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# Non-surgical endodonticy retreatment

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of ............
in Partial Fulfillment for the Bachelor of Dental Surgery

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# Certification of the Supervisor

I certify that this project entitled "…………………………………..………………" was prepared by the fifth-year student …………………………… under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor's name

Date

# *Dedication*

This Thesis Is Dedicated To The People Who Have Supported Me Throughout My Education.

Thanks For Making Me See This Adventure Through To The End.

I Dedicate This Project to My Parents Who Told Me to Always Keep Their Head Up

# *Acknowledgment*

First of all we thank Allah for the most mercy for enabling us to present this project in the best form that we wanted to be, we thank our faculty and doctors who were provided us with all the knowledge. Most of all we are all thankful for our families for their endless love, assistance, support and encouragement also for our friends for their understanding and support to complete this project.

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# Introduction

## Introduction

Endodontic therapy or root canal therapy is a treatment sequence for the infected pulp of a tooth which is intended to result in the elimination of infection and the protection of the decontaminated tooth from future microbial invasion. Root canals, and their associated pulp chamber, are the physical hollows within a tooth that are naturally inhabited by nerve tissue, blood vessels and other cellular entities. Together, these items constitute the dental pulp **(Nanci et al, 2012)**.

Endodontic retreatment is defined in the glossary of the American Association of Endodontists (AAE) as the “procedure to remove root canal filling materials from the tooth, followed by cleaning, shaping, and obturating the canals.” This procedure is indicated in teeth where previous endodontic treatment seems inadequate or has failed, or in cases of long-term exposure of root canal filling material to the oral environment leading to apical pathology related to coronal leakage **(Raj et al, 2018)**.

Retreatment is considered the primary procedural option when the tooth exhibits inadequate initial root canal treatment, has palpation and percussion sensitivity, localized swelling, recurrent caries, leaky provisional restorations, and substandard or missing coronal restorations. Radiographic evaluation may show the presence of untreated canals, poor canal obturation with voids, separated instruments, recurrent caries not located during clinical examination, or defective restorations with open margins that can potentially contribute to nonhealing. Any combination of clinical symptoms, radiographic evidence, and other clinical findings may indicate that nonhealing is evident but may also arise without any contribution of the aforementioned conditions **(Nair et al, 2000)**.

Dentists and/ or endodontists should evaluate whether retreatment is viable from a pathological point of view and also consider whether the dental element will be structurally suitable for adequate restoration and fully functional in the oral environment after endodontic therapy **(American Association of Endodontists, 2016)**. As part of this diagnosis process, the tooth needs to be evaluated to rule out any vertical root fracture (VRF) that may be contributing to the endodontic failure that has presented **(AAE et al, 2015)**.

# Chapter I: Literature Review

# 1. Review

## 1.1 Disease Factors

The treatment of chronic apical periodontitis has an unexpectedly high degree of success considering the fact that the root canal system is infected and that a high percentage of areas within the root canal system are neither touched by instruments nor effectively cleaned using mechanical and chemical antimicrobial strategies **(Kakehashi et al, 2000)**. As a consequence of infection, endo- dontic treatment can fail when root canal treatment has not adequately eliminated or reduced the intrar- adicular bioburden. Failures occur even when the highest standards and the most conscientious proce- dures are adhered to because there are root canal complexities that cannot be cleaned and/or obturated with current technologies. Therefore, infection can persist or quickly reestablish itself. In rare cases, factors located outside the tooth within the inflamed periapical area can impede healing of apical periodontitis after a tooth has been treated endodontically **(Nair et al, 2004)**.

In rare cases, factors located outside the tooth within the inflamed periapical area can impede healing of apical periodontitis after a tooth has been treated endodontically. Nair has identified six biological factors that lead to recalcitrant asymptomatic radi-olucencies: (1) continued intraradicular infection inside the root canal system; (2) extraradicular infec- tion, such as periapical actinomycosis; (3) foreign body reaction due to extrusion of endodontic mate- rials; (4) accumulation of endogenous cholesterol crystals that cause inflammation of periapical tissues; (5) true cysts with no connection to the root canal **(Nair et al, 2000)**.

## 1.2 Endodontic failures

### 1.2.1 Missed canals

The etiology of endodontic failure is multi-faceted, but a significant percentage of failures are related to inadequate débridement of root canal systems. Missed canals contain tissue, as well as bacteria and other irritants that inevitably contribute to clinical symptoms and lesions of endodontic origin (Figure 1). Historically, and all too often, surgical treatment has been directed toward "corking" the end of the canal with the hopes that the retrograde filling material will incarcerate biological irritants within the root canal system over the life of the patient. Although this scenario may provide clinical success, it is not nearly as predictable for healing as non-surgical retreatment. Endodontic prognosis is maximized in teeth whose root canal sys- tems are cleaned, shaped, and obturated in all their dimensions **(Barbosa et al, 2004)**.

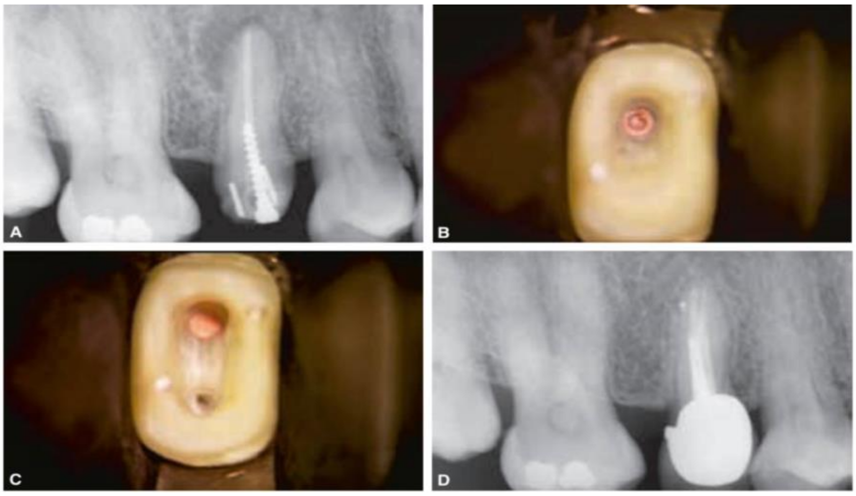


**Figure 1 A, Radiograph of a maxillary right second premolar reveals pins, a post, insufficient endodontic treatment and an asymmetrical apical lesion. B, Photograph (12 original magnification) after removal of the post from the buccal canal. The palatal canal had not been treated. C, Photograph (12 original magnification) of completed access and palatal canal preparation. D, Ten-year recall radiograph shows osseous repair, demonstrating the importance of correct endodontic treatment, and a well-designed prosthesis.**

There are multiple concepts, armamentarium and techniques that are useful to locate canals. The most reliable method for locating canals is to have knowledge regarding root canal system anatomy and appreciation for the range of variation commonly associated with each type of tooth .

Frequently used methods for identifying canals include: radiographic analysis, magnification and lighting (microscopes), complete access, firm explorer pressure, ultrasonics, Micro-Openers (Dentsply Tulsa Dental), dyes, sodium hypochlorite, color and texture, removing restorations, and probing the sulcus.

### 1.2.2 Tooth that more suffer from missed canal:

Endodontic retreatment involves treating missed canals, with 93% of all missed canals being on the maxillary first molar and 44% on maxillary second molars.

A missed MB2 canal is one of the main causes of endodontic failure in maxillary molars. It is not an uncommon practice to miss a canal while carrying out endodontic treatment especially in molar teeth where one root, one canal formula is frequently over ruled by the fact that number of canals are more than the number of roots. Moreover, a less than adequate access opening makes it difficult for the primary dentist to locate the supplemental canals. The inability to treat all the canals is one of the causes leading to endodontic failure. Bacteria residing in these canals lead to the persistence of symptoms. The results of one study carried out on 5616 molars which were retreated showed that failure to locate the MB2 canal had resulted in a significant decrease in the long-term prognosis of those teeth.

### 1.2.3 Mangement of missed canal:

With high magnification the dentist can safely and accurately search the inside of the tooth for the missed canal. Ultrasonic instruments are used to gently trephine further down the tooth. Once the canal is located the dentist will completely clean it out and fill it.

### 1.2.4 Pathological or iatrogenic perforations

One of the foremost causes of endodontic failure is persistent microbiological infection. The role of bacteria in periradicular infection has been well established in literature and endodontic treatment will be afflicted with a higher chance of failure if microorganisms persist in the canals at the time of root canal obturation.

Bacteria present in the periradicular area will be inaccessible to disinfection procedures. Canals with negative cultures for bacteria are said to have higher success rates as opposed to those canals which test positive.

Treatment is more likely to fail in these teeth with pretreatment periradicular rarefactions than those without these radiographic changes.

### 1.2.5 Inadequate obturations

Apart from proper disinfection and debridement of canals, another factor which is of colossal importance is the quality of obturation. The quality of root canal obturation was the most important factor in the success of the endodontic treatment in a study carried out on 1001 endodontically treated teeth **(Tronstad et al, 2019)**. Assessed teeth with endodontic failures, 65% of the cases exhibited poor quality obturation whereas 42% of the teeth had some canals which were left untreated. Success rates are naturally lower for obturations which are under or overextended and are highest for those which end flush or within 2 mm of the apex. Overextended obturation is 4 times more likely to fail than under obturated canals. In the presence of an existing periradicular lesion, an overextended root canal filling will have a worse prognosis than a tooth without excess filling material.

