

Review Article

Endodontic Surgery: A Review of Postoperative and Healing Outcome

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The purpose of this review was to give the reader an update about the postoperative period and healing outcome after surgical endodontic retreatment. Endodontic surgery has become a standard of care for dental maintenance if conventional endodontic retreatment is not able to eliminate the infection, it is important to know how to manage the post-surgical care; due it might directly interfere in the healing outcome after the surgical procedure. Based on the results of the present review, the postoperative period after the surgery treatment is very mild, without any complications, being similar to any dental surgical discomfort, as swelling, bleeding and pain, which could be easily controlled with simple medicine. Regarding the repair after endodontic surgery, the length of follow-up time and the healing evaluation criteria affect the outcome, and 1-year follow-up periods might be insufficient to predict a long-term healing.

Keywords: Apicoectomy; Endodontics; Postoperative Care; Postoperative Period; Wound Healing

Introduction

Initial root canal therapy has been shown to be a predictable procedure with a high degree of success [1-4], although, failures can occur after treatment. Some publications reported failure rates of 14%-16% for initial root canal treatment [1,5]. Lack of healing is attributed to persistent intraradicular infection residing in previously uninstrumented canals, dentinal tubules, or in the complex irregularities of the root canal system [6-9].

Typically, when conventional root canal treatment fails in clinical situations, the preferred subsequent option in most cases is non-surgical retreatment. However, in some instances, other factors, such as a complex root canal system or previous accidents, may interfere with the success of non-surgical retreatment. In such cases, periradicular surgery is the treatment of choice in order to save the tooth [10].

Periradicular belongs to the field of endodontic surgery, and its aims to solve a periapical inflammatory process by surgical access followed by lesion enucleation and root filling. In order to preserve the dental element, in these cases, apicectomy is considered one of the best options [11]. Furthermore, the main objective of an endodontic surgery is to surgically maintain a tooth that has an endodontic lesion which cannot be resolved by non-surgical retreatment [12].

Regarding the success of endodontic surgery, it depends on the condition of the tooth. The prognosis of periradicular surgery is directly affected by the existing bone portion attached to the root framework. It is therefore important to know that the likelihood of success depends on the condition of the dental element [13].

The postoperative period of an endodontic surgery should occur as optimally as possible, so that repair of the periapical region could happen. As a surgical procedure, some discomfort may occur after the surgery, as swelling, pain, discoloration of the soft tissues and

bleeding. The post-surgical management of the patient is important as the surgical management of the patient. Patients who do not receive adequate post-surgical instructions or who ignore these instructions are predisposed to untoward sequelae [14].

This literature review aims to give the reader an update about the postoperative period and healing outcome after a surgical endodontic treatment. The present paper is divided into three sections: Endodontic surgery definition and its indication, postoperative management and healing outcome.

Review**Endodontic Surgery: Definition and its Indication**

If conservative therapy does not lead to healing after a reasonable follow-up, this failure indicates that the periapical lesion remained unchanged because the canal was not adequately treated and filled. If periapical pathology persists and/or treatment through the orthograde route is impracticable or exhausted, the endodontic surgery is indicated [15].

Endodontic surgery has become a standard of care for dental maintenance if conventional endodontic retreatment is not feasible or associated with risks. However, in certain situations, the outcome of endodontic surgery may be compromised or uncertain due to the extent or location of periapical or periradicular lesions [16].

The first endodontic surgery report was performed by Farrar & Brophy (1880) [17,18] who made the apicectomy (root resection) in the United States. Since then, his technique has been refined and this procedure has been practiced by both the general dentist and the special tyone [19,20].

Torabinejad et al. (1995) [15] report that if conservative therapy does not lead to healing after a reasonable follow-up, this failure indicates that the periapical lesion remained unchanged because the root canal was not adequately treated and filled. If periapical

pathology persists and/or treatment through the orthograde route is impracticable or exhausted, endodontic surgery is indicated [15].

The work done by El Swiah and Walter (1996) [21] evaluated the clinical factors involved in the decision to perform an apicectomy, they concluded that a sum of technical and biological factors lead to 60% of apicectomies. The most common biological factors are: persistent symptoms, continuous presence of root lesions and persistent exudate (2%). Therefore, these factors must be taken into consideration when indicating the case for surgery [21].

