ROOT CANAL THERAPY BY MEANS OF APICECTOMY

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THE HISTORY OF APICECTOMY

Surgical approaches to the apical tissues for the relief of pain have been known since antiquity, and indeed this was probably the first dental operation to be performed in order to conserve teeth. A mandible found in Egypt from the 4th dynasty, 2900 to 2750 B.C., contains bur-holes that experts consider could only have been made *in vivo* for the relief of an abscess. (Weinberger, 1948). In this early era more stress was laid on transplanting or re-implanting anterior teeth for aesthetic reasons than on the preservation of existing teeth. According to Weinberger a high degree of skill was attained by the pre-Inca tribes of South America who in the second century A.D. transplanted teeth after first removing the apical portion of the roots.

In the second half of the nineteenth century, the concept that pulp extirpation and root filling was a feasible and desirable method of retaining an abscessed tooth began to take hold (Harris, 1863). The common method at that time was to kill any vital pulpal tissue with an arsenical compound, remove the pulpal remnants with hand-made reamers such as the shaped watch spring used by Maynard (1860) and fill the canal with gold or tin foil (Harris, 1863). The concept of an apical seal was introduced by Storer How in 1890. His method of finding the apical constriction and plugging tin strips to that level with a piece of steel wire bears a close resemblance to modern methods. Contemporaneously, apical resection was being performed by such operators as Farrar (1884) and Rhein (1890), but their rationale was suspect if one examines the following statement of the latter author: ‘wherever death of any portion of a tooth has taken place, the simplest cure is to amputate the necrosed portion of the root and the tissue will close firmly about the remaining healthy portion, which will suffice to support the tooth’. The notion that apical resection was a part of root canal therapy and that surgery itself without an apical seal was inadequate (except in very rare cases) did not come until later. About this time the discovery that disease, and in this particular case a dental abscess, was caused by bacteria led to an interest in the sterility of the root canal during root treatment (Greenbaum, 1902).

The advent of X-rays, which were discovered by Roentgen in 1895 and used for dental radiography 14 days later by Dr. Walkhoff according to Ennis and Berry (1959), gave the dental profession one of its most useful endodontic tools. These advances were utilised in the early years of this century when the operation of apicectomy, virtually as we know it today, was performed by Shamberg in 1906.

PRESENT CONCEPTS

Since its inception the object of root canal therapy has been to retain a dead tooth in the mouth with a healthy normal bony support. Modern advances have
led to the simplification of endodontics so that in essence the mechanical procedure is merely the placing of a Black's Class I type filling at the apex of a tooth (Fig. 1). It is the accuracy of the apical seal that is important and not the use of fancy techniques or drugs.

In 1931 the realisation of the mechanical nature of the procedure led Rickert and Dixon to propound the Hollow Tube Theory. A tooth with an absent or dead pulp can be likened to a blind-ended tube within the tissues. The orifice of the tube is too small to allow the ingress of proliferating granulation tissue which leaves a dead space within the lumen of the tube which is an ideal site for the incubation of bacteria remote from the normal body's defence mechanisms. The toxic products formed by the bacteria within the tube (root canal) could leach out and give rise to an inflammatory reaction in the surrounding tissues—the so-called apical granuloma. Endeavouring to prove this theory, Rickert and Dixon (1931) inserted metal tubes into rabbits' tissues and found that macroscopic areas of irritation were formed.

Goldman and Pearson, however, in 1965 refuted the above results by their own experiments using teflon tubes in rats with rods as controls. Their conclusions are as follows: (1) there is an interchange of tissue fluids into and out of the tube, and (2) there is no evidence of an inflammatory response at the open end of the reamed teflon implants (tubes). These results are substantiated by the work of Selye (1959), who studied connective tissue growth in rats by means of tubes, rods and other shaped implants made of glass. It is, however, a well-known fact that an inadequately sealed root canal will lead to irritation, i.e. granuloma formation, and that this process will be reversed if an adequate apical seal is positioned. Further work is clearly necessary to clarify this phenomenon.

