Republic of Iraq

Ministry of Higher Education and Scientific Research

University of Baghdad

College of Dentistry

Endodontic Surgery: Apicoectomy

A Project Submitted to the College of Dentistry, University of Baghdad, Department of Restorative & Aesthetic Dentistry in Partial Fulfillment for the Bachelor of Dental Surgery

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B.D.S., M.Sc.

2022 م

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SUPERVISOR CERTIFICATE

This is certify that the project entitled "**Endodontic Surgery: Apicoectomy**" submitted by undergraduate student; Abdulla Ahmed Luttfi fulfillment of the requirements for the award of bachelor of Dental Surgery at University of Baghdad is an authentic work carried out by them under my supervision and guidance.

Date:

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Dedication

To my family, the reason of what I become today. Thanks for your great support and continues care.

To our respected teachers whose efforts and wishes are an inspiration.

Acknowledgements

In the name of Allah the most compassionate and most merciful. I am most grateful to God for the presence of health, patience, guidance, and protection through the duration of this study and achieve this study, which I hope it will be useful and objective.

Deep thank to **Prof. Dr. Raghad A. Al- Hashimi**, the Dean of the College of Dentistry, the University of Baghdad. Also to **Assist. Prof. Dr. Anas F. Mahdee**, the Head of the Restorative and Esthetic Dentistry Department for his kindness and help.

I am gratefully thankful to my supervisor **Assist. Prof. Dr Shatha Abdulkareem**, for her kindness, advice, instructions, valuable unlimited cooperation and continued encouragement throughout work and writing of my study. I have indeed learned a great deal from her.

I would like to present special thanks for teaching staff for their great ethics and to all colleagues and all members of Restorative and Esthetic Dentistry Department for their helpful assistance.

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Chapter One

Introduction

1.1 Introduction:

Root canal treatment is carried out when the pulp is nonvital or has been removed to prevent or treat apical periodontitis **(European Society of Endodontology, 2006).** It has been well established that apical periodontitis is an inflammatory process in the peri-radicular tissues sustained by microorganisms in the necrotic root canal system **(Kakehashi S & Stanley HR, 1966).**

The success of primary root canal treatment is dependent on effective removal of this bacterial load below a critical threshold to allow for healing. Root canal treatment has more than 95% of success rate but it fails if infection remains within the root canal **(Garg & Garg, 2019).**

The biological aim of endodontic treatment is to prevent or resolve apical periodontitis by controlled asepsis or through decontamination of the root canal system so as to create an environment in which periradicular healing can occur **(Tsesis I & Faivishevsky, 2009).**

Surgical endodontic procedures are usually undertaken when conventional (orthograde) endodontics has failed. However, the chances of successful re-treatment of a tooth with a failed root filling are higher when non-surgical endodontics is repeated (wherever possible) because it seeks to eliminate the bacteria from within the root canal system rather than by undertaking a surgical approach which isolate but not eliminate the bacteria from the root canal. Surgical endodontics may therefore not be the first option when conventional root canal treatment fails **(Lin l & chance k, 1985) (Cohen S., 2005).** Endodontic surgery is defined "as removal of tissues other than the contents of root canal to retain a tooth with pulpal or periapical involvement" **(Garg & Garg, 2019).**

The etiology of periapical (periradicular) periodontitis is microbial: intra-radicular microorganisms induce an inflammatory and immune response within the periradicular tissues, resulting in bone destruction **(Evans et al ., 2012).**

Surgical intervention is required for cases where retreatment has failed or is not an option, and the tooth is to be retained rather than extracted **(Garg & Garg, 2014).** After case evaluation, surgical success mainly depends on careful management of hard and soft tissues, complete removal of pathognomic tissues and final sealing of root canal. To check the success of surgical procedure, a radiograph should be exposed following treatment for comparison with future radiographs to assess healing **(Garg & Garg, 2019).**

The first cases of endodontic surgery were those performed by Abulcasis in the 11th century. A root end resection procedure to manage a tooth with a necrotic pulp and an alveolar abscess was documented in 1871 and root end resection with retrograde cavity preparation and filling with amalgam in the 1890s. Endodontic surgery was often considered as an alternative to root canal treatment and indications for surgery were proposed first in the 1930s. Over past decade, periradicular surgery has continued to evolve into a precise, biologically based adjunct to non-surgical root canal therapy. Parallel development of new instruments and materials along with a better understanding of the biology of wound healing, has made surgical treatment a viable alternative to extraction. Periradicular surgery, when indicated, should be considered an extension of nonsurgical treatment because the underlying etiology of the disease process and the objective of treatment are the same: prevention or elimination of apical periodontitis **(Garg & Garg, 2014).**

In these guidelines- , surgical endodontics describes a procedure combining root- end resection, apical curettage and root-end filling **(Evans et al., 2012).**

1.2 Aims and Objectives of Surgical Endodontics

The aim of surgical endodontics is to restore the integrity of the supporting tissues of a tooth or teeth with chronic pulpal or periapical disease, where nonsurgical endodontics has failed and re-treatment cannot be undertaken or is contraindicated **(Pedlar & Frame, 2007).**

Objectives: (Garg & Garg, 2019)

1. Removal of diseased periapical tissue like granuloma, cyst, overfilled material, etc.
2. Root inspection for knowing etiology of endodontic failure, fracture, accessory canals, etc.
3. To provide fluid tight seal at apical end by retrograde preparation and obturation.
4. To eliminate apical ramifications by root resections so as to completely remove the cause of failure for endodontic treatment.

Chapter Two

Review of Literature

2.1 Rationale

Rationale of surgical endodontic is to remove the diseased tissue present in the canal and around the apex, and retrofill the root canal space with biologically inert material so as to achieve a fluid – tight seal **(Garg & Garg, 2019).**

2.2 Definition Apicoectomy

Apical surgery is the standard endodontic surgical procedure to maintain a tooth with significant periapical lesion that cannot be treated with conventional endodontic retreatment. When any non-surgical or conventional endodontic treatment fails, apical surgery or apicoectomy is the procedure which is mostly conducted as retreatment **(Avinash et al ., 2019).**

Apicoectomy is the surgical resection of the root tip of a tooth and its removal together with the pathological periapical tissues. Accessory root canals and additional apical foramina are also removed in this way, which may occur in the periapical area and which may be considered responsible for failure of an endodontic therapy **(Fragiskos, 2007).**

2.3 Indications (Fragiskos, 2007)

The indications for apicoectomy include the following cases:

1. Teeth with active periapical inflammation, despite the presence of a satisfactory endodontic therapy.

2. Teeth with periapical inflammation and unsatisfactory endodontic therapy, which cannot be repeated because of:

- Completely calcified root canal.
- Severely curved root canals.
- Presence of posts or cores in root canal.
- Breakage of small instrument in root canal.

3. Teeth with periapical inflammation, where completion of endodontic therapy is impossible due to:

– Foreign bodies driven into periapical tissues.

– Perforation of root.

– Fracture at apical third of tooth.

– Dental anomalies (dens in dente).

5. Where a biopsy of the peri-radicular tissues is indicated.

In the above cases, if after the apicoectomy the apex has not been completely sealed, then retrograde filling is required, which is described further down. The purpose of retrograde filling is to obstruct the exit of bacteria and the by-products of nonvital pulp, which remained in the root canal **(Fragiskos, 2007).**

2.4 Contraindications (Avinash et al., 2019) (Evans G E, Bishop K, 2014).

Contraindications of apicoectomy include:

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- Fused roots making separation impossible.
4- The tooth has no function (no antagonist, no strategic importance serving as a pillar for a fixed prothesis).
5- Unrestorable tooth.
6- Periodontally compromised tooth.

2.5 Presurgical Considerations

The pre-operative assessment includes a full medical and dental history, extra-oral and intra-oral examinations, and special investigations including radiographs. The full root/s and approximately two to three mm of the periradicular region should be included **(European Society of Endodontology, 2006).**

Information gained from conventional films and digital periapical radiographs is limited by the fact that the three dimensional anatomy of the area is compressed into a two-dimensional image. As a result of superimposition, periapical radiographs reveal limited aspects of the three-dimensional anatomy. In addition, there may also be geometric distortion of the anatomic structures imaged. These problems may be overcome using newer three-dimensional (3-D) imaging techniques such as cone beam computed tomography (CBCT) have been recommended for pre-operative planning of surgical cases to determine the exact location of root apices and to evaluate the proximity of adjacent anatomical structures such as the mandibular canal, mental foramen, and maxillary sinus **(Müller H P, Eger T, 2002).**

Additional information such as the thickness of the cortical plate, cancellous bone pattern, fenestrations, and inclination of the roots can be obtained prior to surgical entry **(Nakata K, Naitoh M, 2006).**

One of the most useful potential applications of CBCT may be the assessment of endodontic treatment outcomes, both nonsurgical and surgical. When compared to two-dimensional film and digital images, CBCT is dimensionally precise and can detect smaller changes in bone density **(Marmulla R, Wortche R, 2005).**

To keep the patient's radiation exposure as low as reasonably possible, a risk versus benefit analysis should be carried out beforehand.

One of the aims of the pre-operative assessment is to anticipate and minimize procedural or healing complications. Potential risks, difficulties and complications should be discussed with the patient as part of the process of obtaining informed consent before surgery. Post-operative sequelae such as scarring, gingival recession, denudation of the interdental papilla may alter the anatomical contours and aesthetics of soft tissues and existing coronal restorations. Therefore, it is important to be aware that, among other considerations, different gingival biotypes will dictate the outcome of soft tissue healing. Patients with a thin gingival biotype are prone to suffer from gingival recession post-surgery while those with a thick gingival biotype may end up with pocket formation **(Müller H P, Eger T, 2002).**

Premedication: Nonsteroidal anti-inflammatory drugs, antibiotics, chlorhexidine, and conscious sedation.