### 1.2.6 Complication of instrumentation

Rotary instruments tend to fracture in the canals when either laws of access cavity preparation are not adhered to or guidelines regarding the use of rotary instruments are not followed. As a consequence of fracture, the access to the apical portion of the root canal is decreased and this could have a deleterious effect on canal disinfection and later on, on obturation. Most of the studies done on the effect of fractured instruments have demonstrated the minimal influence on the success rate of the treatment. The stage of instrumentation at which the instrument breaks can have an effect on the prognosis. The disinfection and obturation of the part of canal distal to the fractured instrument becomes difficult possibly leading to the presence of persistent infection in that area. However, the fractured instrument itself has less to do with failure because most of the times, the success is only affected when a concomitant infection is present.A clinical investigation on relationship of broken rotary instruments to endodontic case prognosis confirmed that in the absence of any preoperative infection and periradicular changes, a separated instrument is most likely not to affect the prognosis. Hence it would be very rare that the fractured instrument is directly involved in endodontic failure **(Crump et al, 2000)**.

**Distribution of frequencies (%) of roots, root canals and apical foramina in human permanent teeth**

| | Number of roots | | | Number of root canals | | | | | Number of apical foramina | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maxillary teeth (n=700) | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Central incisors | 100 | - | - | 100 | - | - | - | - | 100 | - | - | - | - |
| Lateral incisors | 100 | - | - | 100 | - | - | - | - | 100 | - | - | - | - |
| Canines | 100 | - | - | 97 | 3 | - | - | - | 100 | - | - | - | - |
| First premolars | 32 | 66 | 2 | 6 | 88 | 6 | - | - | 16 | 81 | 3 | - | - |
| Second premolars | 83 | 17 | - | 25 | 73 | 2 | - | - | 56 | 43 | 1 | - | - |
| First molars | 1 | 6 | 93 | - | 1 | 21 | 76 | 2 | - | 1 | 64 | 33 | 5 |
| Second molars | 2 | 29 | 69 | 1 | 5 | 54 | 41 | - | 2 | 8 | 65 | 25 | - |
| Mandibular teeth (n=700) | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Central incisors | 100 | - | - | 65 | 35 | - | - | - | 100 | - | - | - | - |
| Lateral incisors | 100 | - | - | 58 | 42 | - | - | - | 100 | - | - | - | - |
| Canines | 97 | 3 | - | 78 | 22 | - | - | - | 97 | 3 | - | - | - |
| First premolars | 99 | 1 | - | 70 | 29 | 1 | - | - | 80 | 20 | - | - | - |
| Second premolars | 100 | - | - | 97 | 3 | - | - | - | 99 | 1 | - | - | - |
| First molars | 2 | 95 | 3 | - | 3 | 45 | 51 | 1 | - | 36 | 49 | 15 | - |
| Second molars | 7 | 91 | 2 | 1 | 8 | 87 | 4 | - | 5 | 54 | 40 | 1 | - |

## 1.3 Causes for endodontic failures such as :

**The usual factors which can be attributed to endodontic failure are:**

Persistence of bacteria (intra-canal and extra-canal) Inadequate filling of the canal (canals that are poorly cleaned and obturated) Overextensions of root filling materials.

Root canal bacteria can be isolated as planktonic cells, suspended in the liquid phase of the root canal and in the form of aggregates or congregatures adhered to root canals walls, giving place to several layers of biofilms. Biofilms are a model of bacterial growth where sessile cells interact to form dynamic communities linked to a solid substrate and located in a matrix of extracellular polymeric substances. The microorganisms that live in the same community must have the following characteristics: autopoiesis (having the ability to self-organize), homeostasis (resisting alterations of the environment in which they live), synergism (being more effective in groups than isolated) and the ability to respond to changes as a unit rather than as individuals.

To survive in a sealed duct, microorganisms have to endure the intracanal desinfection measures (chemomechanical preparation and intracanal drugs) and have to adapt to an environment with poor availability of nutrients. Therefore, only the few species that have these abilities may be involved in the endodontic treatment failure. In addition, bacteria located in areas such as apical deltas, isthmuses, lateral canals, irregularities and dentinal tubules, can often escape to endodontic disinfection procedures and it is probable that the bacteria nutrient supply remains unchanged after treatment. In contrast, the bacteria will not be able to survive if the substrate is drastically reduced or if the root filling does not allow the bacteria to access to perirradicular tissues. Nevertheless, resistant bacteria species will survive for relatively long periods by obtaining nutrients from tissue debris and dead cells. Furthermore, if the root filling does not provide an absolute seal, microfiltration of tissue fluids can provide a substrate for bacterial growth. The ability to survive in unfavorable conditions is very important for bacteria because they often experience periods of nutrient shortage. However, not always the microorganisms that manage to survive in these conditions are capable of causing endodontic failure. In fact, this will only occur if bacteria (their toxins and especially their endotoxins) are pathogenic, reach a sufficient number and access to periradicular tissues in order to induce or perpetuate periradicular lesions.

E. faecalis as the main microorganism associated with endodontic failure, nevertheless there are recent studies that isolate, to a greater extent, other bacteria such as Fusobacterium nucleatum and Propionibacterium.

Under normal situations, the long-term success rate for root canal treatment ranges between 80-90% and there is a failure percentage of 10-20%. Although success rates are high, the following are some of the most common causes of root canal treatment failure.

- Coronal leakage
- Root perforation
- Additional tooth roots
- Crack in the tooth

Controlled studies have shown that the endodontic treatment performed by the GDPs has a success rate of 65-75%, while the endodontic treatment performed by the endodontists has a success rate of more than 90%.

Root canal treatment failure is much dependent on the location of a tooth in an arch. In this respect most of the failures occur in posterior teeth. The majority of endodontic treatment failures occurred in the maxillary molars (44.4%), mandibular molars (20%) and maxillary premolars (15.5%) while mandibular incisors have a high endodontic failure rate (5.5%) as compared to maxillary incisors. The overall widely recognised explanation behind endodontic failure in the multirooted teeth was untreated or unfilled canals taken after by underfilling of the root canal system. In the mandibular incisors the reason for a high endodontic failure rate was an additional canal which was left untreated during the initial endodontic treatment.

Nonsurgical and surgical endodontic treatments have a high success rate in the treatment and prevention of apical periodontitis when carried out according to standard and accepted clinical principles. Nevertheless, endodontic periapical lesions remain in some cases, and further treatment should be considered when apical periodontitis persists. Although several treatment modalities have been proposed for endodontically treated teeth with persistent apical periodontitis, there is a need for less invasive methods with more predictable outcomes.

The prevalence of periapical lesions in endodontically treated teeth was 31.2%. PA lesion was associated with molar involvement.

Endodontic treatment is becoming more popular in dental practice to prevent apical periodontitis, particularly in healthy and growing adults . This is due to the significantly higher prevalence of dental caries worldwide.

A recent study to determine the prevalence of root-filled teeth in the age adult population revealed that 82.5% of patients with previously endodontically treated teeth had root-filled teeth. However, the quality of root canal treatment remains debatable, owing to an increase in periapical lesions in endodontically treated teeth.

Prospective researches are instructive to identify the burden and pattern of diseases and associated risk in a community . The removal of micro-organisms from root canals and the placement of a root filling that totally obturates the remaining space, followed by a restoration that produces an adequate coronal seal, form the basis of root canal treatment.

## 1.4 Diagnostic procedure

### 1.4.1 History and informed consent

The diagnostic phase, before any medical or surgical intervention, is based on the collection of the patient's medical history.

In surgical procedures, as endodontic procedures should be considered, the patient's history may be fundamental for establishing a diagnosis and the collection of information by the clinician should be as thorough as possible.

This series of information, which is crucial for obtaining a precise characterization of the disease, will have to be combined with other, equally fundamental, elements, in order to establish a correct treatment plan.

At this stage, the patient's expectations, the desire to preserve the affected teeth and the willingness to undergo treatments that require some time become fundamental.

It is not essential, but may be advisable, to explain to the patient the possible complications that can be encountered if the intervention fails; however, it will be necessary to obtain consent to act not only with regard to the strictly necessary endodontic maneuvers but also to be able to proceed with any alternative solutions.

One emblematic example is when it is impossible to obtain a good result with an endodontic treatment: if the patient has already been anesthetized, the clinician can proceed with the removal of the tooth without having to seek further consent from the patient. All these eventualities must be included and illustrated in an informed consent form, which must be signed by the patient and be prepared in compliance with local regulations.

### 1.4.2Clinical examination

#### 1.4.2.1 Extraoral examination

An extraoral examination should always be carried out to identify swelling or lymph node reactions, which are often the first warning sign of inflammatory diseases of the teeth.

- **Swelling**

Swelling is typical of acute cases and permit a diagnosis at the mere sight of the patient; acute scenarios place emphasis on the seriousness of the pathological process underway and advise a careful assessment of the infected tooth. This complication does not always have to be considered as an unfavorable prognostic element, but it certainly arouses reservations regarding the type of treatment to be undertaken on this tooth.

- **Skin fistulas**

Skin fistulas are rare in modern times.

This condition was more frequent in the past, probably because people less frequently underwent dental treatment.

They are often mistaken for dermatological manifestations and usually persist over time, generating significant bone lesions.

#### 1.4.2.2 Intra-oral inspection

- **Observation of deficient restorations**

The finding of inadequately sealed restorations can be considered a warning.

Several studies have documented the extent to which an inadequate restoration can be conducive to bacterial contamination of the root canal and periapical tissues.