Nishiyama et al. (2002) [22] state that parentodontic surgery (belongs to the field of endodontic surgery) is indicated when signs and/or symptoms remain after all possibilities of solution by endodontic treatments have been exhausted. The promotion of tissue repair through the elimination of the periapical pathological process is the goal of this surgery.

Von Arx (2011) [16] concluded that the evaluation of a case referred for apical surgery must always include a careful weighing of the advantages and disadvantages of surgical and non-surgical intervention. The indication for apical surgery must be based on a careful and thorough clinical and radiographic examination [16].

The endodontic surgery indications were recently updated by the European Society of Endodontics (ESE) (2006) [23] and include the following:

1. Radiological findings of apical periodontitis and/or symptoms associated with an obstructed canal (obstruction proved not to be removable, displacement did not seem feasible, or the risk of damage was very large).
2. Extruded material with clinical or radiological findings of apical periodontitis and/or persistent symptoms over a prolonged period.
3. Persistent or emerging disease after root canal treatment when root canal retreatment is inadequate.
4. Perforation of the root or pulp chamber floor, where treatment by the pulp cavity is impossible.

Kim and Kratchman (2006) [24] argue that a surgical approach is more conservative than a non-surgical treatment for certain cases. A common example is a tooth with acceptable endodontics and a new restoration with root retainer and crown, but a persistent or enlarged periapical lesion. Breaking or disassembling the crown, removing the retainer and retracting the channels would be more dramatic, longer, more expensive and less predictable than a root microsurgical approach. The indications for endodontic surgery in the articles included in this review are shown in Table 1.

There are not many contraindications for endodontic surgery in the literature, they were updated by Chong & Rhodes (2014) [25] and divided into general and local factors as the following:

General

1. Patient factors including psychological considerations and systemic disease for example, bleeding dyscrasias.
2. Clinician factors including the training, skill and experience of the operator, availability of equipment and facilities.

Table 1: Indications for endodontic surgery present in the articles included in this review.

Author	Indications for Endodontic Surgery
Torabinejad <i>et al.</i> (1995)	Periapical pathology persists and /or treatment through the orthograde route is impracticable or exhausted.
El Swiah and Walter (1996)	The most common biological factors are: persistent symptoms, continuous presence of root lesions and persistent exudate (2%).
Nishiyama <i>et al.</i> (2002)	Indicated when signs and /or symptoms remain after all possibilities of solution by endodontic treatments have been exhausted.
Von Arx (2011)	Apical surgery must be based on a careful and thorough clinical and radiographic examination.
European Society of Endodontics (ESE) (2006)	Radiological findings of apical periodontitis and/or symptoms associated with an obstructed canal; Extruded material with clinical or radiological findings of apical periodontitis and /or persistent symptoms over a prolonged period; Persistent or emerging disease after, root canal treatment when root canal retreatment is inadequate; Perforation of the root or pulp chamber floor, where treatment by the pulp cavity is impossible.
Kim and Kratchman (2006)	Tooth with acceptable endodontics and a new restoration with root retainer and crown, but a persistent or enlarged periapical lesion

Local

1. Dental factors including restorability of the tooth, root length, periodontal support and the patient's oral hygiene status.
2. Anatomical factors including the proximity of neurovascular structures. For example, the inferior alveolar and mental nerves may be at risk with surgery of mandibular molars and premolars; similarly, the palatal neurovascular bundle with a palatal flap.

3. Surgical access factors. For example, the ability of a patient to open their mouth wide, which will affect the operator's ability to easily see and access the surgical site. In the posterior region of the mandible the extended width of the external oblique ridge, when combined with linguallly-placed root apices of molar teeth, may complicate visibility and access. Another example is the presence of a large bony exostosis, which may make incision and reflection of a flap considerably more difficult.

Postoperative Management

The postoperative period of an endodontic surgery should occur as optimally as possible, so that repair of the periapical region could happen. As a surgical procedure, some discomfort may occur after the surgery, as swelling, pain, discoloration of the soft tissues and bleeding.

There are some studies which report the most common symptoms that may occur after the endodontic surgery and how to deal with them. It is important to consider, the main role of the patient in the postoperative care, they need to be informed about the procedure, and follow correctly the surgeon's instruction for a postoperative period without any complications.

Swelling is a well-recognized postoperative manifestation and has been thoroughly investigated with endodontic surgical procedures [26-28]. The Royal College of Surgeons (Eng) dental faculty suggests that application of an ice pack 4-6 hours post-surgery minimizes postoperative swelling [29]. Currently, no data exists to study whether this has any significant impact in postoperative pain, but the findings of Chong & Pitt Ford (2005) [30] were that non-prescription analgesia

Table 2: Postoperative symptoms after endodontic surgery present in the articles included in this review.