Administration of an NSAID, either before or up to 30 minutes after surgery, enhances postoperative analgesia **(Sisk AL, Mosley RO, 1989).** NSAIDs generally have proved more effective in the management of postoperative oral surgery pain than placebo or acetaminophen and codeine combinations **(Ahlstrom U, Bakshi R., 1993).** The combination of preoperative administration of an NSAID and use of a long-acting local anesthetic may be particularly helpful for reducing postoperative pain **(Dionne RA, Wirdzek PR., 1984).**

Many types of NSAIDs are available, but ibuprofen remains the usual standard for comparison. The value of antibiotic prophylaxis before or after oral surgery is controversial, and the current best available evidence does not support the routine use of prophylactic antibiotics for periradicular surgery **(Ainsworth G., 2006).** Chlorhexidine gluconate (0.12%) often is recommended as a mouth rinse to reduce the number of surface microorganisms in the surgical field, and its use may be continued during the postoperative healing stage **(Tsesis I, Fuss Z., 2003).** A pre-operative chlorhexidine gluconate (0.2%) mouthrinse for one

minute has been recommended as this reduces the intra-oral microbial load and improves post-operative healing by preventing the risk of infection **(Tsesis I, Fuss Z, 2003).**

Before initiating the surgical procedure, clinician should evaluate the following factors which affect the treatment outcome: - **(Garg & Garg, 2019)**

1- Success of surgical treatment versus nonsurgical retreatment.

2- Review of medical history of the patient and consultation with physician if required.

3- Patient motivation.

4- Aesthetic considerations like scarring.

5- Evaluation of anatomic factors by taking radiographs at different angles.

6- Periodontal evaluation.

7- Presurgical preparation.

8- Taking informed consent.

2.6 Armamentarium

For all surgical procedures, instruments should be set out, preferably in the order in which they will be used. A typical layout is shown in (FIGURE.1), and includes the modern microsurgical instruments. Magnification, with either optical loupes or a surgical microscope, is preferable **(Carrotte, 2005).**

The following instruments are necessary for performing an apicoectomy: **(Fragiskos, 2007)**

- Microhead handpiece (straight and contra-angle) and microbur.
- Special narrow periapical curette tips for preparation of the periapical cavity.

• Apical retrograde micro-mirror and micro-explorers.

• Local anesthetic syringe and cartridges.

• Scalpel handle.

• Scalpel blade (no.15).

• Mirror.

• Periosteal elevator.

• Cotton pliers.

• Small hemostat.

• Suction tips (small, large).

• Irrigation receptacle.

• Needle holder.

• Retractors.

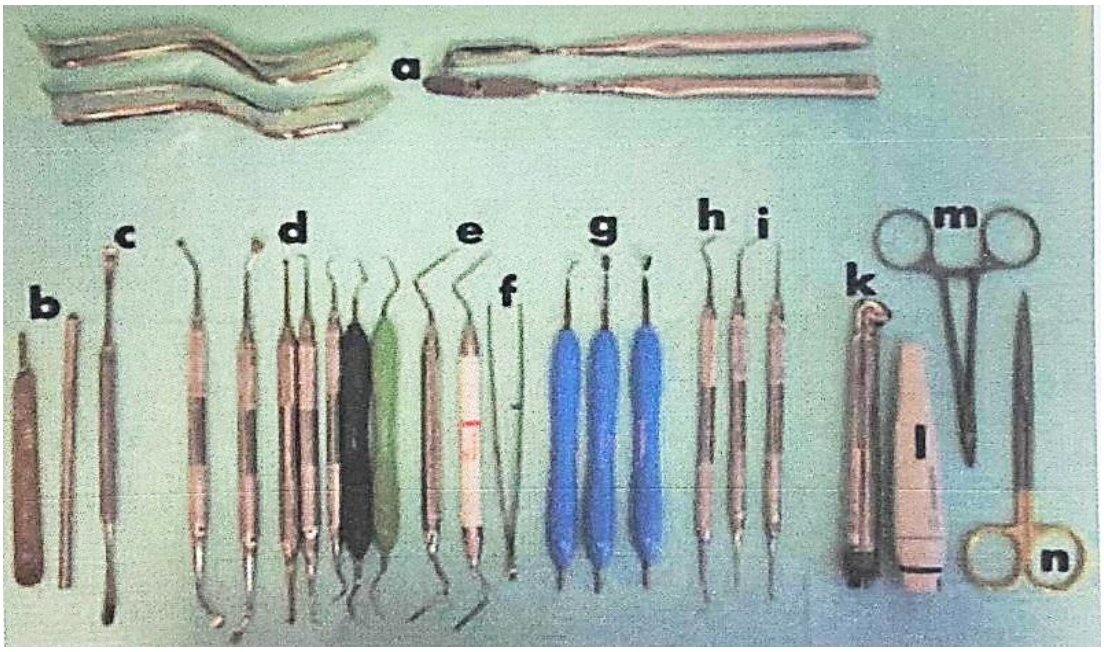

FIGURE.1 A basic surgical kit: (a) retractors; (b) standard surgical and microsurgical handle for scalpel blades; (c) periostea elevator; (d) curettes; (e) root tip elevators; (f) rat-tooth tweezers; (g) sapphire glass retro mirrors; (h) tine flat plastic; (i) burnishers and pluggers; (k) high-speed surgical handpiece; (l) Piezon ultrasonic handpiece; (m) suture holders; and (n) suture scissors, (Carrotte, 2005).

2.7 Treatment planning

Following diagnosis and discussion of the treatment options and risks, consent should be obtained **(Evans et al ., 2012).**

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 **(Standards for Dental Professionals, 2005).**

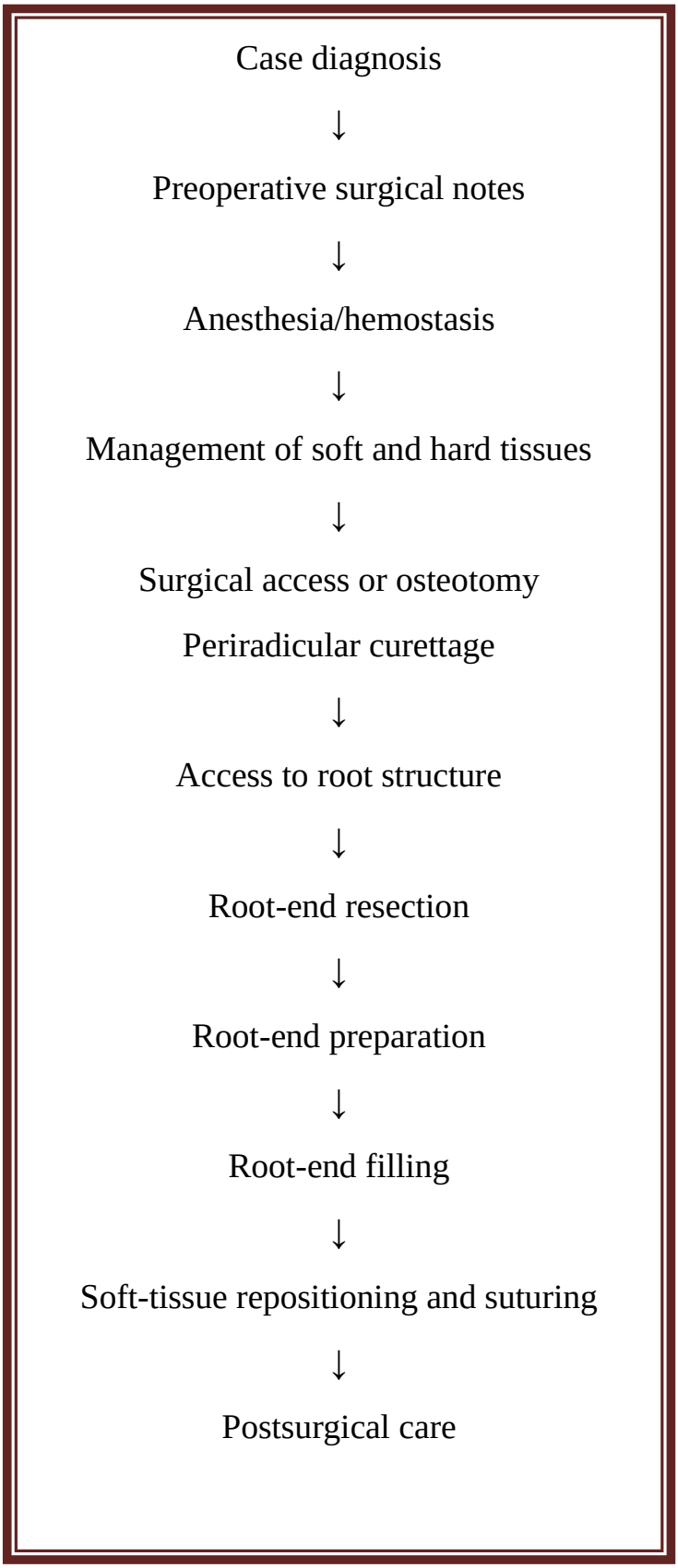

FIGURE.2 Steps in endosurgery (Gopikrishna, 2021).