In this sense, clinical analysis through a scrupulous systematic review of the literature is necessary

- **Observation of missing restorations**

The lack of restorations can also be predictive of endodontic periapical lesions.

Ricucci et al highlighted that the gutta-percha seal, although exposed to oral fluids, is sufficient for preventing bacterial aggression; however, periradicular lesions of endodontic origin are common in teeth without complete restorations.

#### 1.4.2.3 Fistulas

Fistulas can have varying characteristics: from a simple orifice of the vestibular mucosa, more rarely in the palatine area in the upper teeth and lingual area in the lower, to a hypertrophic evagination.

Pus often comes out of the fistula, either spontaneously or after vestibular acupressure. A fistula that drains spontaneously or otherwise is often prognostically unfavorable because this sign is linked to periapical infections sustained by bacteria that have colonized the root surface and therefore can only be eliminated with surgical procedures.

### 1.4.2.4 Swelling

Less frequently than with a fistula, a tooth with periradicular disease may present with visible swelling.

The observation can be supported by the subsequent periapical palpatory examination.

### 1.4.2.5 Radiology

Radiographic examination is essential in the diagnosis of endodontic periapical diseases. The careful observation of a two-dimensional radiogram is fundamental for an infinite series of elements that can be deduced from the black-and-white image.

### 1.4.2.6 Endodontic X-ray

The easiest way to identify a periapical disease is radiographic examination. It is conducted electively through the use of endodontic radiographs with several projections that are rigorously centered by dedicated plate holders.

In a multiradicular tooth, the use of multiple images aims to accurately discern which of the roots is responsible for the periapical pain. However, the identification of disease with this type of examination is not always precise. Indeed, as was well described over fifty years ago by Bender and Seltzer, an absence of involvement of the cortical bone in the destructive process caused by the periapical granulomatous reaction makes the lesion "invisible" radiographically, and it can only be supposed through a detailed examination of the periradicular contour, where the lack of the periradicular radiotransparency continuity would provide a first sign of a disruption of the periodontal ligament, a fundamental clinical indication for establishing the onset of an inflammatory disease of the tissues that support the tooth that originates from the endodontum.

When the cortical bone is also involved, the radiotransparency will be evident.

Thus, it must be considered to be larger than shown on the radiographic image The size of the lesion has significant diagnostic and prognostic values, providing the dentist with the information needed to identify the type of treatment to be carried out, as we will see later.

### 1.4.3 Three-dimensional radiology

#### 1.4.3.1 Cone Beam Computed Tomography (CBCT)

Cone beam computed tomography (CBCT) is a radiological examination that is similar to computerized axial tomography (CT) but is characterized by some relevant peculiarities.

In addition to scientific data in the strict sense of the term, three-dimensional diagnostics in endodontics has applications in the following areas:

The identification, localization, and extent of periapical disease; the possible involvement of one or more roots; and the involvement of neighboring noble structures, such as the maxillary sinus and the lower alveolar nerve and the mental foramen;

1. in cases of internal and external resorption;
2. in traumas of the lower third of the facial bones;
3. in traumas of doubtful cases and in the failure of endodontically treated teeth.

The advantages of a rational use of CBCT are therefore obvious; however, the greater radiogenic exposure to which the patient is subject, compared to two-dimensional endodontic radiographs, must be considered.

## 1.5 Patient Considerations

The indications for root canal retreatment are stated in a Consensus report of the European Society of Endodontology:

• Teeth with inadequate root canal filling with radiological findings and/or symptoms

• Teeth with inadequate root canal filling when the coronal restoration requires replacement

• Teeth with coronal dental tissue that is to be bleached

During the decision-making process it may be decided that in the absence of apical pathosis, an endodontically treated tooth with inadequate obturation may only be monitored but not retreated. Further radiographic monitoring and non-intervention were favored by a majority of general practitioners. However, treatment is recommended in cases of periapical radiolucency and discomfort or pain **(Peters et al, 2001)**.

A reliable and effective alternative to deal with a painful root-treated tooth is extraction of the tooth in question, a step that might entail additional dental treatment and costs. Large non-healing lesions lead to higher frequencies of therapeutic intervention than do smaller persistent lesions. Reit and Grondah found large inter-individual variations among general dental practitioners in attitudes to treatment of asymptomatic periapical lesions. The important decision whether or not to retreat a tooth is further influenced by ethnic values and financial considerations, as well as by the technical quality of the primary treat-ment. In cases where endodontic surgery is planned, orthograde retreatment should be attempted prior to surgery, because renewed disinfection and obturation improves the surgical success rate considerably.

## 1.6 The Technology of Retreatment

With so much potential for endodontic success, the fact remains clinicians are confronted with post-treatment disease. Before commencing with any treatment, it is wise to fully consider all the various treatment options. When the choice is non-surgical endodontic retreatment, then the goal is to access the pulp chamber and remove materials from the root canal space and if present address deficiencies or repair defects that are pathologic or iatrogenic in origin (Figure 1). Furthermore, endodontic access provides the opportu- nity to diagnostically evaluate teeth for coronal leakage, fractures, and missed canals." Importantly, following disassembly procedures, the root canals can be re-shaped and disinfected and obturated in a manner that allows periapical healing **(Wolcott et al, 2002)**.

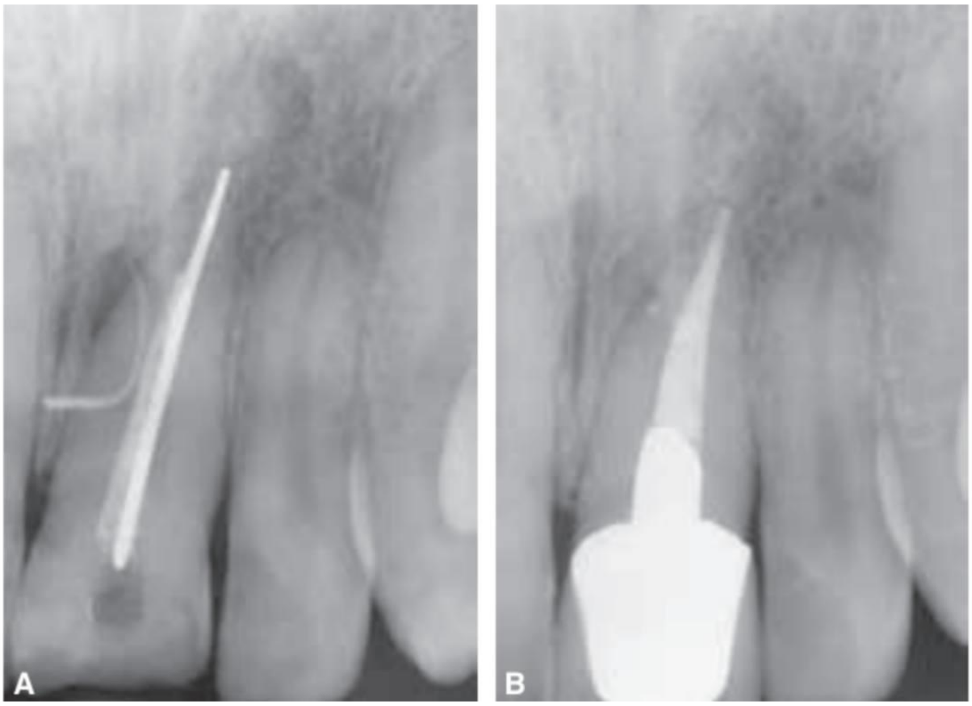

**Figure 2 A, Preoperative radiograph of an endodontically treated, non-healing maxillary central incisor. A gutta-percha point traces a sinus tract to a large lateral periapical lesion. B, Five-year recall radiograph demonstrates osseous repair following cleaning, shaping, and obturation. Note that the lateral lesion was associated with a lateral canal.**

## 1.7 Aim of endodontic retreatment

The aim of retreatment is to perform an endodontic treatment that can render the treated tooth functional and comfortable again, allowing complete repair of the supporting structures. Before starting the retreatment, it is profoundly important to consider all interdisciplinary treatment options in terms of time, cost, prognosis and potential for patient satisfaction.

It is important to evaluate the endodontic failures so a decision can be made among non-surgical retreatment, surgical retreatment or extraction.

Retreatment is classified into two major groups.

● Non-surgical or conventional retreatment: the retreatment procedure is done through the root canals. Used in cases where the initial treatment is incomplete or presence of inadequate treatments diagnosed as failures.

● Surgical retreatment: the treatment procedure is carried out after surgical exposure of the apical portion of the tooth.

Clinicians should always opt for non-surgical retreatment over the surgical option unless a successful outcome cannot be achieved by a non-surgical approach **(Stabholz et al, 2003)**.

## 1.8 Treatment Plan

There are essentially four options for treatment of a tooth that has post treatment disease: monitoring, extraction, nonsurgical retreatment, and surgical treatment .

Avoiding treatment may result in the progression of disease and continued destruction of supporting tissues as well as possible acute exacerbation of systemic side effects such as cellulitis and/or lymphadenopathy. In most cases, these options are unacceptable. Extraction and replacement is a viable option, but replacements for missing teeth rarely are better than an otherwise restorable natural tooth **(Bertrand et al, 2009)**.

## 1.9 Indications for Nonsurgical Endodontic Retreatment

1. Retreatment is considered the primary procedural option when the tooth exhibits inadequate initial root canal treatment.

2. Palpation and percussion sensitivity, localized swelling, recurrent caries, leaky provisional restorations.

3. Substandard or missing coronal restorations.

4. Radiographic evaluation may show the presence of untreated canals, poor canal obturation with voids, separated instruments, recurrent caries not located during clinical examination, or defective restorations with open margins that can potentially contribute to nonhealing.

