RCS
FACULTY OF DENTAL SURGERY

Guidelines for Surgical Endodontics

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Contents

Introduction

The aetiology of periapical (periradicular) periodontitis is microbial:[1–3] intra-radicular microorganisms induce an inflammatory and immune response within the periradicular tissues, resulting in bone destruction. Contamination of the periradicular tissues by microorganisms and root-filling materials may compromise healing.[4]

The aim of endodontic treatment is to disinfect the pulp space(reducing the microbial load and removing necrotic tissue) followed by sealing this space to prevent recontamination. Success rates of 47–97% for primary orthograde root canal treatment have been reported,[5] with failures more likely to be associated with pre-operative presence of periapical radiolucency, root fillings with voids, root fillings more than 2mm short of the radiographic apex, and unsatisfactory coronal restoration.[6]

Options for the management of these failures can be non-surgical root canal retreatment or surgical endodontics.[7] Non-surgical retreatment may provide a better opportunity to clean the pulp space than a surgical approach.[8] However there are clinical situations when non-surgical root canal retreatment is inappropriate.

A wide range of success rates for surgical endodontics has been reported (44–95%).[9] Systematic reviews comparing the outcome of non-surgical root canal retreatment and surgical endodontics[10,11] reveal that, to date, there have been only two randomised controlled trials.[8,12] The data from this limited evidence suggests that although surgery may offer a more favourable outcome in the short term, non-surgical retreatment offers a more favourable long-term outcome.[10,11]

There have been a number of studies evaluating contemporary microsurgical techniques and more biocompatible filling materials,[13–15] which report more consistent success in healing outcomes (88–96%).

In order to attain a successful outcome, an accurate diagnosis of the aetiology of persistent pathology associated with a root-treated tooth and appropriate treatment planning is, of course, essential.

In these guidelines,surgical endodontics describes a procedure combining root-end resection, apical curettage and root-end filling. Other procedures such as apical curettage or root resection alone, hemisection, intentional replantation, and regenerative procedures, have not been included.

Indications for surgical endodontics[16]

1. Periradicular disease associated with a tooth where iatrogenic or developmental anomalies prevent non-surgical root canal treatment being undertaken.
2. Periradicular disease in a root-filled tooth where non-surgical root canal retreatment cannot be undertaken or has failed, or when it may be detrimental to the retention of the tooth (eg obliterated root canals, teeth with full coverage restorations where conventional access may jeopardise the underlying core, the presence of a post whose removal may carry a high risk of root fracture).
3. Where a biopsy of periradicular tissue is required.
4. Where visualisation of the periradicular tissues and tooth root is required when perforation or root fracture is suspected.
5. Where it may not be expedient to undertake prolonged nonsurgical root canal retreatment because of patient considerations.

Contraindications to surgical endodontics

There are few absolute contraindications to endodontic surgery, however the following should be considered:

1. Patient factors, including the presence of severe systemic disease and psychological considerations.
2. Dental factors including:
   - unusual bony or root configurations
   - lack of surgical access
   - possible involvement of neurovascular structures
   - where the tooth is subsequently unrestorable
   - wherethere is poor supporting tissue
   - poor general oral status.
3. The skill, training, facilities available, and experience of the operator, should also be considered.

Clinical assessment

Extraoral examination

A thorough examination should be undertaken, in particular noting:

- regional lymph nodes
- swelling
- mouth opening.

Intraoral examination

Should include:

- general status of the mouth
- presence of local infection, swelling and sinus tracts
- presence, quantity and quality of restorations, caries and cracks
- quality of any cast restorations (marginal adaption, aesthetics, history of decementation)
- periodontal status, including the presence of isolated increased probing depths
- occlusal relationship – is the tooth a functioning unit or is there potential for function?
- sensibility and percussive testing of the suspected tooth, adjacent teeth and its contra-lateral partner.

Radiological assessment

While a long cone parallel periapical view of the teeth and adjacent structures provides a good diagnostic yield, further information (eg root morphology in multi-rooted teeth, or when perforation by a post is suspected) may be gained by taking additional angled (horizontal/vertical) periapical radiographs.

At least 3mm of the tissues beyond the apex of the roots should be radiographically assessed. If a large periradicular lesion is suspected further radiographs such as a dental pantomogram or occlusal views may be required. If a sinus tract is present then a radiograph should be taken with a gutta-percha cone in place to delineate the tract.

Historical radiographs, if available, provide a longitudinal guide to changes in periradicular status.

The high diagnostic yield of cone beam computed tomography has been described by Patel et al[17] with particular reference to assessment of posterior teeth prior to periapical surgery. The use of dental radiographs should, of course, be in accordance with national regulations[18,19] including knowledge of radiation doses.

Diagnosis

The purpose of careful clinical and radiological evaluation is to provide information about the nature, extent and possible aetiological factors of the disease thus facilitating a differential diagnosis.