Author	Postoperative symptoms
Penarrocha <i>et al.</i> (2006)	Swelling is a well-recognized postoperative symptom
Garcia <i>et al.</i> (2007)	Swelling as the first postoperative symptom
Kvist & Reit (2000)	Swelling is the main postoperative symptom
Chong & Pitt Ford (2005)	Pain was experienced early in the postoperative period and decreased in intensity with time
Rhodes JS (2005)	Swelling is worst 24-48 hours post-surgery
Iqbal <i>et al.</i> (2007)	Extreme pain and swelling were reported on the first day after surgery
Seymour <i>et al.</i> (1986)	Pain usually occurs on the first postoperative day. Followed by a steady, progressive decrease in discomfort each succeeding day
Seymour & Rawlins (1982)	Intensive pain, not controlled by mild analgesics
Seymour (1984)	Intensive pain, not controlled by mild analgesics
Von Graffenried <i>et al.</i> (1980)	Intensive pain, not controlled by mild analgesics

provided adequate relief in symptoms following endodontic surgery in two treatment groups who received different root-end filling materials [30]. This study also concluded that pain was experienced early in the postoperative period and decreased in intensity with time. A similar outcome is proposed for swelling: that this is worst 24-48 hours post-surgery, and the author suggests the application of an ice pack for 20 minutes in each hour throughout the day during the day of surgery [31]. There is also evidence to suggest that pain and swelling is more severe in patient with poor oral hygiene and those that smoke [27].

Moreover, the pain following an endodontic surgery is usually minimal. The pain, if any, is of short duration and reaches its maximum intensity on the day of surgery.

Iqbal *et al.* (2007) [32] reported data from 199 patients undergoing surgery through a self-assessment questionnaire. The results showed that pain and edema were significantly related to females and younger patients ($p < 0.05$). Extreme pain and swelling were reported on the first day after surgery. Anterior maxillary surgeries were related to the presence of more pain and swelling. Most patients (67%) rated surgical endodontics more pleasant than expected with less symptomatology (46%) or the same (38%) than non-surgical treatment. The results also show that patients generally have negative feelings and limited knowledge about parentodontic surgery [32].

A significant reduction in pain usually occurs on the first postoperative day, followed by a steady, progressive decrease in discomfort each succeeding day [33]. Some articles shows that just a few patients experience pain that cannot be controlled it by mild analgesics [33-36]. As it is easier to prevent pain than to eliminate pain, analgesic therapy should be initiated prior to surgery [14].

The postoperative symptoms after endodontic surgery in the articles included in this review are shown (Table 2).

According to Gutmann *et al.* (2005) [14] the medication therapy recommended are non-opioid (non narcotic) analgesics with the initial dosage timed, so, that the selected analgesic is approaching peak blood levels before the local anesthesia has worn off. For

Table 3: Correlation between follow-up period and endodontic surgery success rates presents in the articles included in this review.

Author	Follow-up time (year)	Healing outcome after endodontic surgery Success rate (%)
Penarrocha <i>et al.</i> (2007)	1 year	73.9%
Kim <i>et al.</i> (2008)	2 years	77.5%
Torabinejad <i>et al.</i> (2009)	2-4 years	77.8%
Penarrocha <i>et al.</i> (2007)	2-4 years	71.77%
Torabinejad <i>et al.</i> (2009)	4-6 years	71.8%
Rapp <i>et al.</i> (1991)	5 years	65%
Wesson & Gale (2003)	5 years	57%
Torabinejad <i>et al.</i> (2009)	+6 years	62.9%

example, 500-600 mg of acetaminophen, or 800 mg of ibuprofen are given orally just prior to injection of lidocaine with vasoconstrictor for peri radicular surgery [14]. Some studies indicated the use of both acetaminophen (1000 mg) and ibuprofen (600 mg) in combination to eliminate or minimize pain [37].