5. Any combination of clinical symptoms, radiographic evidence, and other clinical findings may indicate that nonhealing is evident but may also arise without any contribution of the aforementioned conditions **(West et al, 2015)**.

## 1.10 Contraindications for Nonsurgical Endodontic Retreatment

1. A major factor to determine the requirement for nonsurgical retreatment is the restorability of the tooth after the necessary removal of preexisting restorative materials.

2. Additional tooth structure may be lost during caries elimination and removal of post and core materials.

3. The restorability decision often requires comprehensive disassembly of preexisting restorations and evaluation of the remaining root canal system.

4. Other factors include the presence of extensive periodontal involvement that weakens tooth support and/or the presence of problematic coronal or radicular fractures.

5. Patients who are not motivated to save the natural tooth are poor candidates for retreatment **(Rios et al, 2014)**.

## 1.11 Nonsurgical endodontic retreatment

The goals of nonsurgical retreatment are to remove materials from the root canal space and if present, address deficiencies or repair defects that are pathologic or iatrogenic in origin. Additionally, nonsurgical retreatment procedures confirm mechanical failures, previously missed canals or radicular subcrestal fractures. The procedures for endodontic nonsurgical retreatment can be grouped into disassembly, repair of existing perforations, access to missed anatomy, shaping and disinfection of the canal system, and obturation **(Smith et al, 2001)**.

Nonsurgical retreatment is indicated in cases of failed endodontic treatment. The effective removal of filling material from the root canal system is essential to ensure a successful outcome of the retreatment procedure .

Several methods have been used to remove root canal filling material, including the use of rotary systems specifically developed for this purpose. One of these systems is the ProTaper Universal retreatment system (Dentsply Maillefer, Ballaigues, Switzerland) . This system consists of 3 instruments: D1 (30/.09), D2 (25/.08), and D3 (20/.07).

Recently, a new reciprocating motion approach was introduced for instru- mentation using nickel-titanium instruments with M-Wire alloy, which is considered more resistant than conventional alloys .

Two systems, Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Maillefer), are based on this motion **(Torabinejad et al, 2010)**.

The Reciproc system consists of 3 single-use files: R25 (25/.08 in the first milli- meters), R40 (40/.06 in the first millimeters), and R50 (50/.05 in the first millimeters). The WaveOne system consists of 3 single-use files: small (21/.06), primary (25/.08 in the first millimeters), and large (40/.08 in the first millimeters) .

## 1.12 Principles of endodontic treatment :

1. Coronal access needs to be completed

2. All previous root-filling materials need to be removed

3. Canal obstructions must be managed

4. Impediments to achieving full working length must be overcome

5. Cleaning and shaping procedures : for effective obturation and case completion.

## 1.13 Coronal Disassembly

Clinicians typically access the pulp chamber through the existing restoration if it is judged to be functionally designed, well fitting, and esthetically pleasing. Endodontically, the decision to remove any restoration is based primarily on whether additional access is required to facilitate disassembly and retreatment. If the restorative is deemed inadequate and/or additional access is required, the restoration should be sacrificed. However, on specific occasions, it is desirable to preserve and remove the existing restorative dentistry. A variety of new technologies allow clinicians to more predictably eliminate coronal restorations **(Gomes et al, 2001)**.

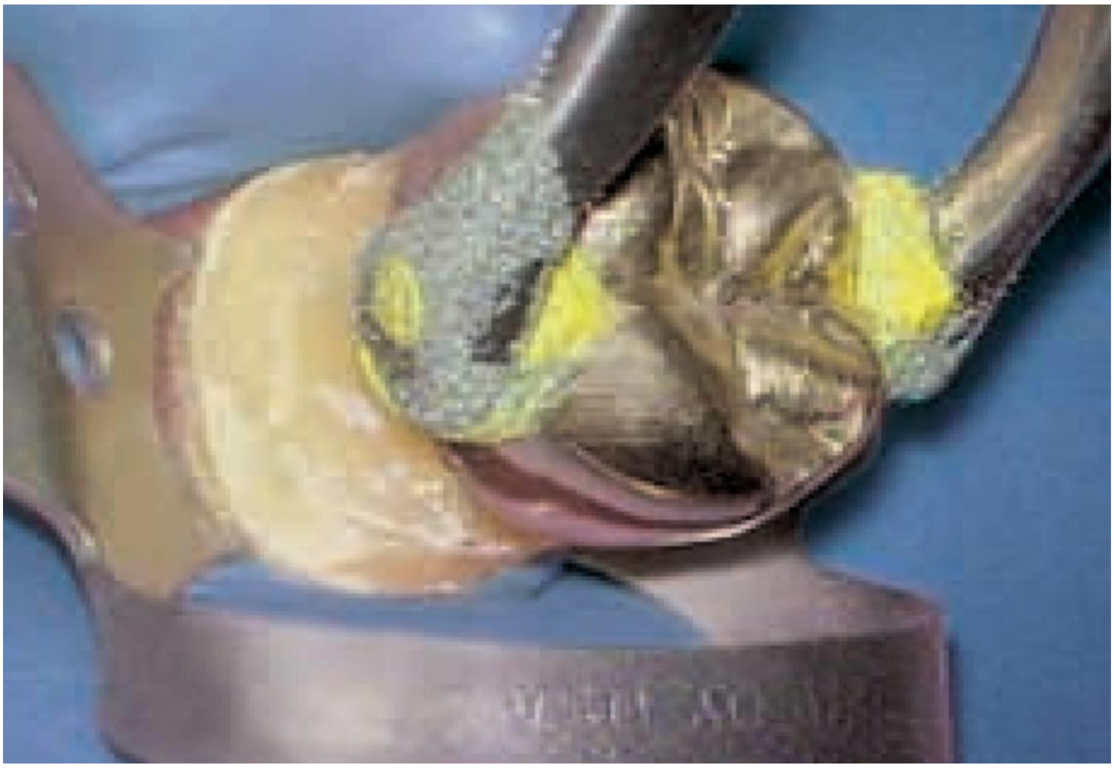

**Figure 3 Removal of a crown using the K.Y. Pliers. Note the grasping pads have been dipped in emery powder to reduce slippage.**

## 1.14 Coronal Disassembly Devices

Although there are many instruments available for coronal disassembly, the following represent a consensus of preferred instruments for the removal of various restorations. The tools used for disassembly have been arbitrarily divided into three categories. They can be used solely; however, it is useful to appreciate that they may be used in combination to synergistically attain removal success **(Johnson et al, 2010)**.

## 1.15 Removal of Obturation Materials

The obturation materials most frequently found in the root canal space generally reflect a past era of knowledge, a current school of thought, or a personal philosophy of treatment. There are some commonly encountered materials found in obturated root canal systems: gutta-percha, carrier-based obturators, silver points, and paste fillers. In addition, new obturation materials based on resin fillers and sealers have recently been recommended for obturation of root canal systems. Resin-based materials can generally be removed using the same technique described for the removal of gutta-percha. Frequently, it is necessary to partially or totally remove an obturation material to achieve endodontic retreatment success or to facilitate placing a post for restorative reasons.

## 1.16 Gutta-Percha Removal

The relative difficulty in removing gutta-percha varies according to the canal's length, cross-sectional diameter, and curvature. Regardless of technique, gutta-percha is best removed from a root canal in a progressive manner to prevent inadvertent displacement of irritants periapically. Dividing the root into thirds, the obturation is initially removed from the canal in the coronal one-third, then the middle one-third, and finally eliminated from the apical one-third.

In canals that are relatively large and straight, loosely fitting cones can, at times, be removed with one instrument in one motion. For other canals, there are a number of possible gutta-percha removal schemes.

The techniques include rotary files, ultrasonic instru-ments, heat, hand files with heat or chemicals, and paper points with chemicals. Of these options, the best technique(s) for a specific case is selected based on preoperative radiographs and clinically assessing the diameter of the orifices after re-entering the pulp chamber. Often, a combination of methods is required to achieve a safe, efficient, and potentially complete elimination of gutta-percha and sealer from the internal anatomy of the root canal system.

Gutta percha is a thermoplastic material; therefore, there are different techniques for its removal. The traditional technique uses K files or H files, along with chemical solvents such as xylol or chloroform to soften the gutta percha component of the obturation material, allowing further penetration of the file deeper into the canal. The procedure begins from the crown to the apex, using copious irrigation with a physiological solution and/or sodium hypochlorite along with the removal. Gates burs can be used for the coronal and middle thirds in root canals with very compact fillings. Later, together with mechanized endodontics, different brands of gutta-percha removal systems have emerged. All function in the same way, generally using rotational movement (Figure 4B).

WaveOne® (Dentsply Maillefer, Switzerland) and Reciproc® (VDW, Germany) instruments, of reciprocating motion, have also been suggested to remove gutta percha with very good results (Figure 4C). In any case, and considering these varied possibilities, a recommended technique would be to use mechanized systems to remove most root filling material without solvent, and then finish the apical portion or curvatures manually with solvent if necessary .

Although the use of solvents facilitates the procedure by softening the gutta percha, on the other hand, gutta-percha sticks to the root canal walls, hindering its complete elimination at times .

Residual solvents may hamper contact of the new obturation material (sealer and gutta percha) potentially creating a poten- tial leakage avenue over time. Therefore, its use is recommended only when essential. Currently, the use of ultrasound under magni- fication is proposed for removing remnants of filling material within the canal and optimizing its cleaning (Figure 4D) **(Weine et al, 2012)**.