2.8 Anaesthesia and haemostasis

Wherever possible, local anaesthesia is the method of choice, although anxious patients who cannot be controlled with tranquillizers may also require intravenous sedation. The local anaesthesia injection also provides haemostasis, essential for good endodontic surgery. Following topical anaesthetic application, an anaesthetic solution with at least 1:80,000 adrenaline is injected slowly into several sites surrounding the surgical field.

In the mandible, block injections should be given, in addition to infiltration of the tissues in the operating area. In the maxilla, the palate must be well infiltrated to anaesthetise the greater palatine nerve. The incisive papilla and canal must also receive sufficient anaesthetic solution to block the long sphenopalatine nerve. The local anaesthetic should be applied at least 10 minutes prior to surgery, to allow profound anaesthesia and maximum haemostasis **(Carrotte, 2005).**

2.9 Surgical Access: Soft and Hard Tissue Management

2.9.1 Soft-Tissue Management

The establishment of good surgical access, both visual and operative, is a requirement for all surgical procedures. Visual access enables the endodontic surgeon to see the entire surgical field. Operative access allows the surgeon to perform the needed surgical procedure(s) with the highest quality and in the shortest amount of time. This will result in the least amount of surgical trauma and a reduction in postsurgical morbidity **(Ingle & Bakland, 2002).**

The final goal in endodontic surgical procedures is to get rid of the periradicular pathosis and at the same time preservation of the soft and hard tissues **(Gopikrishna, 2021).**

The surgeon's goal must always be to minimize trauma to both the soft and hard tissues involved in the surgical procedure **(Ingle & Bakland, 2002).**

The original contour of tissues is retained as far as possible. Especially in the anterior esthetic zone, one has to retain the interdental papilla and gingival contour and manage the frenal attachment. Once it was thought that the only function of the interdental papilla was to deflect food. Periodontists are of the opinion that the role of the interdental papilla is broader and complex; it is more of a biological barrier to the periodontium from the oral environment.

The greatest challenge in periodontal reconstructive surgery is complete and predictable restoration of the lost interdental papilla. The final word is to consider classical and modern soft-tissue strategies in order to fulfill the current esthetic and functional demands **(Gopikrishna, 2021).**

2.9.1.1 Flap Designs and Incisions

The design of the surgical flap should permit an unobstructed view of the operating area and permit easy access for instrumentation **(Carrotte, 2005).** Based on several studies, there are several flap designs suggested by endodontists. However, all the flap designs have both advantages and disadvantages and no single flap design is amenable to all the surgical cases **(Gopikrishna, 2021).**

Principles and Guidelines for Flap Design (Garg & Garg, 2019)

- Avoid horizontal and severely angled vertical incisions, because:

  • Gingival blood supply occurs from supraperiosteal vessels and these follow vertical course parallel to long axis of teeth (FIGURE. 3).
  • Collagen fibers of gingiva and alveolar mucosa form attachments for crestal bone and supracrestal cementum to the gingiva and periosteum of radicular bone.

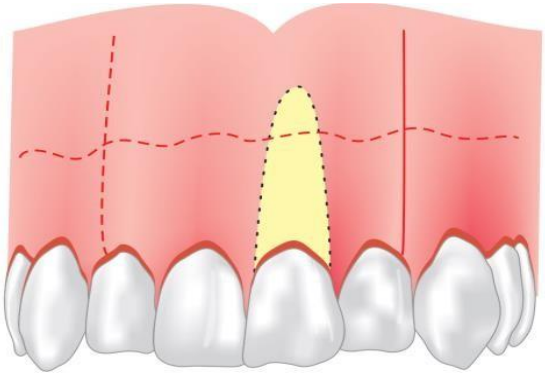

FIGURE.3 avoid horizontal and severely angled vertical incisions (Garg & Garg, 2019)

- Avoid incisions over radicular eminences (e.g., in canines and maxillary first premolars).
- Incisions should be placed such that flap is repositioned over solid bone.
- Base of flap should be more than free margin to preserve an adequate blood supply (FIGURE. 4).

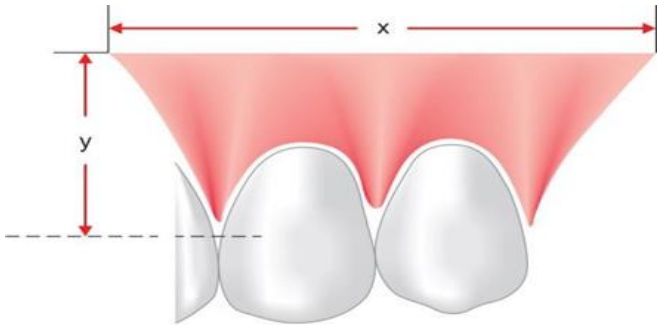

FIGURE.4 Base of flap > free margin (Garg & Garg, 2019).

- Incisions should never be placed over areas of periodontal bone loss or periradicular lesions.
- Hooley and Whitacre suggested that minimum 5 mm of bone should exist between edge of a bony defect and incision line.
- Extent of vertical incisions should be sufficient to allow the tissue retractor to seat on solid bone, thereby leaving the root apex well exposed.

- Extent of horizontal incision should be adequate to provide visual and operative access with minimal soft tissue trauma.
- Avoid incisions in the mucogingival junction.
- Junction of horizontal sulcular and vertical incisions should either include or exclude the involved interdental papilla.
- When submarginal incision is used, there must be a minimum of 2 mm of attached gingiva around each tooth to be flapped.

2.9.1.2 Classification: (Garg & Garg, 2014)

- Full mucoperiosteal flaps

In this, the entire soft tissue overlying the cortical plate in the surgical site is reflected. Major advantage of this type of flap is that supraperiosteal vessels are maintained intact. But disadvantages are postsurgical flap dislodgement, loss of soft tissue attachment level and crestal bone height.

Types of full mucoperiosteal flaps:

1. Triangular (Single vertical releasing incision)
2. Rectangular (Double vertical releasing incision)
3. Trapezoidal (Broad based rectangular)
4. Horizontal (No vertical releasing incision)

- Limited mucoperiosteal flaps

5. Submarginal curved (semi-lunar)
6. Submarginal scalloped rectangular (Luebke-Ochsenbein)

1- Triangular Flap

It is a full thickness most commonly used flap in endodontics (FIGURE. 5) **(Garg & Garg, 2014).**

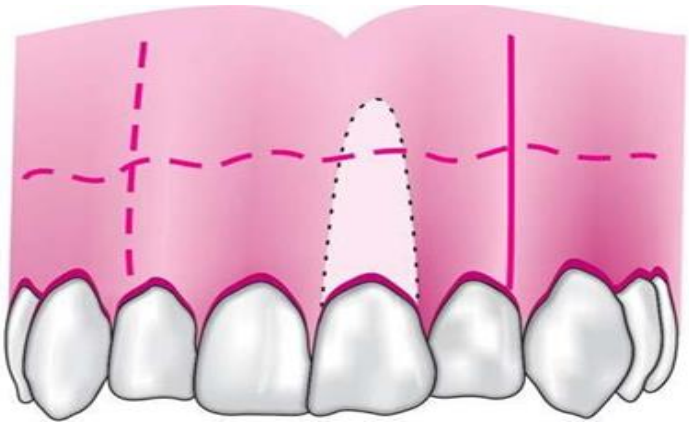

FIGURE.5 Triangular flap (Garg & Garg, 2008).

If access is difficult, then the triangular flap can be converted to a rectangular one by placing an additional vertical relieving incision. This type of flap can be used for periapical surgery, root resorption, cervical resorption, perforation and resection of short roots **(Patel, 2016).**

Indications: (Garg & Garg, 2019)

- Maxillary incisor region.
- Maxillary and mandibular posterior teeth.
- It is the only recommended flap design for posterior mandible region.

Contraindications: (Garg & Garg, 2019)

- Teeth with long roots (maxillary canine).
- Mandibular anteriors because of lingual inclination of their roots.

Advantages (Garg & Garg, 2008)

- Enhanced rapid wound healing.
- Greater access and visibility.

Disadvantages (Garg & Garg, 2008)

- Limited surgical access.
- Difficult to retract.

2- Rectangular Flap

It is extension of triangular flap. Here two vertical releasing incisions and horizontal intrasulcular incision is given (FIGURE. 6) **(Garg & Garg, 2019).**

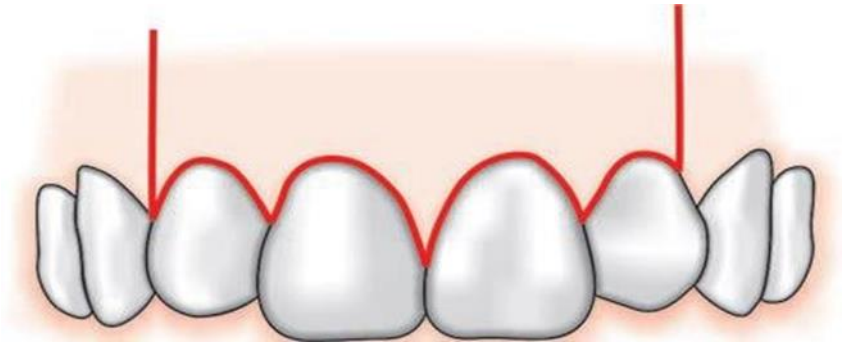

FIGURE.6 Rectangular flap (Garg & Garg, 2014).

Indications (Garg & Garg, 2019)

- Mandibular anteriors.
- Maxillary canines.
- Multiple teeth.

This flap is not recommended for mandibular posterior teeth.

Advantage (Garg & Garg, 2008)

- Enhanced surgical access.