Treatment planning

Following diagnosis and discussion of the treatment options and risks, consent should be obtained.[20–22]

Referral

Once it has been agreed that surgical endodontics is required, consideration should be given as to the appropriate setting for treatment. This will be determined by the competence and training of the practitioner and support staff, facilities available and the patient's medical history. If appropriate, referral should be to a suitably trained colleague.[21]

The referring clinician should provide information as to the clinical findings on presentation, medical and dental history and forward any radiographs relevant to the case. An indication of any proposed restorative treatment of the tooth should be given.

The dentist to whom the referral has been made should only provide the treatment requested where this is felt to be appropriate. If this is not the case, there is an obligation on the dentist to discuss the matter, prior to commencing treatment, with the referring practitioner and the patient.[20–22]

Clinical management

Pre-operative medication

Recent systematic reviews indicate that prophylactic administration of oral antimicrobials to prevent systematic disease is not always in the patient's best interest.[23]

Likewise, prophylactic administration to prevent postoperative infection (in patients not requiring prophylactic antibiotics for medical conditions) has not been shown to be beneficial.[24]

The use of chlorhexidine mouth rinses to reduce plaque formation[25] may be beneficial. Systemic non-steroidal anti-inflammatory drug therapy should be considered prior to surgery in order to reduce post-operative pain.[26,27]

Anaesthesia

Where possible, local anaesthesia should be the method of choice.[28] Haemostasis is of benefit at the surgical site, which is more easily achieved when a local anaesthetic containing a vasoconstrictor is used.[29–31]

Magnification

The use and benefits of the dental operating microscope in terms of improved visualisation and control of the surgical site is well documented.[32,33] The impact of magnification devices on the outcome of endodontic surgery had not been demonstrated until recently when Setzer *et al* reported a positive effect of magnification and a microsurgical technique on outcome.[34]

Soft tissue management

Surgical flap design is variable and depends on a number of factors, including:

- access to and size of the periradicular lesion
- periodontal status (including biotype)
- state of coronal tooth structure
- the nature and extent of coronal restorations
- aesthetics
- adjacent anatomical structures.

Relieving incisions should be placed on sound bone. The lack of predictability in determining the size of the periapical lesion, combined with increased incidence of scarring associated with a semilunar flap, precludes its use in endodontic surgery.[35]

It is not desirable to remove bleeding tags of tissue from the exposed bone or periodontal ligament fibres that were severed during tissue reflection as they will facilitate healing.[36]

The raised flap must be protected from damage and desiccation during surgery and retractors should rest on sound bone.

Hard tissue management

Osteotomy

An assessment of the length of the root and its axis should be made to ensure that bone is removed accurately from the desired site. If the cortical bone plate is thin or absent, curettes may be used to expose the apex of the root. Further bone removal should be carried out with a bur in a reverse-air handpiece, cooled by copious sterile saline or sterile water. Steel or tungsten carbide burs produce less heat than diamond burs.

The superficial osteotomy should be performed with a light shaving motion to reduce the heat generated and allow adequate visibility. Sufficient bone is removed to allow adequate access to the root end. A bony lid technique has been advocated for mandibular molar teeth.[37]. A microsurgical technique should be used where appropriate.[34]

Periradicular curettage

The soft tissue in the periradicular region should be removed with curettes to allow adequate visualisation of the root apex. In some cases it may not be possible to remove all the soft tissue around the root-end until the apex has been resected.

The majority of the inflammatory soft tissue should be removed but the peripheral tissues may be reparative in nature and, if other anatomical structures are likely to be violated, then this tissue should be left.[38] Pathological material should, if possible, be sent for histopathological examination.[39]

Root-end resection

Resection of the root should be carried out as close to 90 degrees to the long axis of the tooth as possible to reduce the number of exposed dentinal tubules[40] and to ensure access to all the apical anatomy.

If possible, at least 3mm of root end should be resected with a rotating bur (using saline or water coolant) thus eliminating the majority of anatomical and/or iatrogenic anomalies in the apical third.

The resected root surface should be examined, preferably under magnification with a micro-mirror, to en-

sure that the resection is complete, that the surface is smooth and that there are no cracks in the root, and to check for canal irregularities.[41,42] The application of a neutral, buffered, sterile dye to the root face may help visualisation of cracks as well as the outline of the root.

Root-end preparation

The preparation should be 3mm deep, in the long axis of the tooth and incorporate the whole pulp space morphology. To achieve these objectives root-end preparation is best carried out with an ultrasonically powered tip.[43–47]

In comparison with a bur in a micro-handpiece, the use of ultrasonic tips minimises the amount of bone removed to gain access for root-end preparation, allows a preparation that more readily follows the long axis of the canal, and facilitates debridement of isthmuses. The tips should be used at low power and with a light touch to reduce the risk of root cracking. Root-end preparation should be carried out with sterile saline or water as a coolant.

Consideration should be given to removing the smear layer with EDTA or citric acid, especially if a bur has been used. The root-end cavity should be examined to ensure that the walls are free of debris, including previous root filling materials.