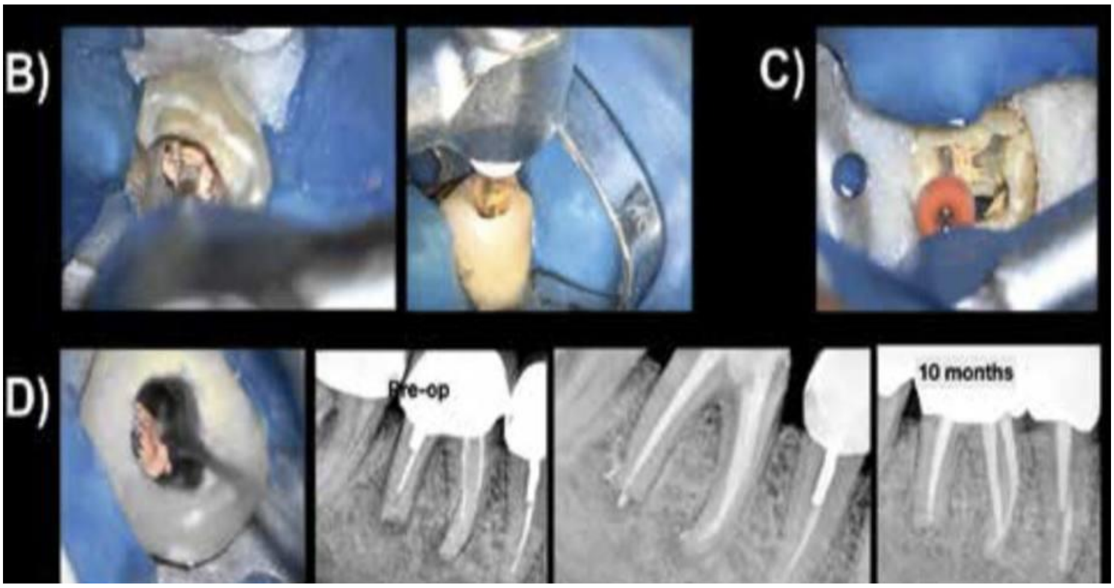

**Figure 4: 4B. Gutta-percha removal under continuous motion ProTaper Retreatment System. 4C. Reciprocation motion WaveOne system. 4D. Ultrasonic removal of gutta-percha**

There are various methods or techniques for the retrieval of gutta-percha like manual, Rotary, laser etc. The selection of each technique depends on the patient factors, the complexity of the root canal anatomy and ultimately the clinician operative skills and experience .

**Gutta-percha can be removed by using :**

- Hand instruments
- Rotary instruments
- Ultrasonics
- Lasers
- Solvents
- Microdebriders

### 1.16.1 Rotary Instrumentation Removal of Gutta-Percha

Rotary instrumentation is the most efficient method for removing gutta-percha from a previously treated root canal (Figure 5). The ProTaper Retreatment Kit (Dentsply International) is an example of a system that is useful in the retreatment of gutta-percha-filled root canals. However, to avoid instrument fracture, rotary instruments should be used with caution in underprepared canals and are generally not selected for removal of gutta-percha in canals that do not have a glide path that allows the instrument to cut passively **(Schirrmeister et al, 2006)**.

When attempting gutta-percha removal, it may be useful to divide the root into thirds and then select two or three appropriately sized rotary instruments that will fit passively within these progressively narrower regions. To mechanically soften and effectively remove gutta-percha, rotary instruments should turn at speeds ranging between 900 and 1200 pm. ultimately, the rotational speed has an effect on the amount of frictional heat generated to mechanically soften and effectively auger gutta-percha coronally. Coronal removal of gutta-percha allows the early introduction of solvents into the canal(s) and facilitates subsequent cleaning and shaping procedures **(Ezzie et al, 2006)**.

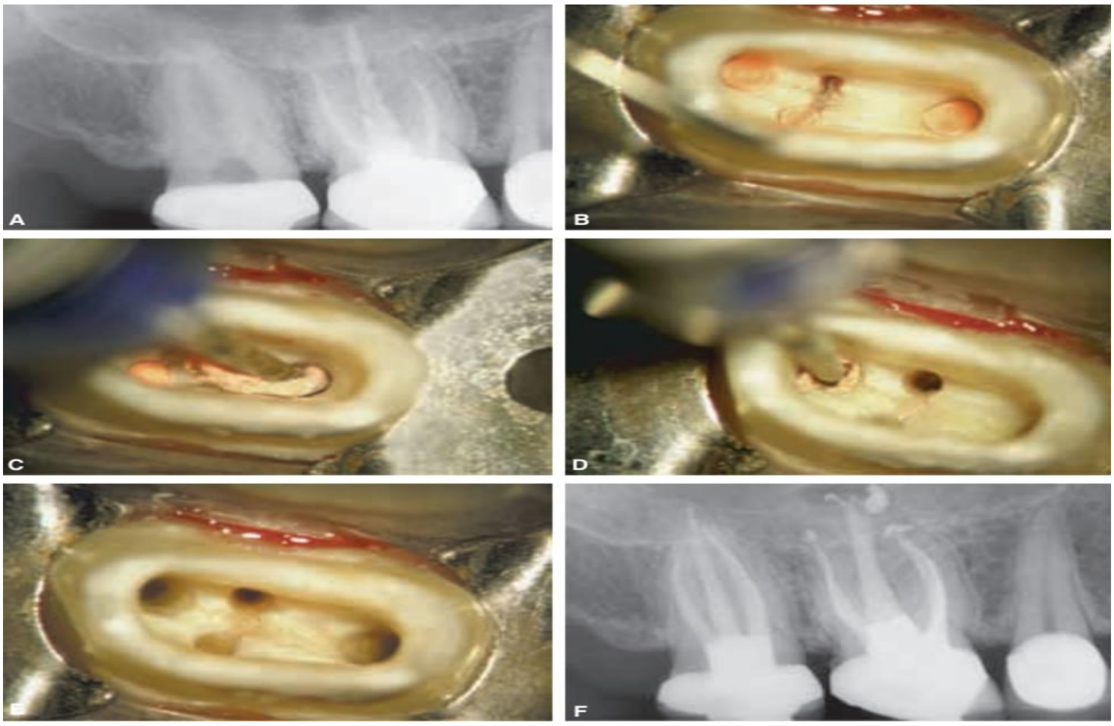


**Figure 5A, Radiograph of an endodontically treated, failing maxillary right first molar. Note the inadequate treatment resulting in an apical lesion .B, Photograph (15 original magnification) after crown removal, adequate access, and the identification of an MB2 root canal orifice. C, Photograph (15 original magnification) demonstrates the removal of gutta-percha from the palatal canal with a 0.06 tapered NiTi rotary profile. D, Photograph (15 original magnification) demonstrates the removal of gutta-percha from the mesiobuccal canal with a smaller sized 0.06 tapered NiTi rotary profile. E, Photograph (15 original magnification) shows the pulpal floor and orifices following canal preparation procedures. F, Postoperative radiograph after completion of retreatment.**

## 1.16.2 Ultrasonic Removal of Gutta-Percha

The piezoelectric ultrasonic effect represents a useful technology to rapidly remove gutta-percha. The energized instruments produce heat that thermo-softens gutta-percha. Specially designed ultrasonic instruments may be carried into shaped canals and will displace gutta-percha coronally into the pulp chamber where it subsequently can be removed **(Pisano et al, 2016)**.

### 1.16.3 Heat Removal of Gutta-Percha

A power source in conjunction with specific electric heat carrier instruments may be used to thermo-soften and remove increments of gutta-percha from root canal systems. The cross-sectional diameter of the heat carrier limits its use in under-prepared canals and around canal curvatures; however, in larger canals, this method works quite well. The technique involves guiding a heated plugger into the most coronal aspect of the gutta-percha. The heated plugger is then deactivated and withdrawn, generally resulting in the removal of an attached portion of gutta-percha. This process is repeated as long as it continues to be productive **(Kopper et al, 2003)**.

### 1.16.4 Heat and Instrument Removal of Gutta-Percha

Another technique to remove gutta-percha employs heat and Hedström files. In this method of removal, a hot instrument is plunged into the gutta-percha and immediately withdrawn in order to only heat-soften the material. A size 35, 40, or 45 Hedström file is then selected and quickly and gently screwed into the thermo-softened mass. When the gutta-percha cools, it will solidify on the flutes of the Hedström file. In poorly obturated canals, removing the file may eliminate the entire gutta-percha mass in one motion.

This technique is recommended in canals where gutta-percha extends beyond the apical foramen.

After removing as much of the gutta-percha as possi-ble, the clinician must verify whether residual gutta-percha and sealer are entrapped within the canal sys-tem. Chemical removal techniques are then used in conjunction with the described technique.

### 1.16.5 File and Chemical Removal of Gutta-Percha

The file and chemical removal technique is best used to remove gutta-percha from small and/or more curved canals. Chloroform is the most frequently used solvent and plays an important role in chemically softening gutta-percha. This sequential technique involves filling the pulp chamber with chloroform, selecting an appropriately sized K-type file, and then carefully preparing the canal while removing the chemically softened gutta-percha. Initially, a size 10 or 15 stainless steel file is used to "pick" into the gutta-percha occupying the coronal one-third of the canal. Frequent irrigation with chloroform in combination with a "watch-winding" motion creates a pilot hole and sufficient space for the serial use of larger files to remove gutta-percha in this specific region of the canal. This method is continued until gutta-percha is no longer evident on the cutting flutes of the files when they are withdrawn from the solvent-filled canal. Only after gutta-percha has been removed from the coronal one-third of the canal should the clinician repeat the technique in the middle one-third and finally in the apical one-third. This progressive removal technique helps prevent the needless extrusion of chemically softened gutta-percha periapically. Once the "file and chemical" gutta-percha removal technique has been completed, the residual sealer and gutta-percha that remain in the irregularities of the root canal system need to remove **(Ricucci et al, 2003)**.

