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Review Article

Apicoectomy – A review

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ABSTRACT

This review article throws a light on the background of theoretical and clinical aspects of apicoectomy procedure. Apicoectomy is also known as root resection, which means amputation of the apex of the root and is considered as a part of peiradicular surgery. The periradicular surgery is a standard oral surgical procedure which includes surgical treatment of area surrounding root and is done when conventional root canal treatment does not suffice the infection. This procedure includes three important steps to eliminate persistent endodontic pathogens: surgical debridement of pathological periradicular tissue, root-end resection (apicoectomy), and retrograde root canal obturation (root-end filling). There is a plethora of literature on the clinical studies and case reports on apicoectomy procedure; our review adds an imperative segment to this standard protocol used in pediatric endodontics and the objective is to give the reader an acquaintance about apical surgery with latest updates.

1. Introduction

Apical surgery refers to the surgical management of a tooth with a periapical or periradicular lesion that cannot be resolved with an orthograde endodontic approach. Apical surgery is often considered as a last resort to preserve a tooth when conventional endodontic retreatment is not feasible or is associated with therapeutic risks.[1] It is the standard endodontic surgical procedure to maintain a tooth with significant periapical lesion that cannot be treated with conventional endodontic re-treatment. Root-resection, also known as apicoectomy which means amputation of the apex of the root was originated as a treatment for dente-alveolar abscess in early eighties. In the year 1884, Apicectomy procedure was well described and defined by J. Farrar as "a bold act, which removes the entire cause of disease and which will lead to a permanent cure which may not be the best in the end, but the most humane.[2] According to Black, the root-resection technique i.e. amputation of the root apex has been originated as a treatment for "pyorrhoea alveolaris" complicated by a dental abscess in the late years of the 19th century as a valid alternative to a dental extraction. Apicectomy (root resection or root amputation) signifies the removal of the apices of pulpless teeth in which satisfactory root or pulp canal therapy has been performed. This operation is performed to remove known or unknown infection, granulation tissue or cystic areas that involve these teeth; yet retaining the major portion of the roots in situ.[3] Periradicular surgery includes three critical steps to eliminate persistent endodontic pathogens:1) surgical debridement of pathological periradicular tissue, 2) root-end resection (apicoectomy), and 3) retrograde root canal obturation (root-end filling).[4]

2. History

The history of apical surgery is longstanding. The first description of a case in which an alveolar abscess of long standing was treated by incision through the soft tissue and the alveolar plate is that which is described in the Dental Register of 1856-1857 by Prof. White who operated on a 14-year old boy in 1846.Long before the complete excision

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of the end of a root was performed, the operation of entering through the alveolar process with a trephine and a bur in the dental engine and drilling away the diseased area of tissue was well established. This led to the more radical method of completely excising the end of a root and the total amputation of one of the roots of the multi-rooted teeth.[5] The pioneers in the apicoectomy technique started operating without any form of anesthesia and simply applied 95% phenol on the gingiva, and then scraping away the inflamed tissue (dental abscess) until the alveolar bone covering the root end was exposed to the action of trephine and the straight bur.[6]

3. Objectives

The objective of apical surgery is to surgically maintain a tooth that has an endodontic lesion that cannot be resolved by conventional endodontic treatment. This goal should be achieved by root-end resection, root-end cavity preparation, and a bacteria- tight closure of the root-canal system at the cut root end with a retrograde filling.[7]

Table 1: Goals of Apicoectomy

Surgical removal of apical delta (root canal ramifications)
Enhancement of access to apex
Creation of a working surface for retrograde preparation
Facilitate debridement of periapical tissue
Observation of resected root end for presence of vertical fractures

Table 2: Goals of root-end obturation

Removing irritants during root-end cavity preparation
Preventing penetration of microorganisms and their by-products from the root canal into the periapical region
Optimizing conditions for periapical tissue healing including regeneration of attachment apparatus[4]

3.1. Indications

Indications for apical surgery have been recently updated by the ESE (European Society of Endodontology, 2006) and include the following:[8]

1. Radiological findings of apical periodontitis and/or symptoms associated with an obstructed canal (the obstruction proved not to be removable, displacement did not seem feasible or the risk of damage was too great).
2. Extruded material with clinical or radiological findings of apical periodontitis and/or symptoms continuing over a prolonged period.
3. Persisting or emerging disease following root-canal treatment when root canal re-treatment is inappropriate.
4. Perforation of the root or the floor of the pulp chamber and where it is impossible to treat from within the pulp cavity.

Modified indications have been published by Wu et al. (2006). According to Weine, indications for tooth resection are:[9]

1. Severe vertical bone loss involving only one root of multi-rooted teeth
2. Through and through furcation involvement
3. Unfavourable proximity of roots of adjacent teeth
4. Preventing adequate hygiene maintenance in proximal areas
5. Severe root exposure due to dehiscence

3.2. Contraindications

1. Tooth has no function (no antagonist, no strategic importance serving as a pillar for a fixed prosthesis)
2. Tooth cannot be restored, the tooth has inadequate periodontal support, or the tooth has a vertical root fracture.
3. Uncooperative patient or a patient with a compromised medical history for an oral surgical intervention.

