat all of the canals. The presence of bacteria in these canals contributes to the duration of symptoms. According to the findings of one study, failing to discover the MB2 canal resulted in a considerable reduction in the long-term prognosis of those teeth.27,28
CHALLENGES OF RETREATMENT

Anatomical factors

Several anatomical and histological studies have shown the complexity of the root canal system's anatomy, including wide variations in the number, length, curvature, and diameter of root canals; the complexity of the apical anatomy with accessory canals and ramifications; communications between the canal space and the lateral periodontium and the furcation area; and the anatomy of the periphery. This intricate anatomy is one of the most difficult aspects of root canal preparation, and it is discussed in greater detail elsewhere in this issue. 29

Microbiological challenges

Both pulp tissue and root dentin may harbor microorganisms and toxins. A detailed description of the complex microbiology of endodontic infections lies beyond the scope of this review, this issue recently has been reviewed by Ørstavik & Pitt Ford, Dahlen & Haapasalo, Spa̦ningberg & Haapasalo and others. 30

OUTCOMES OF RETREATMENT

Weine et al. and Glickman & Dumsha have described the potential iatrogenic damage that can occur to roots during preparation with conventional steel instruments and included several distinct preparation errors: 31

Fracture of retreated teeth

One of the most common unwanted outcomes of retreatment of teeth in endodontics is fracture of the tooth. This is due to excessive thinning of the dentin due to secondary root canal preparation. Moreover there is lack of support at the crown portion and root portion making the root canal treated teeth vulnerable to fracture. 32

Zip

The tendency of the instrument to straighten inside a curved root canal causes root canal zipping. As a result, the canal on the outer side of the curve is over-sized, while the inner side of the curvature at the apical end point is under-prepared. The root canal's primary axis is moved, causing it to diverge from its original path. As a result, this form of uneven flaw is often referred to as straightening, deviation, or transportation. To characterise the resulting shape of the entire apical section of the root canal, the terms "teardrop" and "hour-glass shape" are used interchangeably. 33

Elbow

An ‘elbow’ is a narrow section of the root canal at the point of maximal curvature as a result of the uneven expansion that occurs coronally along the inner aspect and apically along the outer aspect of the curve. It is connected with zipping. Cleaning and filling the apical section of the root canal may be hampered by the irregular conicity and insufficient taper and flow associated with elbow. 34

Ledging

Ledging of the root canal can occur as a result of using inflexible instruments with a sharp, inflexible cutting edge, especially when rotating the instrument. The ledge will appear as a platform on the curvature's outer side, and it may be difficult to avoid because it is frequently accompanied with apical root canal occlusion. The degree of curvature and instrument design were linked to the prevalence of ledges. 35

Perforation

When inflexible devices with a sharp cutting edge are employed in a circular motion, perforations of the root canal might occur (Fig. 8). Perforations are difficult to close and are linked to the breakdown of the root cementum as well as irritation and/or infection of the periodontal ligament. Perforations have been shown to occur anywhere between 2.5 and 10% of the time in both clinical and experimental trials. A subsequent clinical problem with perforations is that if access to the original root canal apically of the perforation cannot be regained, a portion of the original root canal will remain un- or underprepared. 36

Stripper perforation
Over-preparation and straightening along the inner aspect of the root canal curvature causes strip perforations. These midroot holes, which are difficult to close, are linked to the breakdown of the root cementum and irritation of the periodontal ligament. Because the radicular barriers to the furcal aspect of roots are generally quite thin, they are referred to as "risk zones."

Outerwidening

The term "outer widening" was used by Bryant et al. to indicate an over-preparation and straightening along the curve's outer edge without displacing the apical foramen. Until date, this effect was only discovered after the creation of mimicked canals in resin blocks.

Apical occlusion

Apical root canal blockage is caused by tissue or debris packing and resulting in a reduction of working length and root canal patency. As a result, thorough cleaning of the root canal system's most apical portion is difficult.