## 1.17 Fractured Instrument Removal

Every clinician who has performed endodontics has experienced a variety of outcomes ranging from a case well done to a procedural accident such as the separation of an instrument. During root canal preparation procedures, the risk of instrument breakage or fracture exists.

When instrument breakage occurs, it provokes considerable stress to the clinician. In fact, the fractured instrument dilemma has caused such emotional distress that this event is frequently referred to as a "separated" or "disarticulated" file **(Pinto et al, 2006)**.

Many clinicians associate a "broken instrument" with a separated file, but the term could also apply to a sectioned silver point, a segment of a Lentulo instrument, a GG drill, a portion of a carrier-based obturator, or any other device obstructing the canal. With the advent of rotary NiTi files, there has been an increase in the occurrence of fractured instruments.

Today, separated instruments can usually be removed due to technological advancements in vision, ultrasonic instrumentation, and microtube delivery methods. Specifically, the increasing integration of the dental operating microscope into clinical practice allows clinicians to visualize the coronal portion of most fractured instruments. In combination, the microscope and ultrasonic instrumentation have created "microsonic" strategies which have greatly improved the potential and safety of removing broken instruments **(Tamse et al, 2015)**.

## 1.18 Regaining the Apical Patency

The success of the retreatment depends on finding the natural path of root canals usually compromised by iatrogenic causes such as transportation, perforation, ledge, separated instruments, overfilling, or any other event that prevents the location of the apical foramen during root canal reshaping. These mishaps prevent proper disinfection of the whole canal system.

As there is a positive correlation between intracanal infection and endodontic failure , it is reasonable to affirm that cleaning the root canals in their whole extension is crucial to improve the prognosis. This was demonstrated in a prospec- tive clinical trial assessing the success rate of 452 teeth submitted to endodontic retreatment. In this study, Gorni and Gagliani **(Gorni et al, 2004)** concluded that, after a 2-year follow-up period, in teeth in which the original canal anatomy remained unaltered, and patency regained, success rate reached 87%. In contrast, the success rate in cases in which the foramen could not be located—those with altered anatomy—was around 47%, clearly demonstrating the importance of controlling intracanal infection during endodontic procedures.

Then, the best scenario for the retreatment procedure is when the final 3–4 mm of the canal is accessible and can be properly prepared, while the worst scenario is when a blockage prevents achieving patency. In clinical practice, these two param- eters should be carefully evaluated before intervention in order to detect the pres- ence of mishaps and deviations of the original canal path. But sometimes, only an accurated clinical exploration can depict the case and determine the next steps regarding the choice of endodontic retreatment, apical surgery, or extraction of the involved tooth.

## 1.19 Type of solvent in remove of gutta percha

Using of solvents to remove Gutta-Percha since it has been seen that gutta-percha is soluble in chloroform, methyl- chloroform, benzene, xylene, eucalyptol oil, halothane and rectified white turpentine, it can be removed from the canal by dissolving it among these solvents.

Being highly volatile, chloroform is most effective so commonly used. Since at high concentrations, it has shown to be carcinogenic, its excessive filling in pulp chamber is avoided.

Gutta-Percha dissolution has to be supplemented by further negotiation of the canal and removing the dissolved material from it.

The blades of these nickel titanium instruments engage softened gutta percha and effectively auger this material out of a root canal space.

Certainly, hand files in the presence of a chemical, such as chloroform, is another important method to remove gutta percha from smaller and more curved canals. Chloroform rapidly softens gutta percha and, in conjunction with files, allows for the removal of gutta percha in a crown-down manner. With the canals filled with chloroform bath then paper points are utilized to wick residual gutta percha and sealers from the more inaccessible regions of the root canal system.

## 1.20 Root Canal Reshaping

During retreatment, it is impossible to separate the removal of gutta-percha phase from the reshaping canal step since both are carried out simultaneously. An exten- sive body of literature shows the impossibility of completely removing all filling material remnants from previous treatment even after reshaping. So, when evaluating the effects of canal reshaping, it is important to consider the following **(Rossi et al, 2017)**:

- ❖ Reshaped canals are generally widened in the same direction of the initial prep- aration when the same instrumentation technique is used. The clinical signifi- cance of this finding is that, ideally, reshaping should be conducted with a distinct technique . From a practical point of view, this is possible only when the same professional retreats his/her own cases.
- ❖ Patency and apical enlargement are positively correlated with periapical healing.

- ❖ The maintenance of as much of the original morphology of root canals as possible during retreatment, avoiding procedural errors such as canal deviations, ledges, perforations, and broken instruments, is positively associated with clinical success .
- ❖ Excessive dentin removal should be prevented to avoid weakening of the root and increase the risk of vertical root fracture .
- ❖ Some manufacturers developed rotary instrumentation systems specifically designed for endodontic filling removal, but they do not have good performance compared with conventional instruments.
- ❖ The use of the crown-down preparation concept, which starts the removal of fill- ing materials, by widening the coronal and middle thirds before preparing the apical third, is the most suitable approach for attaining the objectives of root canal reshaping in retreatment cases.

### 1.20.1 Type of irragation

The effectiveness and safety of irrigation depends on the means of delivery. Traditionally, irrigation has been performed with a plastic syringe and an open-ended needle through which the irrigant solution enters the canal space. Putting in mind the following point while irrigating the canal:

1. The solution must be introduced slowly and passively into the canal.

2. Needle should never be wedged into the canal and should allow an adequate back-flow

3. Blunted needle of 25 gauges or 27 gauges are preferred.

4. In case of small canals, deposit the solution in pulp chamber Then file will carry the solution into the canal.

5. Canal size and shape are crucial for irrigation of the canal. For effective cleaning of apical area, the canals must be enlarged to size 30 and to larger size.

**Types of Irrigation solutions**

**1. Normal saline**

Normal salineone of the solutions thatused as irrigant in endodontics. It causes gross debridement and lubrication of root canals .Since it very mild in action, it can be used as an adjunct to chemical irrigant. It can also be used final rinse for root canals to remove any chemical irrigant left after root canal preparation .Normal saline as 0.9% W/V is commonly used

**2. Sodium hypochlorite (NaOCl)**

Sodium hypochlorite is a clear, pale, green-yellow liquid with strong odor of chlorine .It is easily miscible with water and gets decomposed by light. The sodium hypochlorite is the most common irrigating solution used in endodontics. Sodium hypochlorite hasmany Desirable properties:

➢ An effective antimicrobial and proteolytic agent

➢ Excellent organic tissue solvent

➢ Lubricant with fairly quick effects.

➢ NaOCl is consider both an oxidizing agent and a hydrolyzing agent.

Unfortunately, even though NaOCl has many desirable properties it has some limitation such as:

➢ Being toxic.

➢ Nonsubstantive

➢Ineffective in smear layer removal

➢ Corrosive.

➢ It may cause discoloration

➢ Unpleasant odor.

➢ When NaOCl is used as a final rinse, bonding of the sealer to the dentin may be altered .

**1.20.2 Reshaping the Canals at the Established Working Length**

Bring the reciprocating instrument of choice back to the scenario again. The recip- rocating instrument should be used at the working length with gentle apical move- ments of 1–2 mm of amplitude without forcing the instrument. In case of resistance, return to the glide path instrument or use another drop of solvent if necessary; however, always after the use of the solvent, irrigate the canal in order to prevent the slurry material precluding further cleaning. Dry the canal and irrigate again with NaOCl delivered with a 30-gauge needle with no pressure. Apical enlarge- ment should be performed based on canal anatomy and in the first instrument that cuts dentin at the apical portion, generally the final 3–4 mm of the canal. Enlarge the canal with an ISO file at least three sizes larger than the initial instrument. After apical preparation, final irrigation should be performed, and the solution must be sonically or ultrasonically agitated for 1 min in each canal. A final flush with 5 mL of saline solution could be performed with the objective of washing out debris. Dry the canal and finish the case with proper filling or place an intracanal dressing of calcium hydroxide mixed with NaOCl or any other calcium hydroxide-based material.

### 1.20.3 Challenges: Oval Canals, Irregularities, and Isthmuses

One of the major challenges is how to clean adequately the untouched canal walls, especially in the presence of gutta-percha remnants and sealer that can preclude access to infected areas at the canal walls. The activation of irrigant solutions seems to be an alternative to fullfil this purpose . This is also true for retreatment procedures.

In fact, the interchange irrigation using EDTA and NaOCl is a good alternative for retreatment, and the irrigant of choice to initiate the procedure is 17% EDTA aqueous solution, for two reasons:

1. Chelating solutions have a slight dissolving effect on most sealers.

2. Chelating solutions dissolve the inorganic components from the root canal walls facilitating the mechanical removal of filling materials.