Nevertheless, contemporary concepts cannot improve on Storer How's contention made in 1890 that 'it is not essential that more should be done than to tightly seal the foramen with tin for success is then surely secured'. According to Messing (1958), as the apical seal is the important factor in root canal therapy this leads one to the conclusion that the root filling need not completely fill the root canal. In order to supplement this observation the author has placed apical fillings, via the retrograde approach, on otherwise unprepared dead teeth. As expected, these 'root fillings' on follow-up radiographs have proved to be as successful as other forms of endodontic therapy.

Since the success of root canal therapy depends upon the efficiency of the apical seal, logic demands a filling material that is well tolerated by the tissues and will not dissolve in tissue fluids. One of the earliest materials to be employed was gold foil, and Hudson of Philadelphia used this in 1830 for filling root canals. Gold foil and threads of other metals such as tin were used as root fillings throughout the last century, but no real advances were made until experts such as Rickert and Grossman proposed root sealers based on zinc oxide and eugenol which were
usually held in place by means of either gutta-percha or silver points. Copper amalgam has been used for many years, certainly since 1925 when Husband published his article on the use of this material. Husband stated that the use of silver amalgam for root canal filling had been suggested by Dr. Litch as early as 1887, but had not been accepted until later. Since that time many authors have used amalgam usually silver/tin alloy for the purposes of obtaining an apical seal (Herbert, 1941; Messing, 1958; Wolf, 1962; Benson & del-Rio, 1963; Herscovitch, 1963; Nicholls, 1965). The present author uses silver amalgam exclusively when surgically approaching an endodontic problem for the following reasons: tissue tolerance, ease of adaption, slight expansion, efficient seal (Herd, 1968), lack of separate sealer and ease of cutting with a rotary instrument. The methods employed will be described in the relative sections.

**INDICATIONS FOR APICECTOMY**

The presence of an apical cyst is stressed by many authors to be an indication for surgery, however Garber (1964), after reviewing 1000 patients who underwent root canal therapy, concluded that it is impossible to distinguish—when small—between a cyst and an apical granuloma on a radiograph, and also that most cases with periapical lesions respond to conventional root canal therapy. Sommer and Ostrander (1966) stated that 7 per cent. of apical areas on radiographs are cystic, but Bhaskar (1966) found that 42 per cent. of 2308 teeth with periapical lesions were in fact cystic. The present author concedes that virtually all apical granulomata will contain epithelial cells—the cell rests of Malassez—but that in his experience very few of the specimens sectioned post-operatively have been true cysts. The size of an area of radiolucency surrounding the apex of a root is not an indication in itself for surgery, as many large areas treated by conventional root canal therapy resolve after inserting an adequate apical seal (Figs 2, A and B). Since apicectomy is a method of root filling a tooth that would be unsavable by conventional endodontic techniques, the indications for a surgical approach can be considered under the following headings:
Physical Impossibility. The teeth in this group would be impossible to root-fill conventionally because of an anatomical or pathological defect of the root, e.g. dilaceration, fish-tail apical foramen, fractured apex, pathological or iatrogenic lateral perforations or internal resorption. Sclerosis, pulp stones or an hour-glass constriction encountered within the canal would present similar difficulties.

Physically Impracticable. The indications in this section include conditions such as open apices (natural or iatrogenic), the presence of broken instruments within the canal, adequate post crowns or even jacket crowns in situ which render conventional root canal therapy difficult or even impossible.

Inconvenience. It may be inconvenient to perform conventional root canal therapy due to a human factor. For example, the patient may be unable to afford the time for successive dressings before the final apical filling. After surveying the cases treated by their students, Grossman et al. (1964) found that root resection resulted in a 95.8 per cent. success rate, and a corresponding investigation carried out at the Eastman Dental Hospital, London, recently, shows a comparably high incidence of success.

CONTRA-INDICATIONS

Although an apicectomy is a relatively minor procedure it is still a surgical operation and has therefore the same medical contra-indications as any other type of non-vital surgery. Local contra-indications are few, the principal one being uncontrolled periodontal disease particularly when local bone loss has jeopardised support for the tooth. Gross resorption or fractures in the cervical third of the root could lead to inadequate final bony support for the tooth. The proximity of local anatomical structures such as the antrum and mental foramen does not constitute a specific contra-indication, but may well lead to consideration of an alternative line of treatment. Patients with a history of rheumatic fever, chorea, congenital heart disease or a heart murmur need antibiotic prophylaxis for endodontic therapy and so a one-stage surgical approach should be considered preferable. Finally, the dental surgeon should be satisfied that the state of the patient’s mouth justifies a surgical procedure to save the tooth.