Damage to the apical foramen

The apical foramen can be displaced and enlarged as a result of inaccurate working length determination, straightening of curved root canals, over-extension, and over-preparation. As a result of the removal of an apical stop, irritation of the periradicular tissues by extruded irrigants or filling materials may develop. The clinical implications of this event are discussed in another section of this issue. In addition to these 'classical' preparation mistakes, the literature has addressed insufficient taper (conicity) and flow, as well as under- or over-preparation, and over- and underextension.

Criteria for assessment of the quality of retreatment

Several parameters, particularly their cleanliness, are of particular importance for measuring the quality of root canal preparation created by tools and procedures. The evidence on the usefulness of manual and/or rotary equipment is contradictory, and no definitive conclusions can be formed. Major flaws in studies on root canal preparation quality include:

While hand instruments are already accessible and have been used for than a century, no clear method of use has emerged as the gold standard. The Balanced Force Technique, on the other hand, can be used as a gold standard in ex vivo and clinical trials.

Only a few rotary systems or rotary procedures are explored and contrasted in the majority of experimental investigations reported in the literature. Only a few research compare four, six, or even more devices and procedures.

Very few of the factors were explored in the bulk of these published research, providing only limited conclusions on a specific device, instrument, or approach. The majority of studies continue to focus on preparation shape in a longitudinal plane, whereas cleaning ability investigations are few. This is most likely due to the difficulty of performing both cleaning and shaping investigations. A wide variety of experimental designs and methodological considerations as well as evaluation criteria does not allow a comparison of the results of different studies even when performed with the same device or technique.

Many articles lack appropriate information on sample composition, operator experience and training, calibration prior to evaluation, such as photographs or electron micrographs, and the results' repeatability (inter- and intra-examiner agreement).

It has been criticised because in many trials, investigator-modified preparation techniques have been implemented and evaluated rather than the manufacturer-recommended preparation protocol. This could lead to ineffective instrument and technique utilisation, as well as erroneous data and conclusions.

OUTCOMES OF ENDODONTIC SURGERY

Postoperative Outcomes
The postoperative period of endodontic surgery should be as short as possible in order to allow for periapical area healing. Following a surgical procedure, some discomfort, such as swelling, soreness, discoloration of the soft tissues, and bleeding, may occur.

Some research have reported on the most prevalent symptoms that may develop during endodontic surgery, as well as how to treat them. It is critical to remember that the patient plays the most significant part in postoperative care; they must be informed about the treatment and follow the surgeon's instructions for a smooth recovery.33

### Swelling

Swelling is a well-known postoperative symptom that has been extensively studied with endodontic surgical procedures. The dental faculty of the Royal College of Surgeons (Eng) recommends using an ice pack for 4-6 hours after surgery to reduce edema. There is currently no data to see if this has any effect on postoperative pain, however Chong & Pitt Ford (2005) found that non-prescription analgesia offered satisfactory alleviation in symptoms following endodontic surgery in two treatment groups with different root-end filling materials.23 Pain was felt early in the postoperative phase and decreased in intensity over time, according to this study. Swelling has a similar outcome: it is worse 24-48 hours after surgery, and the author recommends using an ice pack for 20 minutes every hour during the day on the day of operation. There is also evidence that patients with poor dental hygiene and smokers have more acute pain and edema.24

### Pain

Endodontic surgery normally causes only minor discomfort. If there is any discomfort, it is just for a brief time and peaks on the day after operation. Iqbal et al. (2007) used a self-assessment questionnaire to collect data from 199 individuals undergoing surgery. Pain and edema were shown to be substantially associated with females and younger patients (p<0.05). On the first day after surgery, patients complained of excruciating pain and edema. The prevalence of increased discomfort and swelling was linked to anterior maxillary operations. The majority of patients (67%) found surgical endodontics to be more pleasant than predicted, with less symptomatology (46%) or the same (38%) as non-surgical treatment.25