Besides, chelating solutions can help disinfection since they can interfere with bio- film cohesion. A 10% citric acid solution has similar properties to 17% EDTA and can be an option for irrigation when associated with NaOCl **(Zehnder et al, 2011)** .Once the bulk of gutta-percha is removed, the canals need to be disinfected and the use of sodium hypochlo- rite (NaOCl) in high concentrations (2.5–5.25%) is the first choice because of its broad antimicrobial spectrum and outstanding effect on biofilm, as well as, its capac- ity to dissolve necrotic tissue remnants . The use of sonic and ultrasonic activation of the irrigant has gained popularity among specialists and has been proven to enhance disinfection and debris removal. As a final irrigation, in order to flush the debris out of the canal, when irrigation with high pressure is needed to remove debris from the canal walls, saline solution can be used. High pressure with saline solution is safer than using NaOCl for this purpose. It is important to notice that after the use of saline in the retreatment procedures, the canal should be dried and replenished with EDTA or NaOCl. The clinical recommendation is to use a high volume of irrigation in high frequency, such as 5 mL of irrigant followed by its activation after each instrument use. This recommendation is far above that usually recommended in the literature, but it is necessary in the face of canal contamination, especially in failed cases.

Blocks, ledges, transportations and perforations are another challenges that occur because failure to respect the biological and mechanical objectives for shaping canals and cleaning root canal systems predisposes to needless complications such as blocks, ledges, external trans- portations and perforations. These iatrogenic events can be attributable to working short, the sequence utilized for preparing the canal, and the instru- ments and their method of use.

## Techniques for Managing Blocks

Techniques for managing blocked canals begin by confirming straight line access and then pre-enlarging the canal coronal to the obstruction. A 10 file provides rigidity and is pre-curved to simulate the expected curvature of the canal. The unidirectional rubber stop is oriented to match the file curvature. With the pulp chamber filled with a vis- cous chelator, efforts are directed toward gently sliding the 10 file to length. If unsuccessful, the file is used with an apically directed picking action while concomitantly re-orienting the unidirectional stop which serves to re- direct the apical aspect of the pre-curved file. Short amplitude, light peck- ing strokes are best utilized to ensure safety, carry reagent deeper, and increase the possibility of canal negotia- tion. If the apical extent of the file “sticks” or engages, then it may be use- ful to move to a smaller sized hand file. A working film should be taken and the file frequently removed to see if its curve is following the expected root canal morphology (figure 6). Depending on the severity of the blockage, perseverance will oftentimes allow the clinician to safely reach the foramen and establish patency **(Ruddle et al, 2002)**.

**Figure 6a. A pre-operative radiograph of a maxillary left second bicuspid reveals previous access and pre-enlargement of the canal in its coronal two-thirds.**

**Figure 6b. The post-operative radiograph provides an explanation as to the etiology of the original block. Note the canal bifurcates apically and this system has four portals of exit.**

## Techniques for Managing Ledges

An internal transportation of the canal is termed a “ledge” and frequent- ly results when clinicians work short of length and “get blocked.” Ledges are typically on the outer wall of the canal curvature and are oftentimes bypassed using the techniques described for blocks. Once the tip of the file is api- cal to the ledge, it is moved in and out of the canal utilizing ultra-short push- pull movements with emphasis on stay- ing apical to the defect. When the file moves freely, it may be turned clock- wise upon withdrawal to rasp, reduce, smooth or eliminate the ledge. During these procedures, try to keep the file coronal to the terminus of the canal so the apical foramen (foramina) is han- dled delicately and kept as small as prac- tical. When the ledge can be predictably bypassed, then efforts are directed toward establishing patency with a 10 file. Gently passing a .02 tapered 10 file 1 mm through the foramen ensures its diameter is at least 0.12 mm and paves the way for the 15 file.

A significant improvement in ledge management is the utilization of nickel- titanium (NiTi) hand files that exhibit tapers greater than ISO files. Certain NiTi instruments have multiple increas- ing tapers over the length of the cutting blades on the same instrument (ProTaper, Dentsply Tulsa Dental). Progressively tapered NiTi files can be introduced into the canal when the ledge has been bypassed, the canal negotiated and patency established. Bypassing the ledge and negotiating the canal up to a size 15, and if necessary to a 20 file, creates a pilot hole so the tip of the selected NiTi instrument can passively follow this glide path. To move the apical extent of a NiTi hand file past a ledge, the instrument must first be pre-curved with a device such as Bird Beak ortho- dontic pliers (Hu-Friedy; Chicago, Ill.). Ultimately, the clinician must make a decision based on pre-operative radi- ographs, root bulk and experience whether the ledge can be eliminated through instrumentation or if these procedures will weaken or perforate the root. Not all ledges can or should be removed. Clinicians must weigh risk versus benefit and make every effort to maximize remaining dentin **(Ruddle et al, 2003)**.

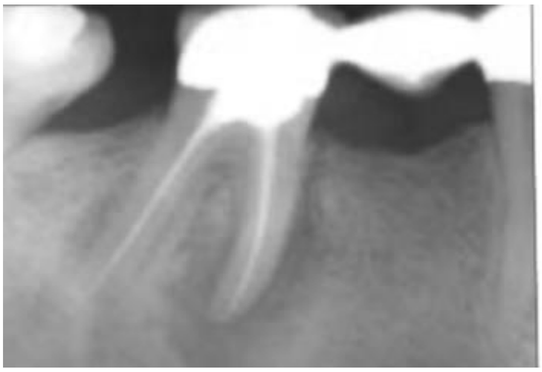

**Figure 7a. A pre-operative radiograph shows an endodontically failing posterior bridge abutment. Note the amalgam in the pulp cham- ber and that the mesial root appears to have been ledged.**

**Figure 7b. A post-treatment film demon- strates ledge management with the obturation materials following the root curvature.**

## Techniques for Managing Perforations

A perforation represents a pathologic or iatrogenic communication between the root canal space and the attachment apparatus. The causes of perforations are resorptive defects, caries, or iatrogenic events that occur during and after endodontic treatment. Regardless of eti- ology, a perforation is an invasion into the supporting structures that initially incites inflammation and loss of attach- ment and ultimately may compromise the prognosis of the tooth. When man- aging these defects the prognosis will be impacted by the level, location and size of the perforation, and further influ- enced by its timely repair.

Techniques and materials for man- aging perforation defects have been described earlier under the heading “Techniques for Managing Transpor- tations.” However, on occasion, tooth- colored restoratives may be the material of choice for repairing certain perfora- tions. Tooth-colored restoratives, such as a dual cured composite, require the placement of a barrier so the material is not contaminated during use. A barrier serves as a “hemostatic” and a “back- stop” so a restorative material can be placed into a clean, dry preparation with control. Calcium sulfate is an excellent absorbable barrier material when using the principles of wet bond- ing because it is biocompatible, osteogenic, and following placement, sets brick-hard **(Sottosanti et al, 2012)**

**Figure 8 a. A pre-operative radiograph of an endodontically involved mandibular left sec- ond molar bridge abutment. Note the previous access and possible floor perforation.**

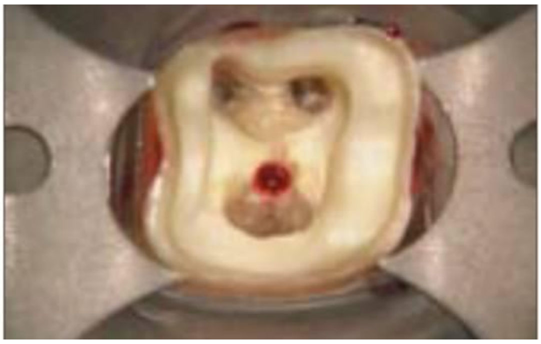

**Figure 8 b. A photograph demonstrates the identified orifices and a frank furcal floor perforation.**

**Figure 8c. This photograph shows the perforation repair utilizing a calcium sulfate resorbable barrier and a dual cured composite restorative.**

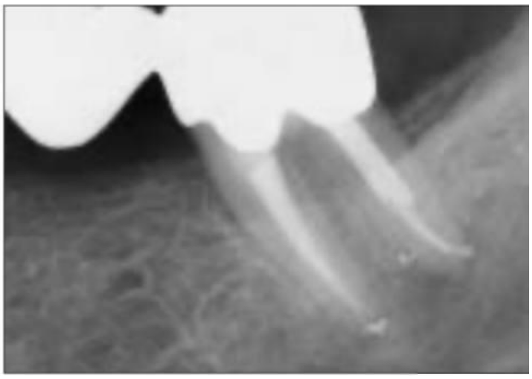

**Figure 8 d. A five-year recall film shows a new bridge and osseous repair furcally and apically.**

## 1.21 Vertical Extent of Instrumentation

The vertical extent of instrumentation and filling in primary endodontic treatment is a controversial topic, resulting in endless discussions between academicians and clinicians. In cases of apical periodontitis, in which bacteria and biofilm are spread throughout the root canal system, including the apical portion , it seems logical that the vertical extent of the preparation should be set the nearest as possible to the apical foramen.

Today, there is no doubt about the superiority of electronic apex locators in deter- mining the working length over the traditional radiographic method. Apex locators that work by impedance difference allow the precise location of the apical foramen, enabling the practitioner to respect the anatomical and morphological limits of the canal, providing greater predictability to the endodontic treatment.

## 1.22 Best File for Retreatment

As discussed before, the complete removal of the filling material from the canal space, regardless of the instrument or technique, is not possible. Manual, rotary, or reciprocating instruments can be used for this purpose, basically with the same results. Therefore, the technique used for endodontic retreatment can be considered a personal preference.