3.3. Procedure

3.3.1. Achieving anesthesia

Long acting anesthetic agent such as bupivicaine (Marcaine) should be given to obtain a sustained level of anesthesia beyond the duration of the surgery. Once the regional anesthesia has been achieved, then a local infiltration of lidocaine 1:50,000 epinephrine is injected over the intended flap extent, concentrating the bulk of the infiltration over the surgical site.[10]

The use of 2% lignocaine with 1:80,000 adrenaline for buccal, palatal or lingual infiltrations is considered the gold standard as mentioned by Kim et al. in 1997.[11] Unless contraindicated, it is mandatory to use local anaesthesia with a vasoconstrictor component in order to aid haemostasis and achieve a dry operating field.[12]

3.3.2. Flap design

It is essential that a flap permits a good view of the operation site, and that adequate access for instrumentation can be achieved. There are several types of flap design and each one of them is suited to different clinical situations. Few of the flap used for apical surgery are full buccal/palatal mucoperiosteal flap, sub-marginal mucoperiosteal flap (Luebke-Oschenbein) and Papilla based incision flap.[13] The semilunar flap is no longer recommended in endodontic surgery as the size of the periapical lesion is unpredictable and there is significant scarring associated with this technique.[1,14]

3.3.3. Location of the apex for osteotomy

In some cases, the cortical bone will be thin or the lesion will have perforated the buccal plate, and location of the apex will be straightforward. However, if this is not the case, an assessment of the length and axis of the tooth will have to be made prior to commencing bone removal.[15] A thin plate of cortical bone may be removed with a curette, but in sites where there is a significant amount of bone, a round bur in a slow speed miniature handpiece will be required.[16]

3.3.4. Osteotomy

The osteotomy size should be kept as small as possible but as large as necessary to carry out the surgical treatment. With the use of micro instruments, an osteotomy of 4–5 mm is sufficient to carry out the required instrumentation.[16] Access to the apical area should be obtained using a round bur in a straight slow hand piece with water irrigation. High speed handpieces should be avoided to prevent the development of surgical emphysema unless a high speed dental surgical 45° handpiece is used. The smaller the osteotomy window, the faster would be the healing. For instance, a lesion smaller than 5 mm would take on average 6.4 months, a 6–10 mm size lesion takes 7.25 months and larger than 10 mm requires 11 months to heal. Thus, the osteotomy should be as small as possible, but as large as necessary to accomplish the clinical objective.[10] The soft tissue present in the periradicular region is removed via curettage. The tissue removed from the periapical area should be submitted for histopathological analysis.

3.3.5. Apical resection

Root-end resection is carried out to remove the apical delta and to create sufficient space for placement of the retrograde filling material. It is recommended that 3 mm of apical tissue is removed. This increases the likelihood of removal of apical ramifications and lateral canals.[17]

Apical resection should be done using a fissure bur at 90° or with a bevel not higher than 10° for better access as demonstrated by Thesis et al.[18] Good surgical access is very important when placing the retrograde filling, however, so for this reason, a minimal bevel is often necessary. It should be kept as close to 90 degrees as possible.

3.3.6. Root-end preparation

Root end preparation or a retrograde cavity preparation is done to clean and shape the root tip so to achieve a retrograde cavity with retentive or parallel walls in the long axis of the tooth in order to retain the chosen biocompatible filling material. Also its purpose is to include all the fins and anatomical isthamus and be sufficiently centred in order to maintain adequate wall thickness. The conventional technique of root-end cavity preparation was the use of a small round bur or of an inverted cone bur in an angled micro-handpiece which has limitations with regard to direction and depth of the retrocavity; the development of sonic or ultrasonic driven microtips (retrotips) was a major breakthrough in apical surgery, and has considerably simplified the technique of root-end cavity preparation.[17] Ultrasonic tips are now routinely used for root-end preparation. Micro-handpieces are not the choice of modern day practice. However, access is very difficult, and there is an increased risk of perforation of lingual wall of the root-end cavity with this method.[19] Remaining root-filling material has to be removed, along with any irritants. The cavity must be 3 mm deep and the walls should be parallel to retain the filling material. In comparison with a bur in a micro-handpiece, the use of ultrasonic tips minimizes 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.[20] Haemostasis is mandatory during the surgical procedure in order to maintain a dry surgical site and enhance visibility.[4] It is achieved by applying pressure (gauze packs, bone wax etc.) or starting with the vasoconstrictor in the local anaesthetic and followed by small strips of non-cotton fibre gauze soaked in 1:1000 adrenaline. Other adjunctive coagulants include gelfoam, ferric sulphate etc.