Disadvantages (Garg & Garg, 2014)

- Wound closure as flap re-approximation and postsurgical stabilization are more difficult than triangular flap.
- Potential for flap dislodgement is greater.

3- Trapezoidal Flap

Trapezoidal flap is formed by two releasing incisions which join a horizontal intrasulcular incision at obtuse angles (FIGURE. 7) **(Garg & Garg, 2008).**

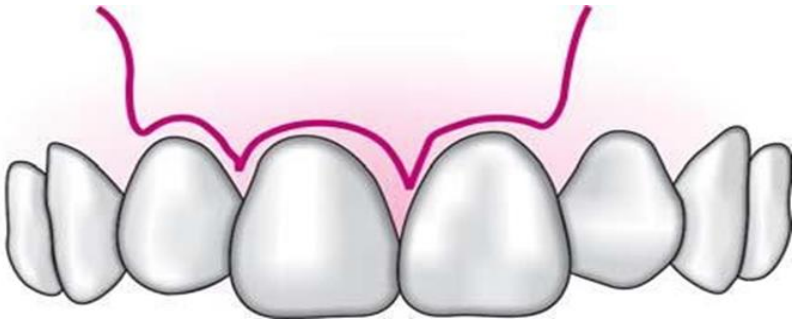

FIGURE.7 Trapezoidal flap (Garg & Garg, 2014).

Indications (Fragiskos, F. D., 2007).

The trapezoidal flap is suitable for extensive surgical procedures, especially when the triangular flap would not provide adequate access.

Disadvantages (Garg & Garg, 2019)

- Wound healing by secondary intention.
- Pocketing or clefting of soft tissue.
- Compromise in blood supply.
- Contraindicated in periradicular surgery.

4- Envelope Flap

The horizontal, or envelope, flap is created by a horizontal, intrasulcular incision with no vertical releasing incision(s) (FIGURE.8) **(Ingle & - Bakland, 2002).**

FIGURE.8 Envelope flap (Fragiskos, F. D., 2007).

Indications - (Garg & Garg, 2014)

- For repair of perforation defects.
- For root resections.
- In cases of hemisections.

Advantages (Garg & Garg, 2019)

- Improved wound healing.
- Easiness of wound closure and postsurgical stabilization.

Disadvantages (Garg & Garg, 2014)

- Extremely limited surgical access.
- Essentially impractical for periradicular surgery. But some use it for palatal surgery.

5- Semilunar Flap

The semilunar flap (FIGURE.9) is rarely used in contemporary root end surgery. With this flap a horizontal incision is made in the alveolar mucosa over the root to be treated. This type of flap has been indicated when aesthetic crowns are at risk of gingival recession from the proposed surgery.

The flap itself expedites surgery by reducing incision and reflection times, maintains the integrity of the gingival attachment and eliminates potential crestal bone loss. Although this flap does not disturb the periodontal attachment, it has the disadvantages of limited access and visibility, encroachment on and closure over osseous defects, increased potential for hemorrhage, and healing with scar formation, predisposition to stretching and tearing of the flap and difficulties exposing the lesion in its entirety. Again this flap is mentioned from a historical

point of view and is now somewhat obsolete in cases of peri-radicular surgery **(Johnson, 2004) (bobby patel, 2016).**

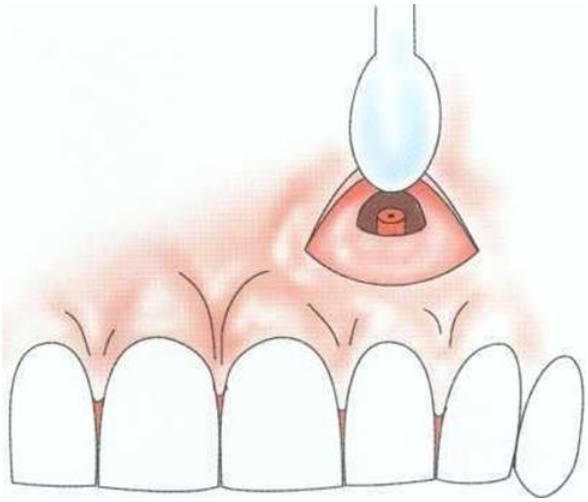

FIGURE.9 semilunar flap. (Johnson, 2004)

6- ochsenbein-Luebke Flap

This flap is modification of the rectangular flap (FIGURE. 10). Flap design in this scalloped horizontal incision is given in the attached gingiva which forms two vertical incisions made on each side of surgical site **(Garg & Garg, 2008).** This flap gives advantage of vertical flap along with semilunar flap **(Garg & Garg, 2014).**

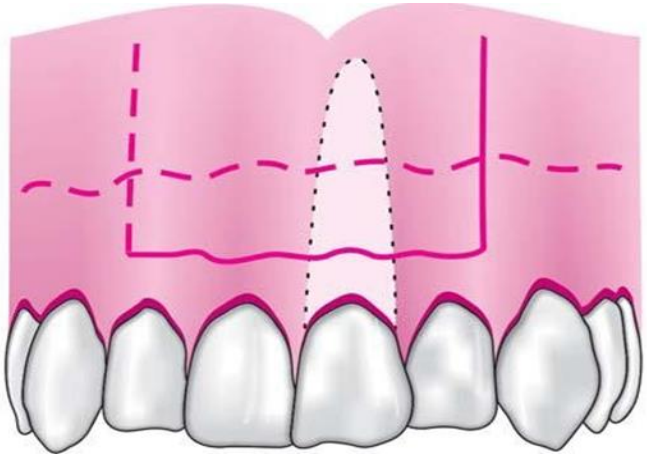

FIGURE.10 Ochsenbein-Luebke flap (Garg & Garg, 2008).

Indications (Garg & Garg, 2019)

- In presence of gingivitis or periodontitis associated with fixed prosthesis
- Where bony dehiscence is suspected

Advantages - (Garg & Garg, 2014)

- Marginal and interdental gingiva are not involved
- Unaltered soft tissue attachment level
- Crestal bone is not exposed
- Adequate surgical access
- Good wound healing potential—as compared to semilunar flap

Disadvantages (Garg & Garg, 2019)

- Disruption of blood supply to unflapped tissues
- Flap shrinkage
- Difficult flap reapproximation and wound closure
- Untoward postsurgical sequelae
- Healing with scar formation
- Limited apical orientation
- Limited or no use in mandibular surgery

2.9.1.3 Flap reflection

Is the process of separating the soft tissues (gingiva, mucosa, and periosteum) from the surface of the alveolar bone. This process should begin beneath the vertical incision a few millimeters apical to the junction of the horizontal and vertical incisions in the attached gingiva (FIGURE. 11). A number of periosteal elevators and curettes are available for mucoperiosteal flap elevation (FIGURE. 12). The periosteal elevator of choice should be used to

gently elevate the periosteum and its superficial tissues from the cortical plate **(Ingle & Bakland, 2002).**

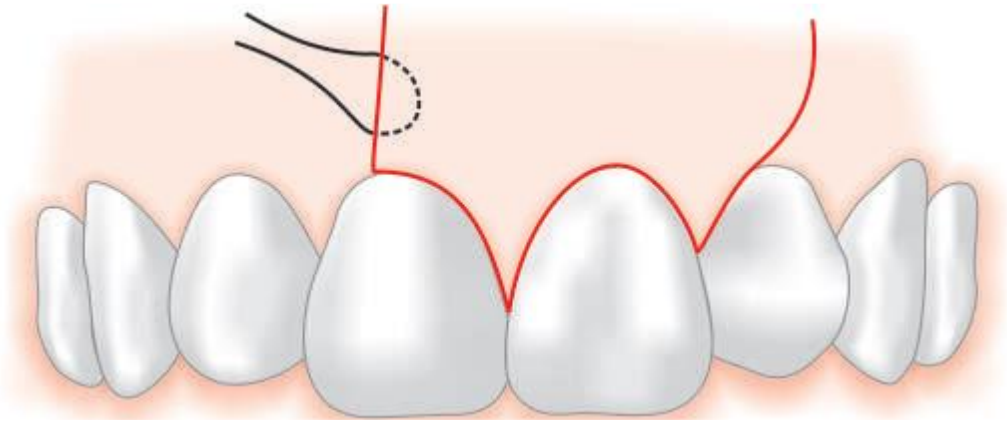

FIGURE.11 Flap reflection begins with the periosteal elevator placed in the attached gingiva a few millimeters apical to the junction of the vertical and horizontal incisions. (Ingle & Bakland, 2002)

FIGURE.12 Molt elevator (above) and Howarth periosteal elevator (below) used to reflect the flap once incision has been made. (bobby patel, 2006).

Once these tissues are lifted from cortical plate, periosteal elevator is placed between tissue and bone. It is moved coronally to separate marginal and interdental gingiva from underlying bone and opposing incisional wound edge without direct application of dissectional forces.

This technique is termed undermining elevation and should be continued throughout the length of the horizontal incision until the attached gingival is lifted from underlying bone and apically to the alveolar mucosa **(Garg & Garg, 2019) (Gutmann JL, Harrison JW, 1994).** Care must be taken in regions of bony prominences, irregularities, concavities and areas of fenestrations where risk of tearing is high **(Patel, 2016).**

2.9.1.4 Flap Retraction

Flap retraction is the process of holding in position the reflected soft tissues. Proper retraction depends on adequate extension of the flap incisions and proper reflection of the mucoperiosteum **(Ingle & Bakland, 2002).**

After the tissue is reflected, it must be retracted to provide adequate access for bone removal and root-end procedures. The main goals of tissue retraction are to provide a clear view of the bony surgical site and to prevent further soft-tissue trauma. Accidental crushing of the soft tissues leads to more postoperative swelling and ecchymoses **(Harrison JW, Jurosky KA, 1991).**

The general principles of retraction are as follows: (Berman, Louis H, 2020).