The development of the asymmetric reciprocating movement allowed an effective approach for the removal of root filling materials and represents our preferred technique for retreatment because of its simplicity, efficacy, and low incidence of procedural errors. The use of a reciprocating instrument for retreatment was first described by Zuolo et al **(Zuolo et al, 2013)**. the authors compared the percentage of filling material found on the canal walls after performing different retreatment techniques. The use of a reciprocating instrument resulted in an overall gutta-percha removal of 95%. A great number of authors also support that the reciprocating movement is safe and effective for this purpose. The reciprocating movement is also faster than manual or rotary instruments for gutta-percha removal. Silva et al **(Silva et al, 2018)**. demonstrated that the reciprocating technique performed by under- graduate students was the most effective and less time-consuming in the removal of gutta-percha than rotary or manual techniques. Together, these results emphasize the efficacy and simplicity of this technique for endodontic retreatment. Clinically, we have seen that the use of Reciproc instruments usually remove gutta-percha in large fragments, especially at the coronal and middle portions of the canal, and is associated with less time required to take out the bulk of filling materials (Figure 9).

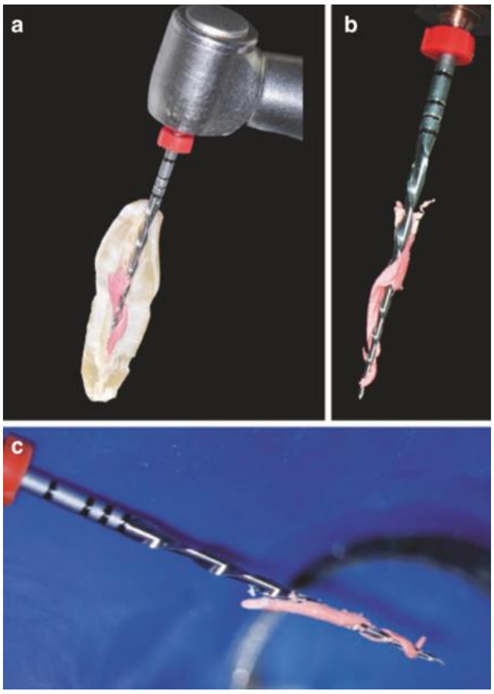

**Figure 9: (a) Reciproc R25 M-wire instrument removing filling material from the root canal of an extracted endodontically- treated tooth. The tooth was split in halves to facilitate visualization of the efficiency of the R25 instrument to imbricate into the filling material. (b) The filling material in (a) was almost entirely removed from the root canal by the R25 instrument. (c) Clinical image showing the removal of filling material with the R25 M-wire instrument**

The safety of the reciprocating movement has also been tested to evaluate transportation in curved canals. Rödig et al **(Rödig et al, 2014)**. showed no procedural errors such as canal blockage, ledge, or perforation in the preparation of 60 curved canals with Reciproc instruments.

Nevares et al. compared Reciproc and ProTaper Next for reshaping mesial root canals of molar with severe curvature and reported no significant difference between the two systems regarding the remaining of filling materials, volume of dentin removed, or apical transportation. Bago et al. tested four retreatment NiTi systems and showed that Reciproc M-Wire and ReciprocBlue instruments were effective in removing filling materials from curved canals of extracted teeth compared to WaveOne Gold and ProTaper retreatment systems.

Extrusion of debris should be avoided during the removal of filling material as it has been associated to some retreatment techniques or instruments. Silva et al. compared the rotary and reciprocating techniques regarding the extrusion of debris and observed that Reciproc and WaveOne systems resulted in less extrusion of debris than the ProTaper retreatment system. Other authors confirmed these results . In addition, Comparin et al. found that reciprocating and continuous rotary systems were equivalent regarding the incidence, intensity, and duration of postoperative pain after endodontic retreatment.

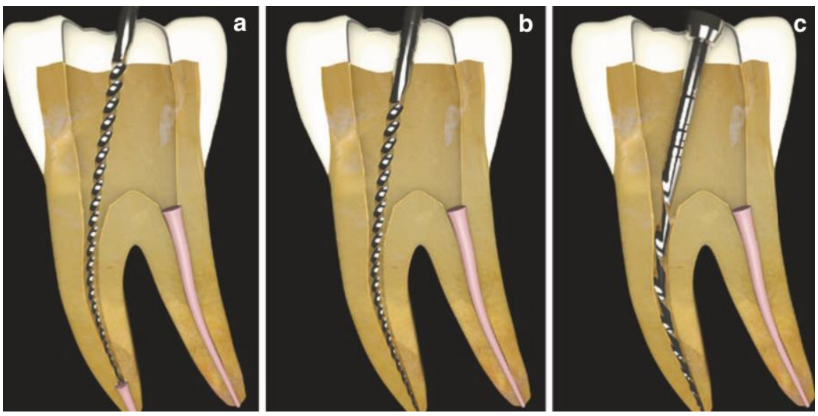


**Figure 10: Schematic illustration of the retreatment protocol in a mandibular molar . (a) Removal of the filling remnants of the apical third with a hand instrument. (b) Determination of working length with a hand file. (c) A reciprocating instrument prepares the final apical portion of the canal to a size 25/0.06 or 0.08 taper**

## 1.23 Obturation

### 1.23.1 Materials used for obturation

Plastics: Gutta-percha, resilon

Solids or metal cores: Silver points, Gold, stainless steel, titanium and irridio-platinum.

Cements and pastes:

•Hydron

•MTA

•Calcium phosphate

•Gutta flow

### 1.23.2 Root Canal Sealers

Root canal sealers are needed to adequately seal the root canal space to prevent microleakage. The sealer fills voids and irregularities of the root canal space left unfilled by the obturation core material . Adequate sealing of the obturation material inside the root canal is important to the success of endodontic treatment, because up to 60 % of endodontic treatment failures are caused by the incomplete obturation of the root canal. Root canal may leak and become exposed to periradicular tissue sealers; however, they are generally not very biocompatible . Root canal sealers can vary greatly in composition and contain zinc oxide eugenol, calcium hydroxide, glass ionomer, composite resin, silipoint, urethane methacrylate, formaldehyde, and bisphenol A . The sealers are typically delivered by auto-mix syringes to reduce the risk of operator mixing errors.

### 1.23.3 Obturation Techniques

Gutta-percha filling techniques use a prefitted primary point procedure, verified by a radiograph to fit the full length of the canal and to still fit tightly in the apical region of the root canal . Normally, if the instrumented canal has an adequate condensation space or flare has been prepared, it is often impossible to fill the length of the canal with a gutta-percha point that fits tightly at the root apical region. The largest possible gutta-percha point is normally selected according to the size of the last instrument used to the full length of the prepared canal. A radiograph of the root canal must be taken with the gutta-percha point inserted to check that it fits the working length of the root canal. If it does not fit, it may be necessary to reprepare the apical aspect of the canal or to select another gutta-percha point.

The root canal must be dried with paper points prior to its obturation, as residual irrigation fluids will leave voids. The sealer is evenly coated on the prepared canal surface, with the last instrument used to spread it throughout the canal length using an up and down motion .

The fitted gutta-percha point is cut to the root canal working length, and a spreader is used to condense it into the root canal space. A radiograph is taken to evaluate the quality of the root canal obturation and to assess the need to reposition the point or apply more condensation pressure. In anterior teeth, if the filling is satisfactory, the gutta-percha should be removed to the gingival line or below it, because gutta-percha can discolor the tooth . In posterior teeth, it is advisable to have a “bed” of gutta-percha on the floor of the pulp chamber; this can act as a guide for retreatment or to alert the operator that he is getting too close to the floor of the crown when making a final preparation . It will also assist in the sealing of furcal accessory canalsIn many complex situations where the tooth is infected or damaged, these obturation techniques are most commonly used to provide the necessary irrigation needed for treating affected teeth:

- Cold Lateral Compaction: As the most commonly taught technique, cold lateral compaction uses scalpel blades, spreaders, and gutta-percha cones to replace defects related to the lateral or side areas of the root channels. Sealers and gutta-percha work in these cases to entomb any remaining infection that cannot be thoroughly accessed.
- Warm Vertical Compaction: Most often, the complex branching of root channels can sometimes lead to channels that have more vertical development, meaning they'll firm up and down along the inside of the teeth. Warm vertical compaction attempts to compensate for damages to the vertical channels by using irrigating systems such as saline, gutta-percha cones, and heating devices that allow the gutta-percha cones to establish a tighter seal within the root channels and pulp areas.
- Warm Lateral Compaction: Like warm vertical compaction, but instead of accessing the root channels through the top of the tooth or the tooth's grooves, it instead accesses the root channels through a lateral or side position. The same methods are applied, using sealers, irrigation acids to remove microscopic bacteria, gutta-percha cones, and gutta-percha heating devices.
- Continuous Wave Compaction: This technique is known to be less time-consuming than the warm compaction techniques. The continuous wave compaction technique uses electrical heat pluggers that provide a continuous wave of heat to the area, allowing the gutta-percha cones to have more mobility through the

root channels and accelerating the packing process. Through this device, the gutta-percha is moved through the channels in a continuous motion, allowing the sealer to adhere to the inner channels of the tooth and create a tighter seal overall.

## 3.Conclusions

The persistence of bacteria within the root canal system is the primary cause of endodontic failure after initial root canal treatment. To reduce the bacterial loads during retreatment, it is important to remove the filling material and gain access to the apical foramen , which, in turn, facilitates adequate cleaning, shaping, and disinfection of the root canal system. Before commencing with any treatment, it is profoundly important to consider all interdisciplinary treatment options in terms of time, cost, prognosis and potential for patient satisfaction. Endodontic failures must be evaluated so a decision can be made among nonsurgical retreatment, surgical retreatment, or extraction.

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