PRACTICAL METHODS

Conventional Apicectomy. This method is used when the greater part of the root canal may be negotiated through the usual access cavity to the pulp chamber, but the apical regions of the canal are not readily accessible. A distal curve on the apex of an upper lateral incisor is a case in point (Fig. 3, A). The object is to place a root seal at the apex of the tooth, but in this case the root seal is positioned as far apically as possible and then the root is fashioned so that the new apex is where the root seal terminates. If the patient presents with the tooth in an acutely infected condition then drainage—preferably through the pulp chamber—and, if necessary, antibiotic therapy are instituted before surgery is carried out.
Stage I. The placing of the root seal.

An access cavity in line with the major part of the root canal is created through the palatal or occlusal surface of the tooth. A diagnostic wire X-ray of the tooth is taken using a straight wire, which is passed into the tooth as far as is practicable in a direct line (Fig. 3, B). This radiograph is a useful guide for determining what should be the position of the new apex. The tooth is now reamed to this level so that fresh dentine is removed from the apical portion. Further reaming is continued using another two or three sizes of reamer at a level 2 to 3 mm. coronally from the initial reaming. This provides a step within the root canal to prevent
the apical seal from being dislodged during subsequent manipulations within the canal such as post-crown preparation. A stainless-steel plugger of suitable diameter is custom-made to fit into the reamed canal from orthodontic stainless-steel wire. The plugger is marked in the same way as the reamers. Silver amalgam is prepared and wrung out in the usual manner and increments of amalgam are deposited within the prepared canal using a suitable amalgam carrier such as that described by Hill (1967). The individual increments of amalgam are then condensed within the prepared canal to a length of 4 to 5 mm. (Fig. 3, c). If, during this procedure the canal is ‘wet’ due to serum leakage from the apex, the first increment of amalgam will be ‘contaminated’ with moisture but will be an effective barrier to further leakage. The canal can then be re-dried and amalgam inserted in the normal way. Remember that the moisture-contaminated amalgam will be removed during the surgical procedure. The remainder of the canal should be occluded with dry cotton wool and the access cavity filled with a suitable material.

Stage II. The surgical procedure.

The tooth is now ready for surgery and the author recommends that this should be done immediately after inserting the amalgam filling. A local anaesthetic solution is injected, taking care to block all nervous pathways to the area concerned. For example, an upper lateral incisor would require buccal infiltrations on both sides of the midline, and palatal infiltrations, i.e. one distal to the tooth in order to anaesthetise the greater palatine nerve and one directed into the incisive papilla to block the long sphenopalatine nerve. It is a common experience of most operators that pain is experienced by patients when granulation tissue is curetted, and the author believes that this is almost invariably attributable to inadequate palatal anaesthesia. In the mandibular region blocks are used to anaesthetise the field; for example, the incisors will require a minimum two mental blocks in addition to infiltrations. The surgical approach is via a straight line or semilunar incision placed approximately 5 to 7 mm. from the gingival margin. The length of the incision is designed to provide good access to the apical regions of the tooth; usually its extent is one toothwidth on each side of the tooth to be operated upon. The mucoperiosteal flap is raised with a Howarth’s periosteal elevator. Access to the apical area is gained by using a No. 6 or 7 tapered fissure surgical bur in a straight handpiece using warm, sterile normal saline as a cooling and lubricant agent. The retention of one of the measuring instruments which were used in stage I provides a guide to the position of the apex of the tooth. Once the apex is located it is removed with the tapered fissure bur to a level just coronal to the first increments of amalgam, i.e. contaminated amalgam, with a labial inclination to ensure maximum visibility of the amputated root surface (Fig. 3, d). This root surface is checked both visually and by probing to ensure that amalgam completely occludes the root canal, and it is not necessary to amputate the root to a level of sound bone as was previously taught. Any granulation tissue present is removed with a suitable excavator. The bony cavity is washed out with sterile normal saline to remove residual debris, and a final inspection is undertaken. The mucoperiosteal flap is replaced and sutured using a 3/0 circle 16 mm. eyeless needle with 3/0 braided silk. A post-operative radiograph is taken and the patient dismissed and instructed to use regular hot saline mouth baths after 12 hours.