(1) Retractors should rest on solid cortical bone, if retractor rests on the base of reflected tissues; it can result in damage to microvasculature of alveolar mucosa and thus delayed healing **(Garg & Garg, 2014).**

(2) Firm but light pressure should be used.

(3) Tearing, puncturing, and crushing of the soft tissue should be avoided.

(4) Sterile physiologic saline should be used periodically to maintain hydration of the periosteal surface of the flap, It is not necessary to irrigate the superficial

surface of the flap because the stratified squamous epithelium prevents dehydration from this surface.

(5) The retractor should be large enough to protect the retracted soft tissue during surgical treatment (e.g., prevent it from becoming entangled in the bone bur).

Selection of the proper size and shape of the retractor is important in minimizing soft-tissue trauma. If the retractor is too large, it may traumatize the surrounding tissue. If the retractor is too small, flapped tissue falls over the retractor and impairs the surgeon's access **(Ingle & Bakland, 2002).**

Time of Retraction (Garg & Garg, 2019).

Longer the flap is retracted; greater are the complications of the following surgery because:

-Vascular flow is reduced during retraction

-Tissue hypoxia may result causing delayed wound healing

2.9.2 Hard-Tissue Management

After reflection of flap, root apices are approached by making an access through cortical plates. In case, radiolucency is present around root apex, osseous tissue need not be removed surgically. But when radiolucency is not present periapically, osseous cutting is required to gain access to the root apex **(Garg & Garg, 2019).**

Osseous Tissue Response to Heat:

Erikson et al in 1982 in their study found the sequence of bone injury and response of osseous tissue to heat. They noted the following response of tissues to heat: **(Garg & Garg, 2014)**

- Above 40°C blood flow initially increases.
- 47°C to 50°C for 1 minute significantly reduces bone formation and is associated with irreversible cellular damage and fatty cell infiltration **(Matthews LS, Hirsch C., 1972).**
- 50°C to 53°C for 1 minute—blood flow stasis and death of vascular channels within 2 days.
- At56°C, bone alkaline phosphatase undergoes rapid inactivation.
- At60°C or more—termination of the blood flow and tissue necrosis

Tissue Response to Bone Removal

Bone in surgical site has temporary decrease in blood supply because of local anesthesia. This causes bone to become more heat sensitive and less resistant to injury. So, any small changes during bone removal can affect bone physiology and viability **(Garg & Garg, 2019).**

Speed of Cutting (Garg & Garg, 2014)

- At 8000 rpm: Almost similar tissue response are seen when irrigation is done with or without a coolant or with a mixture of blood and saliva or water.
- At high speed (up to 300000 rpm): Favorable tissue response is noted when other parameters (coolant, pressure, type of bur) are controlled.

Use of Coolant

Coolant (water, saline) should be used to dissipate heat generated during cutting osseous tissue and keep the cutting flutes of instrument free of debris there by reducing friction and using cutting efficacy of bur **(Garg & Garg, 2019).**

Types of Burs for Cutting

Cutting of osseous tissue with a No. 6 or No. 8 round bur produces less inflammation and results in a smoother cut surface and a shorter healing time than when a fissure or diamond bur is used **(Garg & Garg, 2014).**

The round bur has the best shape for removing osseous tissue. This type of bur also readily allows access of coolant to the actual cutting surfaces. Studies comparing the heat generated with round and fissure burs found more favorable results with the round burs **(Calderwood RG, Hera SS, 1964).**

Cutting with round burs produced a wound site with less inflammation, which is more favorable for rapid wound healing. Although fissure-type burs cut efficiently on the sides, the tip of the bur is very inefficient because it allows no coolant access. The net result is increased inflammation and a reduced healing response. Use of a diamond bur to remove osseous tissue is inefficient and slows ultimate wound healing.

Because of its larger surface area, more of a diamond bur is in contact with the bone tissue. As a result, less coolant reaches the cutting surface, and the bur has a greater tendency to become clogged with residual bone fragments. The net effect is greater heat generation, increased inflammation, and reduced healing **(Calderwood RG, Hera SS, 1964).**

Pressure and Time during Cutting Procedure (Garg & Garg, 2014)

- Pressure should be minimum possible and time the bur stays in contact with bone should be as short as possible.
- This reduced time factor along with light pressure can be achieved by employing the technique of 'Brush stroke' cut method.

2.9.3 Principles of Surgical Access to Root Structure

Normally, when radiolucent area is present periapically, root is visible through cortical plate. But if periapical radiolucency is not present, then bone is to be removed to gain access to the root. Guidelines to be strictly followed for determining location of root apex are: **(Garg & Garg, 2019)**

- Assess angulation of crown to the root.
- Measure entire tooth to root length.
- Locate root from coronal to apex where bone covering root is thinner. Once it is located, then remove the covering bone with light brush strokes working in apical direction.
- Expose radiographs from different angles.
- Probe the apical region using endodontic explorer or straight curette to know whether a small defect is present or not.
- If a small defect is present in the bone, then place a small piece of lead sheet, gutta-percha point, or plug of alloy to know the position of apex.

2.10 Root End Resection

Apicoectomy is the surgical resection of a tooth and its removal together with pathological periapical tissue **(Garg & Garg, 2019).**

Root-end resection is a common yet controversial component of endodontic surgery. Historically, many authors have advocated periradicular curettage as the definitive treatment in endodontic surgery without root-end resection. Their rationale for this approach centered primarily around the perceived need to maintain a cemental covering on the root surface and to maintain as much root length as possible for tooth stability **(Ingle & Bakland, 2002).**

The root end is resected in order to identify the root canal and provide access to the source of infection. Historically, resection and beveling was carried out in

order to improve access to the root canal for preparation with a round bur. The apex of most teeth contains multiple foramina and by removing the apical 2–3 mm of the root most of these can be removed, but care must be taken not to compromise the crown-to- root length ratio **(Rhodes, 2006).**

It has been shown that 98 % of apical canal anomalies and 93 % of lateral canals system ramifications occur in the apical 3 mm. Where possible it is recommended to remove at least 3 mm of root end with an appropriate bur with appropriate water cooling. The resected root end should be inspected under magnification and illumination using a micro-mirror to ensure resection is complete and there are no cracks in the root and to check for any anatomical canal irregularities, missed canals or isthmuses. The bevelled root surface can also be inspected after staining with a neutral, buffered, sterile dye such as methylene blue. A radiograph can be taken at this stage to ensure resection has been carried out to the appropriate level **(Patel, 2016).**

High speed handpiece with surgical length fissure bur usually results in satisfactory resection. Use of round bur may result in gouging of root surface whereas crosscut fissure burs can lead to uneven and rough surface. Recently studies have shown the use of Er:YAG laser and Ho:YAG laser for root end resection but among these Er:YAG laser, wavelength 2940 nm is better as it produces clean and smooth root surface **(Garg & Garg, 2008).** It also possesses enhanced anti-inflammatory power, reducing bacterial infiltration within the resected root after api-coectomy and retrograde obturation **(Yasuda, Y., Kawamorita, T., 2010).**

Advantages of use of laser in periradicular surgery over the traditional methods include: (Garg & Garg, 2014)

- Reduction of postoperative pain.
- Improved hemostasis.

- Reduction of permeability of root surface.
- Potential sterilization of the root surface.
- Do not produce secondary heat damage.
- Reduction of discomfort.

Extent of Resection

Factors to be considered while performing root-end resection are: **(Garg & Garg, 2008).**

1. Access and visibility of surgical site.
2. Anatomy of the root, i.e., its shape, length, etc.
3. Anatomy of the resected root surface to see number of canals.
4. Presence and location of iatrogenic errors.
5. Presence of any periodontal defect.

According to Cohen et al, root resection of 3 mm at a 0° bevel angle eliminates most of the anatomic features that are possible cause of failure (FIGURE. 13)

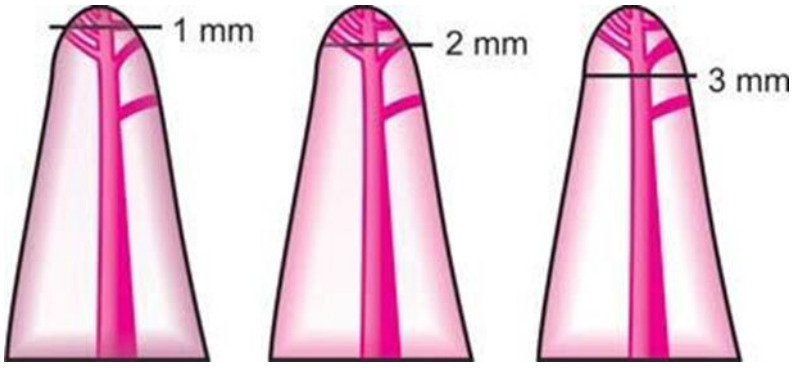

FIGURE.13 Frequency of ramifications at different levels of root canal (Garg & Garg, 2008)

Angle of Root-End Resection

Earlier it was thought that root-end resection at 30–45° from long axis of root facing buccally or facially provides improved accessibility and visibility of

resected root end. But studies have shown that beveling of root end results in opening of dentinal tubules on the resected root surface which communicate with root canal space, causing apical leakage even after retrofilling is done (FIGURES. 14 1 and 2) **(Garg & Garg, 2019).**

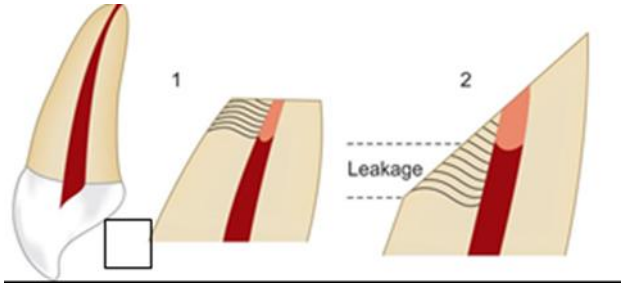

FIGURE.14 1 and 2 (1) Zero degree bevel exposes less of dentinal tubules to oral environment; (2) Beveling results in opening of dentinal tubules on resected tooth surface, which communicate with root canal space, and result in apical leakage. (Garg & Garg, 2019)

Nowadays a bevel of 0 to10° is recommended with resection at the level of 3 mm. Irrespective of the angle or extent of the resection, the main fundamental of the root resection is that it should be complete and no segment of root is left unresected **(Garg & Garg, 2014).**

Advantages of a Zero Degree Bevel (FIGURE.15) **(Garg & Garg, 2008).**

- Maintains maximum root length.
- Reduced osteotomy size.
- Lesser apical leakage.