Root-end filling

The root-end preparation should be isolated from fluids, including blood. A suitable haemostatic agent should be placed in the bony crypt[30,31]and the root-end cavity dried.

The root-end filling material should be compacted into the cavity with a small plugger to ensure a dense fill. There should be no excess material on the resected root face.

A biologically compatible material should be used where possible. Mineral trioxide aggregate is an osteo- and cement-inductive material and is associated with a high clinical success rate.[13,48–54] Of the other materials that have been investigated super EBA, glass ionomer,[55] composite resin (with a dentine bonding agent)[56,57] and reinforced zinc oxide-eugenol are also considered suitable. Amalgam is not recommended.[58–61]

There should be careful debridement of the bony crypt to ensure that haemostatic agents, root-end filling material and debris are removed.

Radiographic verification of the quality of the root end filling is appropriate before wound closure.

Closure of the surgical site

The soft tissue flap is re-apposed with sutures, optimum healing being achieved with primary closure. After suturing, the tissues should be compressed with damp gauze for 3–5 minutes. Sutures are removed 48–96 hours post-operatively (providing the wound is stable), when reattachment of the periodontal fibres at the gingival margin has taken place.[62] Sutures left longer than this may become infected by 'wicking',[63] particularly if they are of the multi-filament type. Synthetic monofilament sutures are therefore the preferred choice in order to minimisemicrobial colonisation.

Post-surgical considerations

Post-operative complications should be uncommon.

Post-operative pain

May be controlled with non-narcotic analgesics.[64–66] A long-acting local anaesthetic given at the end of the procedure may also be beneficial. Long-term pain as a result of surgical damage to the peripheral nerves occurs rarely.

Haemorrhage

Must be controlled intra-operatively. Soft tissue bleeding is controlled by haemostatic agents delivered via local anaesthetic, epinephrine pellets, ferric sulphate, electrosurgery and/or with sutures. Bleeding in the bony crypt is also affected by the vasoconstrictor in the local anaesthetic agent and topically applied agents. The latter should be removed from the crypt prior to closure of the surgical site.

Post-operative swelling

Minimised by applying cold compresses with an ice pack for the first 4–6 hours after surgery.[66] Chlorhexi-

dine mouthwashes help to prevent plaque accumulation for the period when tooth brushing is less than optimal.[25]

Ecchymosis

Patients should be informed that bruising may occur, that it is self-limiting and will usually resolve within two weeks of surgery.

Infection

Infection of the soft tissues may result in secondary haemorrhage, cellulitis or local abscess formation. It is best prevented by maintenance of good oral hygiene measures and the use of chlorhexidine mouthwashes immediately pre-operatively and post-operatively. Antimicrobials should be prescribed where signs of systemic involvement are present with pyrexia and regional lymphadenopathy,[68] in combination with surgical drainage if appropriate.

Clear, written post-operative instructions given to the patient, together with telephone communication within 24 hours avoids misunderstandings and allows further supportive care and advice.

Outcomes of surgical endodontic intervention

An initial review appointment is required to remove sutures and assess early healing. Thereafter, regular review appointments should be made to assess healing using criteria based upon clinical and radiological examination.

Radiological examination should be conducted at annual intervals until healing is observed.[69,70] Periapical radiographs should be taken, endeavouring to achieve the same angulation as the pre-operative view to allow accurate comparison.

Outcomes may be classed as successful, incomplete, uncertain and unsuccessful. Outcomes must be defined and quantified to enable audit to establish best practice, as there is a shortage of reliable clinical data. A range of 37–91% has been reported for healing following surgical endodontics.[71]

Successful outcome

Clinical

This is achieved when the presenting symptoms and signs of the disease associated with the tooth have been eliminated.

Radiological

The treated tooth should show a normal periodontal ligament width or a slight increase, not wider than twice the normal periodontal ligament space. The periradicular rarefaction should be eliminated and the lamina dura and osseous pattern should be normal. There should be no root resorption evident.[72]

Clinical criteria cannot be used to determine the amount and type of repair histologically. The aim should be to provide an environment that allows regeneration of the cementum and periodontal ligament over the resected root apex. However, in many cases repair of the tissue takes place with the formation of a fibrous tissue scar.

Incomplete outcome

Clinical

There are no signs and symptoms.

Radiological

There is partial regeneration of the periapical bone. This may be due to the formation of fibrous scar tissue and is often associated with a through and through lesion where both buccal and lingual cortical plates have been perforated by infection or during the surgical procedure.

Uncertain outcome

Clinical

There may be vague symptoms, which may include mild discomfort or a feeling of pressure and fullness around the treated tooth.

Radiological

There is partial regeneration of periapical bone

Unsuccessful outcome

Clinical

The presence of signs and/or symptoms of periradicular disease, including root fracture.

Radiological

There is no regeneration of periapical bone

Should failure occur after surgery then the cause needs to be established prior to a plan of treatment. Further surgical intervention has been associated with a lower success rate (35.7%).[73]

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