Suture removal is carried out on the 4th or 5th day. The appointment for the first follow-up radiograph is arranged after an interval of 3 to 6 months (Fig. 3, e).
Retrograde Apicectomy. The retrograde method is indicated when an apical seal has to be placed directly into the prepared apex of a tooth that is inaccessible via the lumen of the root canal. For instance, when a post crown is present or the tooth is grossly dilacerated. The apicectomy is performed when the apical condition is chronic.

Method. Local anaesthesia is administered as suggested previously, and the surgical exposure is obtained by either a semilunar or gingival margin incision.

FIG. 4
E, Completed filling.
so that the flap may be replaced on sound bone. The only danger with the gingival margin flap is that when artificial crowns are in place the post-operative gingival line rarely covers the margins of the crowns. After raising the flap, satisfactory surgical access can be ensured by retaining both the flap and the upper lip in the retractor devised by Hill (1964).

The anatomical apex of the tooth is located and smoothed so that it is angulated towards the labial side, and any granulation tissue curetted (Fig. 4, A). A Black’s Class I type cavity is now prepared within the smoothed portion of the root to include the root canal. A half-round bur in a right-angled handpiece is often the most convenient instrument to use for this cavity, undercutts being prepared on the mesial, distal and palatal or lingual surfaces (Fig. 4, B). Amalgam is prepared and wrung out in the normal way and small increments introduced into the dried cavity with an amalgam gun (Luks, 1956) (Fig. 4, C). Each increment is condensed using a convenient plastic instrument, and it is sensible to remove any excess amalgam with an excavator after each increment has been placed (Fig. 4, D). When the prepared cavity is filled, the bony space is thoroughly washed out with sterile normal saline and the mucoperiosteal flap replaced and sutured into position (Fig. 4, E).

This method of occluding the root canal of otherwise inaccessible roots can be used for eliminating any other defects or connections between the root canal and the periodontal membrane, e.g. a lateral canal. The defect is located, a small cavity prepared, and packed with amalgam to effect a seal.

Through-and-through Apicectomy. This final method is a combination of the two preceding methods and used for cases with an open apex (Fig. 5, A and B). It should be appreciated that no dentine is present against which amalgam could be packed either by the conventional or retrograde approaches, and, therefore, this compromise method has been devised.
Method. The crown of the tooth is opened using a conventional access cavity and a local anaesthetic administered. A flap is raised and the apex of the tooth is located. The internal surface of the root is now reamed and filed to fresh dentine (Fig. 6, A). The apex of the tooth is smoothed to produce a flat surface and undercuts are placed within the lumen of the root canal at the apical end with a small round bur. The open apical end of the root is occluded with a suitable instrument (Messing, 1960), or a plastic instrument of sufficient size to cover the apical opening, and amalgam introduced from the coronal end of the canal with an amalgam gun and condensed from that end as in the conventional method—4 to 5 mm. depth of amalgam is sufficient (Fig. 6, B). The wound is closed after surgical toilet, and the access cavity occluded by a suitable filling material.

![Fig. 6](image)

A, Reaming internal root surface.  
B, Introduction and condensation of amalgam.

COMPLICATIONS

The operation of apicectomy is almost invariably complicated by facial oedema, but pain is usually minimal. Occasionally post-operative haematoma formation occurs and prophylactic antibiotic therapy may be necessary. Haemostasis should be ensured prior to suturing, and in doubtful cases the author places a rubber dam drain in the wound and leaves it in situ for 24 hours. Alternatively, the use of pressure packs can be helpful. Failure of primary union is rare, but in the eventuality of wound breakdown healing by secondary intention should occur satisfactorily provided that the area is kept clean. Tooth mobility may be present post-operatively depending on the amount of bone loss, but usually the tooth becomes firmer as bone regeneration takes place. Rarely patients may complain of tingling in the gingivae of the area some months post-operatively, but full return of normal sensation eventually occurs. After the first radiographic examination, subsequent radiographic checks are taken at yearly or two-yearly intervals.
SUMMARY

The history and current theory of apicectomy is discussed and this is applied to the three methods of performing this operation.

REFERENCES