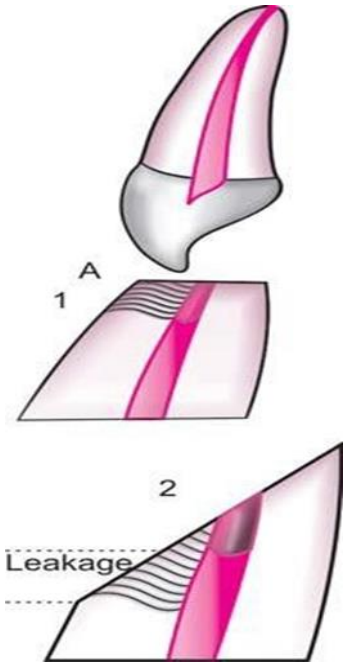

FIGURE.15 Beveling of root end results in more exposure of dentinal tubules and thus leakage (Garg & Garg, 2008)

2.11 Root-End Preparation

Main objective of root-end preparation is to create a cavity to receive root-end filling. Root-end preparation should accept filling materials so as to seal off the root canal system from periradicular tissues. Car and Bentkover defined an ideal root-end preparation as "a class I preparation at least 3.0 mm into root dentine with walls parallel to a coincident with the anatomic outline of the pulp space". **(Garg & Garg, 2019).**

Five requirements suggested for a root-end preparation to fulfill: **(Garg & Garg, 2014)**

1. The apical 3 mm of root canal must be freshly cleaned and shaped.

2. Preparation must be parallel to anatomic outline of the pulp cavity.

3. Creation of an adequate retention form.

4. Removal of all isthmus tissue if present.

5. Remaining dentine walls should not be-weakened.

Traditional Root-End Cavity Preparation

Miniature contra angle or straight handpiece, with a small round or inverted cone bur is used to prepare a class I cavity at the root-end within confines of the root canal (FIGURE. 16). One of the main problems in root-end preparation is that these preparations seem to be placed in the long axis of the tooth, but they are directed palatally, ultimately causing the perforations **(Garg & Garg, 2008).**

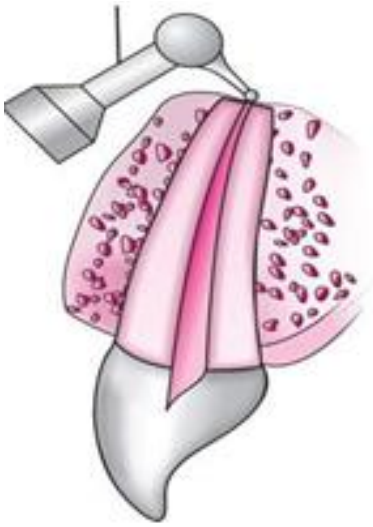

FIGURE.16 Root end preparation using endopiece (Garg & Garg, 2008)

Ultrasonic Root-End Preparation

It was developed to resolve the main shortfalls of bur preparation. (FIGURES. 17 and 18) **(Garg & Garg, 2019).**

FIGURE.17 Ultrasonic tip for root-end preparation (Garg & Garg, 2019)

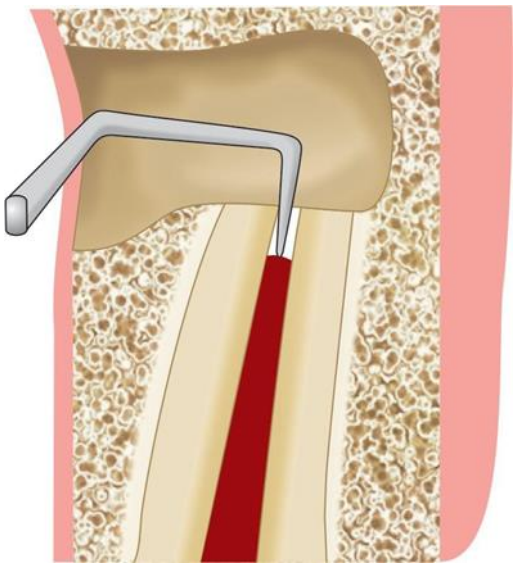

FIGURE.18 Retrograde cavity preparation using ultrasonic handpiece. (Garg & Garg, 2019)

Advantages **(Garg & Garg, 2014)**

- Smaller preparation size and better access.
- Less or no need for root-end beveling.
- A deeper preparation possible, coincident with the anatomic outline of pulp space.
- More parallel walls for better retention.
- Less debris and smear layer than those prepared with a bur.

Preparing the Root End for a Root-End Restoration

The area is dried and isolated after irrigation with normal saline or distilled water. The root canal seen through the cut end of the root is located **(Gopikrishna, 2021).**

2.12 Retrograde Filling

The main aim of the endodontic therapy whether nonsurgical or surgical is three dimensional obturation of the root canal system. Therefore, after the apical surgery, placement of a root-end filling material is an equally important step.

Root canal filling material is placed in the prepared root-end in a dry field. To place a material in the retropreparation, it is mixed in the desired consistency, carried on the carver (hollenback) and placed carefully into the retropreparation (FIGURE. 19) and compacted with the help of burnisher.

After the material is set, excess of it is removed with carver or periodontal curette (FIGURE. 20). Finally, the root-end filling is finished with carbide finishing bur and a radiograph is exposed to confirm the correct placement of the filling **(Garg & Garg, 2014).** In order to place a root end filling, haemostasis must first be achieved. Using an adequate quantity of local anaesthetic with a vasoconstrictor is important, as is ensuring that the relieving incisions for flaps are made as vertical as possible.

Horizontal incisions have the potential to cause more bleeding. A welltrained assistant using a microaspiration tip will help control small localized bleeds. Placement of haemostatic agents within the bony crypt will help control bleeding **(Rhodes, 2006).**

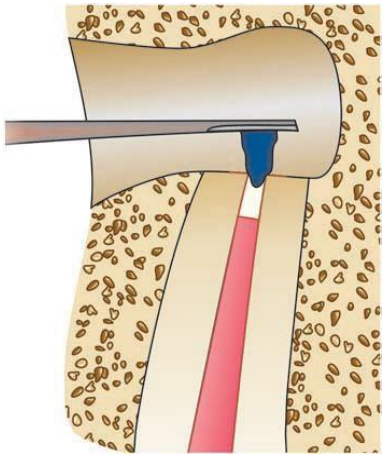

FIGURE.19 Placement of restorativematerial (Garg & Garg, 2014)

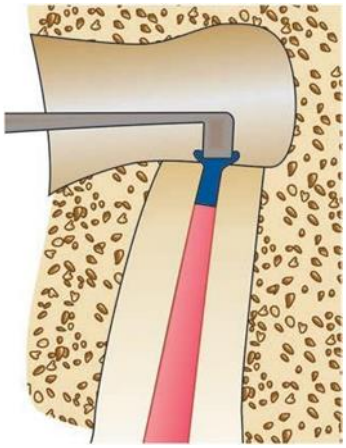

FIGURE.20 Removal of excess material (Garg & Garg, 2014)

Ideal properties of a root-end filling material are that it: (Garg & Garg, 2008)

1. Should be well tolerated by periapical tissues.
2. Should adhere to tooth surface.
3. Should be dimensionally stable.
4. Should be resistant to dissolution.
5. Should promote cementogenesis.
6. Should be bactericidal or bacteriostatic.
7. Should be non-corrosive.
8. Should be electrochemically inactive.
9. Should not stain tooth or periradicular tissue.
10. Should be readily available and easy to handle.
11. Should allow adequate working time, then set quickly.
12. Should be radioopaque.

Commonly used root-end filling materials (Garg & Garg, 2019)

- Amalgam
- Gutta-percha

- Gold foil
- Titanium screws
- Glass ionomers
- Zinc oxide eugenol
- avit
- Composite resins
- Polycarboxylate cement
- Poly HEMA
- Super ethoxybenzoic acid (EBA)
- Mineral trioxide aggregate (MTA)
- Biodentine

Amalgam

It is one of the most popular and widely used retrograde filling materials since last century. (Garg & Garg, 2014) Traditionally amalgam has been used for many years as a root-end filling material. As dentists we are familiar with amalgam and its popularity was based on the fact that it was relatively inexpensive, easy to use and radiopaque and previously thought of as acceptable from a healing outcome perspective **(Patel, 2016).**

Advantages - (Garg & Garg, 2019)

- Easy to manipulate
- Readily available
- Well tolerated by soft tissues
- Radiopaque
- Initially provides tight apical seal

Disadvantages (Garg & Garg, 2014)

- Slow setting
- Dimensionally unstable
- It shows leakage
- Stains overlying soft tissues, resulting in formation of tattoo.
- More cytotoxic than IRM, super EBA or MTA.