3.3.7. Retrograde filling

The root-end cavity should be examined to ensure that the walls are free of debris, including previous root filling materials. The root-end preparation should be isolated from fluids, including blood. A suitable haemostatic agent should be placed in the bony crypt, and the root end cavity is 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. The objective of retrograde filling is to select a biocompatible material capable of producing a hermetic seal that prevents residual irritants and oral contaminants from exiting the root canal system and entering the periradicular tissues.[21] For root-end filling, a variety of materials have been propagated in the past for the root end filling. Almost every material that was introduced in operative and restorative dentistry as a temporary (Super- EBA, IRM, Cavit, etc.) or permanent (gold, amalgam, resin composite, glass ionomere cement, compomere, etc.) restoration material was sooner or later also utilized in apical surgery.[7]

Amalgam was considered the root-end filling material of choice until the 1990s but is not recommended now. The guidelines as per the Royal College of Surgeons of England state that amalgam is not recommended for this purpose.[22] However, mineral trioxide aggregate (MTA) appears to have become the gold standard as root-end filling

material. It has been suggested that MTA has many of the properties of the ideal root-end filling material.[16] MTA is a powder consisting of fine hydrophilic particles of tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. It also contains small amounts of other mineral oxides, which modify its chemical and physical properties. Bismuth oxide powder has been added to make the aggregate radio-opaque.

Many clinical comparative studies have reported higher success rates for MTA than for any other material, although the differences were not found to be significant.[23] (MTA) have shown to be superior to amalgam in terms of sealability and biocompatibility.[24] It has been shown that MTA allows regeneration of the periradicular tissues rather than repair.[18] In vivo studies have shown that, as a root-end filling material, it has the capacity to induce bone, periodontal ligament and cementum formation.[25] MTA also has potential bactericidal effects due to its release of hydroxyl ions and production of a high pH environment. Another advantage of MTA is its ability to set in the presence of moisture. The powder is mixed with water (3:1 ratio) to form a gel with a pH of 12.5, which solidifies in approximately three to four hours. The MTA is applied using a carrier and condensed endosonically as suggested by Torabinejad et al. A dampened cotton pellet is used to clear the root tip of the excess MTA.[24]

Another promising biocompatible root-end material is BiodentineTM (Septodont),[22] a biocompatible material with a tricalcium silicate core, which has superior handling properties to MTA, and exhibits similar biocompatibility. More long term follow-up studies are still needed in order to establish firmly the qualities of this material. One of the possible drawbacks of Biodentine is its reduced radio-opacity, which makes this material difficult to assess on a post-operative radiograph.[25]

After retrograde filling, a radiograph should be taken to assess the apical restoration at the surgical site prior to the closure of the wound and this post-operative radiograph will act as a reference for assessing future healing.

3.3.8. Suturing / wound closure

Careful examination and rinsing of the surgical flied is done before wound suturing. The flap thus raised is approximated closely and properly with single interrupted sutures, preferably utilizing fine suture material (5-0, 6-0, 7-0). Slight compression with gauze is recommended to bring the periosteal tissue in contact with the bone.[7] Suture materials can be divided in to two groups: resorbable and non-resorbable. Resorbable materials potentially cause irritation in the tissue until they are metabolised or removed. Therefore, in suturing gingival wounds, non-resorbable materials are recommended as the inflammation reaction is less and ceases after the sutures have been removed, provided they are removed within a few days, to prevent epithelial tract formation along the suture line. Sutures are normally removed within 3–5 days after surgery. The prescription of antibiotics has not shown any benefit for immediate postoperative healing.[26,27]

3.3.9. Surgery outcome/ follow up/ healing

Various factors presumably capable of influencing the outcome of apicoectorny have been analyzed in past. Such factors are, for example, age and sex of the patient, tooth group, quality of the orthograde root filling, time of root filling in relation to operation, retrograde root filling, periodontal status, size of the periapical destruction, experience of the oral surgeon, etc The treatment outcome of apical surgery should be assessed clinically and radiographically. From a practical point of view, healing is normally evaluated 1-year postsurgery, although small (<5 mm) periapical defects might heal within a few months. 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.[7] 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.[28] 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.[29]

Guided tissue regeneration (GTR) techniques have also been projected as an adjunct with the intention to promote healing after periapical surgery but are sparsely used in pediatric surgical endodontic procedures.[30] Bernabé et al reported a case of peri-radicular surgery with a combination of MTA and bovine bone graft and a cortical collagen membrane. They suggested that this procedure can be used to save teeth with questionable prognosis and is also favourable for osseous healing. It also aids in the regeneration of bone, periodontal ligament and cementum after periapical surgery.[31] Recently, better methods for surgical root-end cavity preparation, flattening or minimally beveling the apex, carefully handling soft tissue, and thoughtful flap design work concomitantly to facilitate surgery and increase chances for success. Use of magnification, excellent lighting, and use of recently available filling materials found to promote bony healing may all contribute to a lower percentage of surgical failure when performing an apicoectomy.[32]

4. Conclusion

1. Apicoectomy is an expedient surgical procedure for the cases unresponsive of conventional root canal treatment.
2. This periradicular sugery forms an indispensible segment of pediatric endodontics for the management of young permanent and permanent teeth traumatic injuries.
3. This review gives a total insight of apicoectomy procedure from history to contemporary development.

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6. Conflict of Interest

The authors declare that they have no conflict of interest.

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