The findings also reveal that patients have negative views regarding periodontic surgery and have insufficient information about it. The first postoperative day usually sees a large reduction in pain, followed by a consistent, increasing decrease in discomfort each day after that. According to certain studies, only a small percentage of individuals have pain that cannot be managed with modest analgesics. Analgesic therapy should be started before to surgery since it is easier to avoid pain than it is to eliminate it.28
Figure 1: Postoperative symptoms after endodontic surgery present in the articles included in this review

According to Gutmann et al. (2005), non-opioid (non narcotic) analgesics are recommended, with the first dosage timed so that the chosen analgesic reaches peak blood levels before the local anaesthetic wears off. For peri radicular surgery, for example, 500-600 mg of acetaminophen or 800 mg of ibuprofen are administered orally just prior to injection of lidocaine with vasoconstrictor. Some research suggested using acetaminophen (1000 mg) and ibuprofen (600 mg) together.30

Antibiotic prophylaxis for endodontic surgery is not suggested because post-surgical infections after surgical endodontic operations are extremely infrequent. When infection occurs, it may be caused by non-oral microorganisms as a result of poor aseptic surgical techniques, or by bacterial penetration of the surgical site as a result of poor re-approximation and stabilisation of elevated and reflected tissues, resulting in a continuous influx of oral microorganisms that overwhelm the tissues' defensive mechanisms.31

Infection

If an infection does occur, indications and symptoms include increased and worsening swelling and discomfort, which may or may not be linked with suppuration, fever, and lymphadenopathy 36-48 hours following the treatment. Antibiotic medication is started as soon as possible, and the patient is closely watched to ensure that the antibiotic used is effective. Penicilllnase-resistant antibiotics, extended-spectrum antibiotics such ampicillin and amoxicillin, cephalosporins, azithromycin, clarithromycin, or clindamycin, or a combination of the above, are commonly used. However, there is no scientific evidence to back up the choice of these antibiotics for treatment.32

The use of chlorhexidine gluconate as a preventative strategy is recommended not only before surgery but also afterward to minimise the amount of pathogenic bacteria in the oral cavity. Chlorhexidine is indicated for use twice daily for one minute around the surgical site while discussing endodontic surgery performed in the contemporary day. It is particularly advised at the surgical site, when tooth brushing is often impossible, and chlorhexidine gluconate mouthwashes have been shown to inhibit the production of dental plaque.33

During the 6-8 hours following endodontic surgery, when rest and intermittent administration of cold compresses are required, patients should limit their activity. Patients can normally return to work the next day after surgery, but those in physically demanding jobs should rest for two days. Patients who are medically fragile or who are elderly may need to curtail their activities for longer periods of time. In endodontic surgery, the removal of sutures is especially important because their extended presence has been linked to a ‘wicking’ effect.34

In one experiment, rabbits were separated into three groups and a mucoperiosteal flap was raised and subsequently adjusted. Sutures were removed after three, five, and seven days, and the researchers found enough variations between the groups to suggest that sutures be removed after five days. Other studies have strongly contradicted this, stating that sutures should be removed after 48 hours but not allowed to remain after 96 hours. Eliyas et al. (2014) recommend removing surgical sutures after only three days in microsurgical procedures.35

HEALING OUTCOME

After endodontic surgery, repair is defined as the absence of bone defect and symptomatology, and should be evaluated clinically and radiographically with a one-year follow-up. Pain, sinus tract, swelling, apico-marginal communication, and tenderness to palpation or percussion are all signs and symptoms of clinical healing. Complete healing, incomplete healing (“scar tissue formation”), uncertain healing (partial resolution of postsurgical radiolucency), and unsatisfactory healing are the four standard radiographic healing classes (no change or an increase in postsurgical radiolucency).36