Zinc Oxide Eugenol Cement

Unmodified ZOE cement is weak and has long setting time and high water solubility. On contact with moisture, it -releases free eugenol which is responsible for most of the effects caused by zinc oxide eugenol cement **(Garg & Garg, 2019).**

Effects of Free Eugenol (Garg & Garg, 2014)

- Competitively inhibit prostaglandin synthetase by preventing biosynthesis of cyclo-oxygenase.
- Inhibits sensory nerve activity.
- Inhibits mitochondrial respiration.
- Kills arange of natural oral microorganisms.
- Can act as allergen.

Intermediate Restorative Material

Reinforced zinc oxide–eugenol cement such as IRM has been advocated as a root- end filling material for many years. IRM can be placed into the root end cavity with a carrier or fine flat plastic and packed into place with micropluggers. The material is burnished against the root surface and, when set, the resected root end is finished with an ultrafine diamond or tungsten carbide

bur, leaving a highly polished surface. This material produces a better seal than amalgam and periapical healing following its use as a root-end filling material has generally been shown to be good **(Rhodes, 2006).**

Super Ethoxybenzoic Acid

It is ZOE cement modified with EBA to alter the setting time and increase the strength of mixture **(Garg & Garg, 2019).**

Powder **(Garg & Garg, 2014)**

- 60 percent zinc oxide
- 34 percent silicone dioxide
- 61 percent natural resin.

Liquid **(Garg & Garg, 2014)**

- EBA—62.5 percent
- Eugenol—37.5percent.

Advantages (Garg & Garg, 2019)

- Low solubility and nonresorbable
- Radiopaque
- Strongest and least soluble of all ZOE formulations
- Yield high compressive and tensional strength

Disadvantages (Garg & Garg, 2014)

- Difficult to manipulate because setting time is short and greatly affected by humidity.
- Tends to adhere to all surfaces—difficult to place and comfort.

Composite Resins

Composite resins such as Retroplast have been shown to be clinically effective as root-end filling materials. Maintaining a dry field is a prerequisite when placing any composite and this is probably its greatest disadvantage. The use of this type of material also is dependent on root- end cavity design based on a saucer-type preparation with a concave root-face preparation, which makes adhesion of the composite more amenable **(Patel, 2016).**

Mineral Trioxide Aggregate

Mineral trioxide aggregate (MTA) is composed of tricalcium silicate, tricalcium aluminate, tricalcium oxide, bismuth oxide and silicate oxide **(Garg & Garg, 2019).**

Mineral trioxide aggregate (MTA) developed at Loma Linda University, California, USA, has been shown to be biocompatible and encourage hard tissue deposition of cementum (cementogenesis) and excellent healing in randomized prospective clinical studies confirming its use as a root-end filling material **(Patel, 2016).**

MTA has been recommended as a root-end filling material and for the repair of perforations **(Rhodes, 2006).** Its pH is 2.5 (when set) and setting time is 2 h 45 min **(Garg & Garg, 2019).** The material is able to set and form a seal even in the presence of water or blood. MTA comes as a powder and is mixed with sterile water to a slurry consistency. It can be a difficult material to handle, has a long setting time (2 hours 45 minutes) and normally requires a two-visit approach for perforation repair. Radiographically, the material appears slightly more opaque than gutta percha (FIGURE 21) **(Rhodes, 2006).**

FIGURE.21 Mineral trioxide aggregate (MTA) (Rhodes, 2006)

MTA Placement Technique (Garg & Garg, 2014)

1- Preparation of root-end is completed.

2- Bony crypt is packed with sterile cotton pellet.

3- MTA powder and liquid are mixed to put consistency.

4- Mix is carried to the site with amalgam carrier or messing gun and is placed into the preparation (FIGURE.22)

FIGURE.22 Carrying MTA with messing gun or amalgam carrier (Garg & Garg, 2014)

5- MTA is compacted using micropluggers.

6- Cleaning of the surface is done with damp cotton pellet.

Advantages of MTA - (Garg & Garg, 2014)

- Least toxic of all filling materials.
- Excellent biocompatibility, in contact with periradicular tissues, it forms connective tissue and cementum, causing only very low levels of inflammation.
- Hydrophilic—not adversely affected by blood or slight moisture.
- Radiopaque
- Sealing ability—superior to that of amalgam or super EBA**.**

Disadvantages (Garg & Garg, 2019)

- More difficult to manipulate
- Longer setting time
- Expensive

Biodentine

Biodentine™ is a calcium silicate based cement and it was released in January 2011 by Septodont (France). This new cement has dentin-like material and according to the manufacturer it can be used for crown and root dentin repair treatment, repair of perforations or resorbtions, apexification and root-end fillings.

Biodentine, in contrast, offers similar properties to those of MTA, but it consists of powder in a capsule and liquid in a pipette (FIGURE.23). The powder mainly contains tricalcium silicate, calcium carbonate, and dicalcium silicate, the principal components of MTA. Zirconium oxide serves as the radiopacifier. The liquid consists of calcium chloride in aqueous solution with an admixture of polycarboxylate. The powder is mixed with the liquid in a capsule in a triturator for 30 seconds, and once mixed; its setting time is around

12 minutes. During the setting of the cement, calcium hydroxide is formed. The consistency of Biodentine is similar to phosphate cement **(Dammaschke T., 2012).**

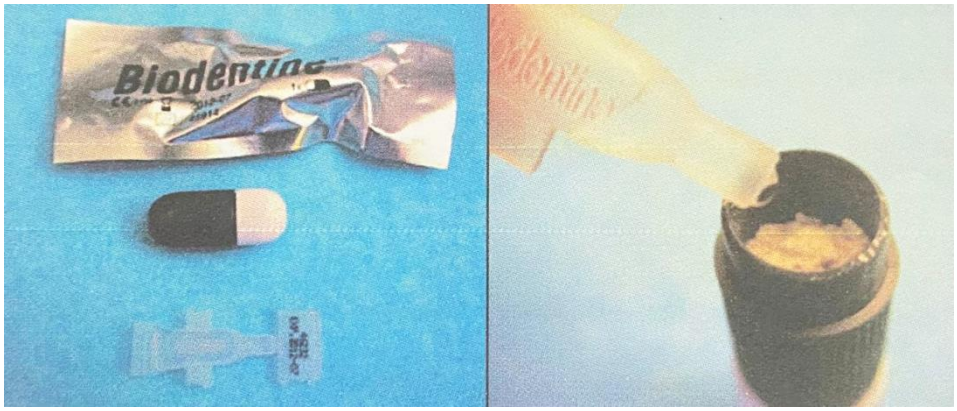

FIGURE.23 (a) Biodentine is commercialized as predosed sets including a capsule containing the powder and a liquid. (b) After pouring the liquid, the capsule must be vibrated at 4000 RPM for 30s (International Journal of Oral Science, 2014).

Biodentine Placement Technique (Garg & Garg, 2019)

1- Preparation of root-end is completed.

2- Isolate the area. Achieve hemostasis. Dry the cavity with paper points.

3- Prepare biodentine and dispense it in the cavity with an amalgam carrier, a spatula or a Root Canal Messing Gun.

4- Remove excess material and clean the surface of the root.

5- Take an X-ray to check that the material is correctly positioned.

Advantages of Biodentine (Dammaschke T., 2012).

- Biocompatibility.
- Long-term sealing of the cavity.
- Antimicrobial properties.
- The ability to induce hard-tissue regeneration.
- Stable, insoluble, non-resorbable, hydrophilic.
- Improved radiopacity.

- Easy to prepare and place.
- Short setting time.

Biodentine versus Mineral Trioxide Aggregate versus Intermediate Restorative Material for Retrograde Root End Filling: An Invitro Study

The main benefits of Biodentine over other calcium silicate based materials are the reduced setting time, better handling and mechanical properties. The importance of marginal adaptation is that it may have an indirect correlation with the sealing ability of retro-filling materials. The aim of this study was to evaluate the marginal adaptation of Biodentine in comparison with MTA and IRM, as a root end filling material, using Scanning Electron Microscopy (SEM). The overall results showed that the mean gap at the dentin-retrograde filling material interface was maximum for Biodentine (1. 446 ± 0.367 um), followed by IRM (0. 942 ± 0.353 um) and MTA (0. 792 ± 0.201 um) **(Saravanapriyan Soundappan et al., 2014).**

Debridement

After the root-end filling is inserted, the tissues are irrigated with sterile saline. An excavator can be used to remove debris, but a Briault probe is preferred to remove fine particles of filling material because it minimizes inadvertent packing of these into bone surface. Debris can also be displaced with a fine jet of sterile saline. Some clinicians take a radiograph at this stage. This provides an opportunity to correct an inadequate apical seal before wound closure. Residual other radio-opaque debris within the apical tissues will also appear on the radiograph and can be removed before wound closure **(Pedlar & Frame, 2007).**

2.13 Suturing

A suture is strand of material used to close the wound. Purpose of suturing is to approximate incised tissues and also stabilize the flapped mucoperiosteum

until reattachment occurs **(Garg & Garg, 2019).** The interdental papillae are first repositioned to their correct anatomical location. Simple interrupted sutures may be placed to secure the edges of the mucoperiosteal flap **(Pedlar & Frame, 2007).**

