European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 9, Issue 8, Autumn 2022

REVIEW ARTICLE

Endodontic failures: A review

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Received: 10 February, 2022 Accepted: 14 March, 2022

ABSTRACT

The key factors that help to save a pulpally involved tooth in the dental arch are the the accurate diagnosis, prevention, and treatment of diseases of pulp. However, the root canal system anatomy plays a remarkable role in endodontic success and failure. Other factors such as instrumentation technique, proper mechanical debridement, obturating materials and techniques, irrigants, root canal morphology, root resorption, coronal leakage and follow up period also play an important role for the success of the treatment. Sometimes, despite an ideal root canal treatment, failures do occur. This paper reviews the endodontic failures and the factors associated with it in order to help in increasing the chances of preventing the possible endodontic treatment failures.

Keywords: endodontic, failure, retreatment

INTRODUCTION

Endodontic therapy is one of the most challenging aspects of paediatric dentistry because of limited communication skills with the children and their incapability to express fears and anxieties.

The general factors which can be held responsible for endodontic failure are: persistence of bacteria (intra-canal and extra-canal), the intrinsic or extrinsic non- microbial factors which can be held accountable for foreign body reaction in the peri- radicular tissues, inadequate filling of the root canal (canals that are poorly cleaned and obturated), overextensions of obturating materials, improper coronal seal (leakage), untreated canals (both main and accessory), iatrogenic procedural errors such as poor access cavity design and complications of instrumentation (ledges, perforations, or separated instruments). [1]

The quality of obturation is another cause which is of enormous importance. Success rates are diminished in case of obturations which are under or overextended.[2] Also, it is not atypical to miss a canal while carrying out endodontic treatment which can also induce endodontic failure. The procedural faults such as broken instruments, perforations, ledges and so on are also some of the significant causes of treatment failure. The failure of endodontic treatment causes complications such as: post- endodontic inflammation or infection, pain and irritation to the periapical tissues, bacterial accumulation and re- infection etc.[3]

Knowledge about the cause of failures of endodontic therapy facilitates the choice of an appropriate retreatment therapy.
The purpose of this systematic review was to evaluate the endodontic failures and their causes.

REVIEW

The factors associated with endodontic failures are discussed below:

A. CORONAL DISASSEMBLY: The first step in endodontic treatment is the access opening of the root canals. Coronal access enables non-surgical retreatment of an endodontic failure. The decisiveness of removing any restoration is based fundamentally on whether additional access is required to facilitate disassembly and retreatment. If the existing restoration is found to be functionally designed, well fitting, esthetically pleasing or if the replacement is too costly, then opening of the pulp chamber is to be gained through that restoration itself.[4] However, the impulse to preserve a coronal restoration should not be at the expense of having to compromise the requirements of adequate access, namely to: un-roof the entire pulp chamber, enable an unobstructed view of the canal orifices, allow instruments to negotiate canals unhindered help preserve a temporary restoration.[5]

REMOVING CROWNS

If a crown has faulty margins or has been undermined by caries, it should be removed. Retaining such a restoration may imperil successful root canal retreatment because of the probability of reinfection.

REMOVAL OF A FRACTURED POST

There are three steps of removal of fractured posts from within the root canal.

1. Make space – space is required to remove the fractured piece of post. This provides an exit pathway.
2. Loosen – the post fragment or post is normally loosened using ultrasonics. Irrigant spray will also break up and remove luting cement from around the post.
3. Removal/retrieval – if ultrasonics are unable to remove the post, then it can usually be retrieved using the Masserann kit.[6]

B. ENDODONTIC PERFORATIONS: A perforation is a communication that arises between the periodontium and the root canal space.[7]This may ultimately lead a tooth towards unfavourable prognosis. Perforations at or below the crest of bone certainly pose a serious threat to an otherwise favourable endodontic prognosis.[4]

AETIOLOGY

1. IATROGENIC PERFORATIONS

a) **Perforations of the Coronal Third:** Result whilst attempting to locate and open canals
b) **Perforations of the middle-third:** Overzealous instrumentation, using files that are too large or the filing technique shapes the canals too aggressively away from the centre of the root. It can also occur during the pursuit of sclerosed canals.
c) Perforations of the apical third:

Inadequate cleaning and shaping of the canal can lead to blockages and ledges. Once formed, these can cause instruments to deviate, transporting the canal away from the centre of the root, until a perforation occurs. Stiff instruments placed into curved canals may also straighten the canal, causing zip perforations. (Figure 1a and 1b)[7] Passing of the endodontic

files too aggressively through the apical constriction can also lead to these perforations. (Figure 2)

d) Post-space Perforations:

Following obturation, careless post space preparation may result in these perforations. (Figure 3) [7]

Fig.1: a) There is an acute curve distally in the apical region of the 24

Fig.1:b) This has not been respected during instrumentation resulting in straightening of the canal and apical perforation

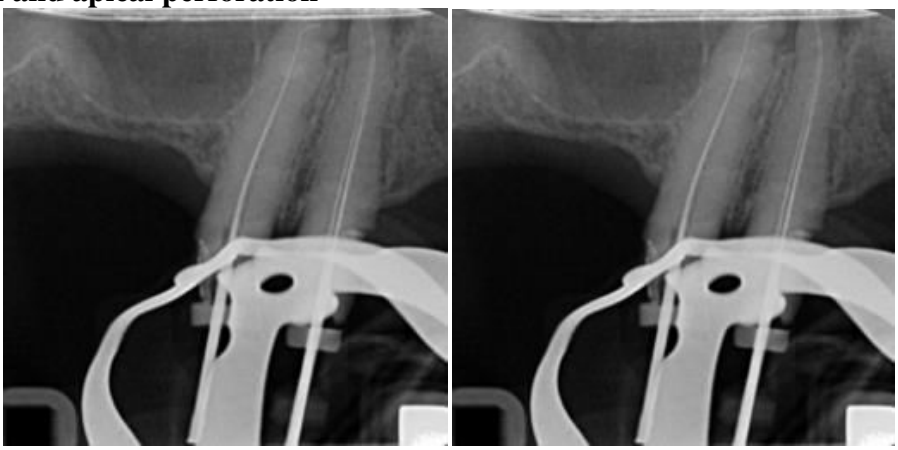


Fig.2: A lack of control during the distal canal preparation of the 46 has resulted in over preparation and significant over extension of the guttapercha (as well as separation of an instrument in the mesial canal)

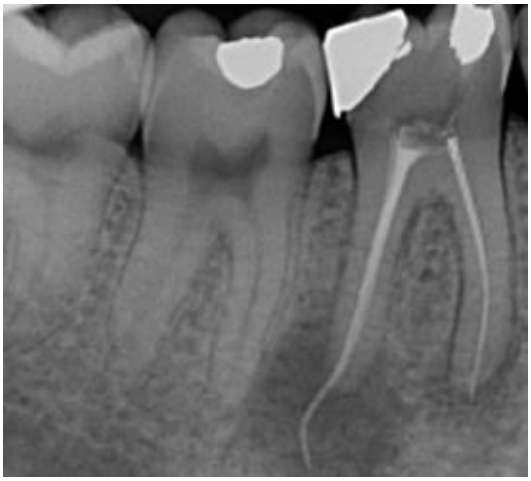
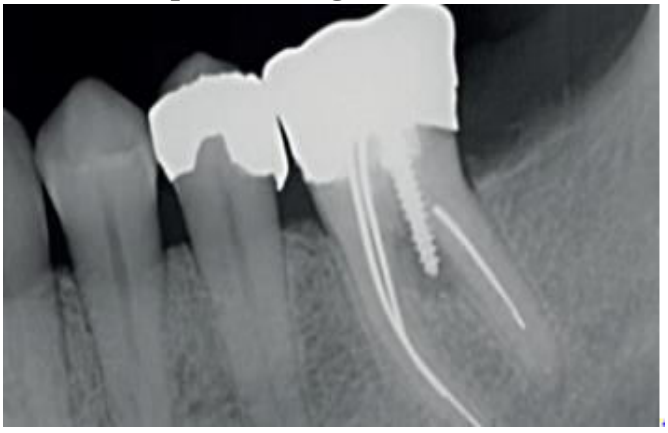