The use of an antibiotic prophylaxis is not recommended for endodontic surgery, because the post-surgical infections following surgical endodontic procedures are very rare. When the infection occur it may result from non-oral microorganisms, as a result of in adequate aseptic surgical techniques, or from bacterial penetration of the surgical site because of poor re-approximation and stabilization of elevated and reflected tissues, which can result in a continuous influx of oral microorganisms that overwhelm the tissues' defensive mechanisms [14]. If an infection should develop, signs and symptoms of infection are usually present 36-48 hr after the procedure and include increased and progressive swelling and pain, which may or may not be associated with suppuration, fever, and lymphadenopathy [38]. Antibiotic therapy is initiated promptly and the patient is monitored to ensure the selected antibiotic is effective. There is a tendency to use penicillinase-resistant drugs, extended spectrum drugs such as ampicillin and amoxicillin, cephalosporins, azithromycin, clarithromycin or clindamycin, or some combination of the above. However, there is no scientific evidence available to support the choice of these drugs for the antibiotic therapy following surgical endodontic intervention [14].

As a preventative measure, the use of chlorhexidine gluconate is indicated not just for preoperatively, but during the post-surgical care, as a way to reduce the number of pathogenic microorganisms in the oral cavity.

When discussed in relation to endodontic surgery performed in the modern day, it is recommended Chlorhexidine for use twice daily for one minute, around the surgical site [39]. Its use is recommended particularly at the surgical site, as tooth brushing is often not possible, and chlorhexidine gluconate mouthwashes do demonstrate evidence to suppress the formation of dental plaque [40].

The patient restriction of activity is recommended during the 6-8 hr following endodontic surgery, when rest and the intermittent application of ice compresses are necessary. Patients can usually return to work the day following surgery, but those in strenuous occupations should limit their activity for 2 days. Medically compromised and

geriatric patients may require longer periods of activity restriction [14].

The removal of sutures in endodontic surgery can carry particular importance as their prolonged presence has been associated with a 'wicking' effect' [29,41]. One animal study divided rabbits into three groups, raised a mucoperiosteal flap and then repositioned this. Sutures were removed at three, five and seven days, and the investigators demonstrated significant differences between the groups to recommend the removal of sutures after five days [42]. This has been strongly refuted by other studies, which suggest sutures may be removed after 48 hours, but should not be allowed to remain post-96 hours [43-46]. In microsurgical procedures, Eliyas et al. (2014) [47] advise the removal of surgical sutures after only three days [47].

Healing Outcome

Repair is the absence of bone defect and symptomatology after the endodontic surgery, and should be assessed clinically and radiographically, with follow up atleast of one year.

Clinical healing is based on the absence of signs and symptoms such as pain, sinus tract, swelling, apico-marginal communication, and tenderness to palpation or percussion. Standard radiographic healing classes include complete healing, incomplete healing ("scar tissue formation"), uncertain healing (partial resolution of postsurgical radiolucency), and unsatisfactory healing (no change or an increase in postsurgical radiolucency). This classification is based on landmark studies that have compared radiographic findings with histopathologic results of periapical tissues of teeth that had to be extracted after apical surgery [48,49].

Regarding to healing outcome, the classification of healing should be based on defined clinical and radiographic healing criteria. Cases should be monitored at yearly intervals until a final diagnosis (success or failure) can be established. It has been shown that 95-97% of cases classified as successful at the 1-year control remain so over the long-term (5 years). Generally, lower success rates have been reported for re-surgery cases, and for teeth with combined endodontic-periodontal lesions. For both problems, the indication to perform apical surgery must be carefully weighed against extraction and implant/prosthetic rehabilitation [16].

Torabinejad et al. (2009) [50] showed in his systematic review a statistically significant decrease in success with each increasing follow-up interval for endodontics surgery studies. The endodontic surgery weighted success for 2-4 years was 77.8%, which declined at 4-6 years to 71.8% and further declined at 6+ years to 62.9%. With respect to the nonsurgical retreatment success rates, a statistically significant increase in weighted success was observed from 2-4 years (70.9%) to 4-6 years (83.0%) [50]. Frank et al (1992) [51] reported surgical outcomes from a population that showed healing at a nearly recall but found that 43% failed when the recall was extended beyond 10 years [51].

Mead et al. (2005) [52] published a literature review for clinical studies related to endodontic surgery. They reported that the search found 79 clinical studies. Among these studies, there was no one at the highest-level of evidence and that the vast majority of literature is low-level case series [52].

Several articles analyzed the healing outcome after endodontic surgery and reported their success rates below, as Rapp et al. (1991) [53] performed a radiographic analysis of apicectomies in 424 patients after five years of surgery and found success in 65% of cases [53].