Sutures are required to hold the tissue flap in position and prevent dislodgement, thereby allowing healing by primary intention. Many different materials have been suggested. Braided or multistrand sutures such as those made of silk can become infected with bacterial plaque that wicks along the material when exposed to the oral environment. It is necessary to use an antibacterial mouthwash such as chlorhexidine gluconate while the sutures are in place to prevent them becoming infected, which results in localized inflammation **(Rhodes, 2006).**

Any dehiscence caused by excision of a sinus or fistula tract can also be sutured. Resorbable sutures are suitable **(Pedlar & Frame, 2007).** The sutures are normally removed after 48–72 hours, at which point early epithelialization will have occurred. If silk sutures are left in situ for too long, there is a risk of damage to the dental papilla. Single-strand or monofilament sutures such as polyglactin, polypropylene, polyethylene or Teflon (polytetrafluoroethylene) result in no bacterial wicking and little inflammation but can sometimes be more difficult to place. A variety of sutures sizes 4/0 to 6/0, with various curvatures and radii of needle are used, depending on the anatomical situation. The minimum number of sutures that are required to retain the flap should be used. Interrupted sutures are frequently used to retain a full- thickness flap. They can be modified to provide a sling, thereby avoiding having to place the suture material through the papilla .Mattress sutures have been advocated for securing partial-thickness flaps. However, there can be difficulties with tensioning, when using this technique **(Rhodes, 2006).**

Once the mucoperiosteal flap has been repositioned and sutured back into place, gentle pressure is applied to the flap for a few minutes with a moist gauze swab to obtain haemostasis. If a postoperative radiograph was not taken before wound closure, this is usually done now **(Pedlar & Frame, 2007).**

Table 1- : Classification of sutures (Garg & Garg, 2019)

According to absorbency	**According to physical property**
• Absorbable • Nonabsorbable	• Monofilament • Multifilament • Twisted or braided

Principles of Suturing (Garg & Garg, 2019)

- Needle should enter the mucosal skin perpendicular to surface of tissue.
- Needle should always pass from free tissue to fixed tissue.
- Needle should always be inserted at an equal depth and distance from incision line on both sides.
- Tissue should not be closed under tension.
- Sutures should be spaced evenly.
- Suture should not be too tight. If sutures are too tight, there will be local ischemia underneath the suture tracks.
- Suture knot should never lie on the incision line.
- After tying, knot should be left to one side.

2.14 Postsurgical Care

Postsurgical Care It includes providing genuine expression of concern and reassurance to patient, good patient communication regarding the expected and normal postsurgical sequelae as well as detailed home care instructions **(Garg & Garg, 2019).** The patient's awareness that the surgeon cares and is readily available, should the patient have a problem, is a priceless adjunct to healing. A

telephone call to the patient, the evening following or the morning after endodontic surgery, is very reassuring and helps to build a strong doctor–patient relationship. This also allows any patient anxieties to be dealt with before they become major concerns **(Ingle & Bakland, 2002).**

2.15 Instructions: (Garg & Garg, 2014)

- No difficult activity or work for the rest of day.
- No alcohol or any tobacco for next 3 days.
- Good nutritious diet. Drink lot of liquids for first few days after surgery.
- Do not lift up lip or pull back cheek to look at where surgery was done. It may pull the stitches loose and cause bleeding.
- A little bleeding from the surgical site is normal and it should last for a few hours. Little swelling or bruising of face is normal and will last for few days.
- Application of ice bags on face where surgery was done— 20 minutes on and 20 minutes off till 6 to 8 hours.
- Next day after surgery—hot fomentation for 3 to 5 days.
- Prescribed medicines should be taken regularly **(Garg & Garg, 2014).** Post- operative pain may be controlled by the administration of a long-acting local anesthetic at the end of the surgery, and by the prescription of non-steroidal anti- inflammatory drugs (NSAIDs) **(Carrotte, 2005).**
- Rinsing of mouth with chlorhexidine mouthwash twice daily for one week.
- Suture removal.
- Follow-up appointment.
- In case of any problem or any question—contact the doctor.

2.16 Complication

The most common perioperative and postoperative complications that may occur during and after the surgical procedure, respectively, are: **(Fragiskos, 2007)**

- Damage to the anatomic structures in case of penetration of the nasal cavity, maxillary sinus and mandibular canal with the bur.

- Bleeding from the greater palatine artery during apicoectomy of palatal root.

- Splattering of amalgam at the operation site, due to inadequate apical isolation and improper manipulations for removal of excess filling material (FIGURE.24).

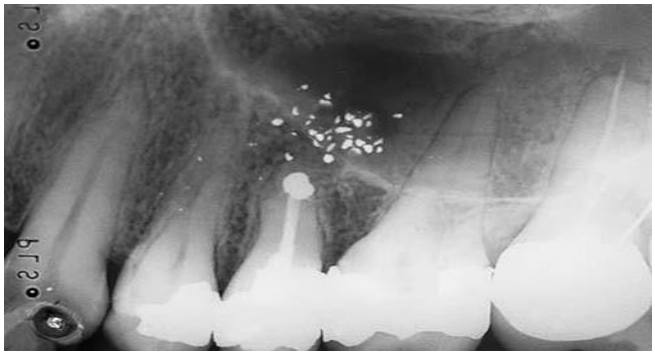

FIGURE.24 Amalgam splatters at operation site, as a result of improper manipulations for removal of excess material (Fragiskos, 2007)

- Staining of mucosa due to amalgam that remained at the surgical field (amalgam tattoo) (FIGURE .25).

FIGURE.25 Staining of mucosa due to amalgam that remained at surgical field after apicoectomy (amalgam tattoo) (Fragiskos, 2007)

- Healing disturbances, if the semilunar incision is made over the bony deficit (FIGURE.26) or if the flap, after reapproximation, is not positioned on healthy bone.

FIGURE.26 Wound dehiscence, as a result of improper design of semilunar incision (Fragiskos, 2007)

- Dislodged filling material due to superficial placement, as a result of insufficient preparation of apical cavity (FIGURE .27).

FIGURE.27 Malpositioned retrograde obturation material, due to insufficient preparation of apical cavity (Fragiskos, 2007)

- Incomplete root resection, due to insufficient access or visualization and misjudged length of root (FIGURE .28). As a result, the apical portion of the root remains in position and the retrograde filling is placed improperly, with all the resulting consequences.

FIGURE.28 Periapical radiograph showing unsatisfactory apicoectomy at maxillary second premolar, due to failure to define root before resection (Fragiskos, 2007)

Endodontics or Implants?

Contemporary dental treatment has advanced to a point where clinicians demand esthetic and predictable restorations for their dental patients. The advent of implant dentistry has provided a viable alternative to compromised teeth deemed unrestorable by conventional dental procedures. Implant dentistry has a long-term predictability and cost-effectiveness. When performed to the standard of care and under ideal circumstances, the surgical and prosthetic phases of the procedures can be done in an expeditious manner with a high level of satisfaction to the patient and the doctor.

There are many benefits to preserving one's natural dentition vs. extraction and implant therapy. When performed to the standard of care, endodontic therapy provides patients with a long-term result and a shorter mean time to restoration. Time to restoration is also reduced relative to implant therapy. In addition, endodontic therapy provides patients with a service that maintains the periodontal ligament, or PDL. The PDL is crucial to proprioception in order to maintain occlusal feedback and avoid damage to the temperomandibular joint. Preservation of the natural periodontal complex also allows for future orthodontic movement if needed, whereas an osseointegrated implant is an ankylosed structure that may impede orthodontic therapy. The negative psychological implications of tooth loss is never experienced by a patient who keeps his or her own dentition, and the long-term satisfaction rate is just as high relative to implant therapy.

When deciding upon extraction and implant therapy vs. saving the dentition via endodontic therapy, we must consider each case on an individual basis. Treatment decisions should be patient-centered, evidence-based, long- lasting, and cost-effective. Various factors need to be considered, such as clinician's expertise, strategic location of the tooth, bone quality, soft-tissue quality and

quantity, the patient's periodontal status, tooth restorability, and the patient's medical history. When giving patients options for their restorations, an implant surgeon must address the possibility of endodontic therapy and general dentists/endodontists must discuss the ramifications of implant therapy. As dentists, we are trained to preserve the natural dentition for our patients, and it is our ethical responsibility to do so whenever possible **(Toskos D, DiBernardo J., 2012).**

2.17 Conclusion

Success of surgical endodontics varies between 30% and 80%. The preservation of natural teeth should be our ultimate goal, because natural teeth are always far better than any man-made replacement. Endodontic surgery is considered as last resort to save a tooth with endodontic failure. With advent of magnification, microinstruments, ultrasonic tips and biologically acceptable root end filling materials, the success rate of surgical endodontics has shown to increase up to 92% along with favorable patient response **(Garg & Garg, 2019).** The dental profession has experienced considerable difficulty in finding within its procedures a suitable niche for surgical endodontic therapy, at one extreme, this type of treatment, has been overused and abused **(Leuebke et al., 1964).** Based on the contemporary understanding of endodontic concepts for success and failure, assessment and subsequent treatment of apicoectomy procedures have greatly improved. Advances in apicoectomy armamentaria and materials have enabled endodontists to treat challenging cases with much greater efficacy. The surgical technique which has been applied in this case i.e., apicoectomy, was appropriate and the results were satisfactory **(Avinash et al ., 2019).**

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