Fig.3: A threaded post has been placed though the furcation

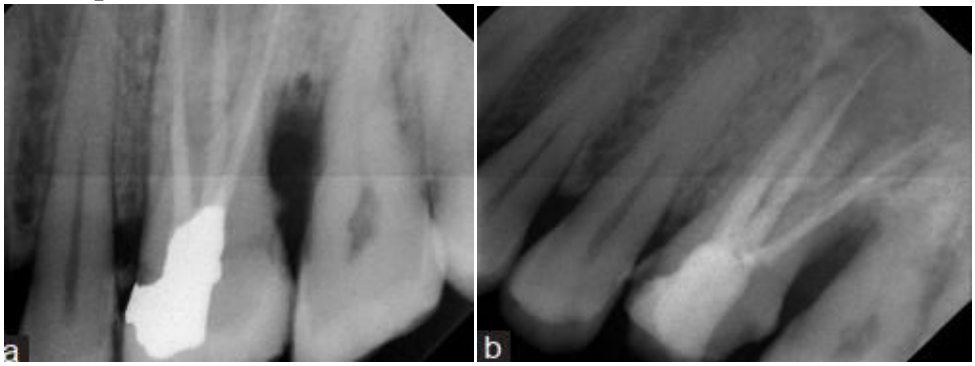


2. PATHOLOGICAL PERFORATIONS: These can result from root resorption or caries.
Diagnosis of Root Perforation: The basis of diagnosing root perforation is by clinical and radiographic examination. If there is persistent bleeding during coronal access or root canal preparation, it is indicative of perforation. Also, it is suggestive of perforation if a paper point is inserted into the root canal and it appears soaked with blood.[8]Another method for accurate diagnosis is by applying calcium hydroxide paste in the canals to detect the direction of perforation. The dental operating microscope and Cone-beam computed tomography (CBCT) also aid in detecting perforations during surgical endodontics. [9]

C. MISSED CANALS: One of the significant causes of the failure of root canal therapy is inability to locate and treat all of the canals of the root canal system which in turn requires endodontic retreatment. A missed canal in an endodontically treated tooth could be a result of operator's finiteknowledge of tooth anatomy, complexities in canal configuration, or improper design of the access cavity. Missed canals may be a reservoir for microorganisms, which is one of the chief causes of persistent apical periodontitisand may have an impact on thetreatment outcome.The peril of missing canal during root canal treatment is high because of the complexity of the root canal system.[10]A proper access cavity preparation is of utmost importance in localizing the orifices of the root canals. A below par access opening makes it difficult for the primary dentist to locate the supplemental canals. [11]

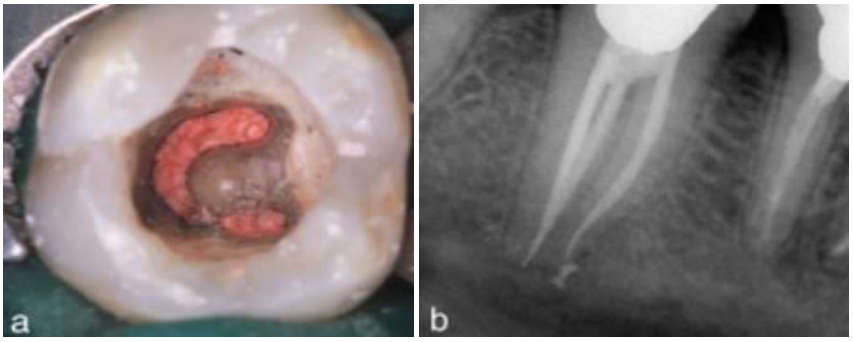
The results of one study conducted by Wolcott J et al. in the year 2005 on 5616 molars which were retreated showed that failure to locate the MB2 canal had resulted in a significant decrease in the long-term prognosis of those teeth. (Figure 4) [11]

Fig. 4: (a) Patient remained symptomatic after the treatment of maxillary first molar. (b) On follow-up visit, mesiobuccal 2 canal was located and obturated.



Shemesh A et al in 2014 presented a case report which introduces a rare appearance of a C-shaped canal in a mandibular first molar that was undetected during clinical work and revealed only after obturation. (Figure 5)[12]

Fig.5:Anatomy of C-shaped molars (a) Access cavity after the obturation showing a continuous C-shaped canal. (b) Post-operative radiograph showing a division of the C-shaped canal into three canals: two distal joining at the root middle third and one mesial.