Molven et al. (1996) [54], in his study with 24 cases, showed that 1 case was completely repaired, 1 failed and 22 remained in the same repair group and characterized by a reduction in bone defect [54]. Also, Kim et al. (2008) [55] reported a successful outcome of 77.5% in apicoectomized teeth with combined endodontic-periodontal lesions, compared to a successful outcome of 95.2% in teeth with isolated endodontic lesions [55].

The correlation between follow-up period and endodontic surgery success rates in the articles included in this review are shown (Table 3).

All these studies indicates that the length of follow-up time and the healing evaluation criteria affect the outcome, and 1-year follow-up periods might be insufficient to predict a long-term healing.

Conclusion

Endodontic surgery has become a standard of care for dental maintenance if conventional endodontic retreatment is not feasible or associated with risks. However, in certain situations, the outcome of endodontic surgery may be compromised or uncertain due to the extent or location of periapical or periradicular lesions [16]. This literature review aimed to update the reader about the surgery endodontic treatment with scientific evidences about the postoperative management and the healing outcome, after the procedure.

The postoperative period after an endodontic surgery, is very mild, without any complications, being similar to any dental surgical discomfort, as swelling, bleeding, and pain, which could be easily controlled with simple medicine. It is also important to consider, the main role of the patient in the postoperative care, they need to be informed about the procedure, and follow correctly the surgeon's instruction, for a better outcome.

Some articles report the symptoms, and the swelling is a well-recognized postoperative manifestation and has been thoroughly investigated with endodontic surgical procedures [26-28]. They suggest the application of an ice pack 4-6 hours post-surgery, to minimize the swelling [29]. Rhodes et al. (2005) [31] states that swelling is worst 24-48 hours post-surgery, and the author suggests the application of an ice pack for 20 minutes in each hour throughout the day during the day of surgery [31]. There is also evidence to suggest that pain and swelling is more severe in patient with poor oral hygiene and those that smoke [27].

Furthermore, the pain following an endodontic surgery is usually minimal. The pain, if any, is of short duration and reaches its maximum intensity on the day of surgery. Chong & Pitt Ford (2005) [30] concluded that pain was experienced early in the postoperative period and decreased in intensity with time [30]. Some articles shows that just a few patients experience pain that cannot be controlled it by mild analgesics [33-36]. As it is easier to prevent pain than to eliminate pain, analgesic therapy should be initiated prior to surgery [14].

Regarding the use of an antibiotic prophylaxis for endodontic surgery, is not recommended, because the post-surgical infections following surgical endodontic procedures are very rare. It will only be used in case of microbial infection, as drug therapy.

Concerning about the healing outcome, there are many factors that can directly and indirectly interfere in the process of bone defect repair, furthermore, the analysis of the results of this search shows that very few high-level studies proved the success and failure rates after an endodontic surgery with relevant clinical and radiography criteria, due several studies had various variables, and different follow-up times, that might reflect in the successful cases rates.

Torabinejad et al. (2009) [50] showed in his systematic review a statistically significant decrease in success with each increasing follow-up interval for endodontics surgery studies. The endodontic surgery weighted success for 2-4 years was 77.8%, which declined at 4-6 years to 71.8% and further declined at 6+ years to 62.9% [50]. Penarrocha et al. (2007) [56] reported a success rate of 73.9% after 12 months of follow-up, and 71,77% success rate after 2-4 years of follow-up [56]. Also, Wesson& Gale (2003) [57] reported a 'complete healing' rate at 5 years of 57% [57].

These data shows a decrease in success rate with each increasing follow-up interval for endodontics surgery, furthermore, the short coming is that they determine success or failure strictly on the basis of radiographic findings. Different observers may not agree with what they see on a radiograph, and the same observer may disagree with himself or herself if asked to reassess the same radiograph later [58]. In addition, radiographic studies can be considered of limited use when radiographic images are not evaluated using standardized angles (custom jigs) along with standardized evaluation criteria [52].

Therefore, based on the results of the present review, the endodontic surgery has become a standard of care for dental maintenance if conventional endodontic retreatment is not able to eliminate the infection. The postoperative period after the surgery treatment is very mild, without any complications, being similar to any dental surgical discomfort, which could be easily controlled with simple medicine. Regarding the repair after endodontic surgery, the length of follow-up time and the healing evaluation criteria affect the outcome, and 1-year follow-up periods might be insufficient to predict a long-term healing.

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