This categorization is based on groundbreaking research that compared radiographic findings with histopathologic results of periapical tissues from teeth that had to be extracted following apical surgery. In terms of healing result, specific clinical and radiographic healing criteria should be used to classify healing. Cases should be followed up on at least a yearlong basis until a conclusive diagnosis (success or failure) can be made. It has been demonstrated that 95-97 percent of instances categorised as successful at the one-year control maintain successful over time (5 years). In general, re-surgery cases and teeth with mixed endodontic and periodontal diseases have worse success rates.37
The rationale for apical surgery must be carefully balanced against extraction and implant/prosthodontic rehabilitation for both situations. In their comprehensive review, Torabinejad et al. (2009) found a statistically significant decline in success with each increasing follow-up period for endodontic surgery studies. Endodontic surgery weighted success was 77.8% during the first 2-4 years, 71.8 percent for the next 4-6 years, and 62.9 percent for the next 6+ years. In terms of nonsurgical retreatment success rates, there was a statistically significant increase in weighted success from 2-4 years (70.9%) to 4-6 years (70.9%).

Torabinejad et al. (2009) found a statistically significant decline in success with each increasing follow-up interval for endodontic surgery studies in their systematic review. Endodontic surgery weighted success was 77.8% during the first 2-4 years, 71.8 percent for the next 4-6 years, and 62.9 percent for the next 6+ years. In terms of nonsurgical retreatment success rates, there was a statistically significant increase in weighted success from 2-4 years (70.9%) to 4-6 years (83.0%). Frank et al. (1992) reported surgical outcomes from a group that demonstrated healing at a near-recall but failed 43% when the recall was extended beyond 10 years.

A literature review covering clinical studies related to endodontic surgery was published by Mead et al. (2005). According to them, the search yielded 79 clinical studies. There was no study at the highest level of evidence among these, and the vast majority of the literature is low-level case series.

Rapp et al. (1991) performed a radiographic analysis of apicectomies in 424 patients after five years of surgery and found success in 65 percent of cases, as Rapp et al. (1991) performed a radiographic analysis of apicectomies in 424 patients after five years of surgery and found success in 65 percent of cases.

Molven et al. (1996) found that one instance was totally fixed, one failed, and 22 remained in the same repair group with a reduction in bone defect in their research of 24 patients. In addition, Kim et al. (2008) found that apicectomized teeth with combined endodontic-periodontal lesions had a 77.5 percent successful outcome, compared to 95.2 percent for teeth with isolated endodontic lesions.

<table>
<thead>
<tr>
<th>Author</th>
<th>Follow-up time (year)</th>
<th>Healing outcome after endodontic surgery</th>
<th>Success rate (%)</th>
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<tr>
<td>Penarrocha et al.</td>
<td>1 year</td>
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<td>Kim et al. (2008)</td>
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<td>77.5%</td>
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<td>Torabinejad et al.</td>
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<tr>
<td>Penarrocha et al.</td>
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<td>Torabinejad et al.</td>
<td>4-6 years</td>
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<td>Rapp et al. (1991)</td>
<td>5 years</td>
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<td>65%</td>
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<td>Wesson &amp; Gale (2003)</td>
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<td>Torabinejad et al.</td>
<td>+6 years</td>
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<td>62.9%</td>
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Figure 2: Correlation between follow-up period and endodontic surgery success rates presents in the articles included in this review

II. CONCLUSION

Based on this review, it appears that endodontic surgery has a better initial success rate, while nonsurgical retreatment has a better long-term success rate. After a root canal treatment fails, clinicians are frequently faced with a variety of options. In today's world, patients prefer to keep their natural teeth, so non-surgical retreatment should be the preferred treatment. The latest generation of endodontic instruments, magnification, materials, and technology, combined with the fundamental principles of endodontic retreatment, have aided in the preservation of the patient's natural tooth structure in terms of form and function. In clogged, calcified, or nonnegotiable canals, a surgical technique can be used. If conventional endodontic retreatment is not possible or is linked with
dangers, endodontic surgery has become the standard of therapy for dental maintenance. However, depending on
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