D. REMOVAL OF OBTURATION MATERIALS: Obturating material can be removed from the root canal using different techniques, such as using manual endodontic files, reciprocating and rotating nickel–titanium files, and Gates Glidden and Peeso drills. [13]

GUTTA-PERCHA REMOVAL

The length of the root canal, its cross-sectional dimensions, and curvature determines the difficulty in removing gutta-percha from the canal. Regardless of technique, gutta-percha is best eliminated from the root canal in a progressive manner to prevent extrusion of irritants peri-apically.[4] The opportunities for using the rotary techniques have been propagated by the rotational and reciprocating systems, thereby reducing the amount of residual filling material, to optimize clinical time. [14]

Rotary Removal: Rotary instruments have a higher efficiency and effectiveness. So they have been advocated to remove gutta-percha from the treated root canals. The most effective and efficient group of rotary instruments in removing gutta-percha from a formerly treated root canal are NiTi 0.04 and 0.06. [4]

Heat and Instrument Removal: Heat and Hedstrom files also helps in removal of gutta-percha from the root canal. In this method, a heated instrument is engaged into the gutta-percha and immediately withdrawn to heat-soften the material. [4]

File and Chemical Removal: This method is used to remove gutta-percha as well as condensed guttapercha from narrow and curved canals. Solvents available for dissolution of gutta-percha filling material are: chloroform, eucalyptol oil, xylene, halothane, turpentine oil and pine needle oil.[15]

Paper Point and Chemical Removal: Gutta-percha is miscible in chloroform and is then absorbed and removed with the help of appropriately sized paper points. Drying solvent filled canals with paper points is known as ‘wicking’ and is the final step towards gutta-percha removal. [4]

Silver Point Removal: Before selecting a silver point retrieval technique, it is useful to recall the canal preparation ideally prescribed for this method of obturation. It is important to recognize the silver point that is parallel over length, hope for a coronally shaped canal, and take advantage of this space discrepancy when approaching retreatment when evaluating a silver point failure. [16]

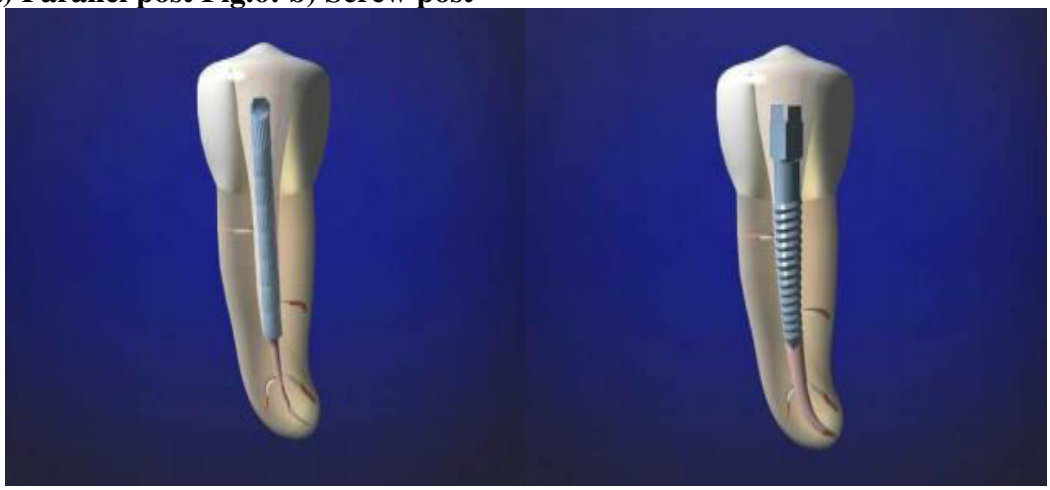
Carrier-Based Gutta-Percha Removal: Recognizing that the carrier is frozen in a sea of hardened gutta-percha increases successful removal of gutta-percha.

The Instrument Retrieval System (IRS) may be used to remove a carrier. This system is used to remove a carrier only the carrier is metal and has cutting flutes that engage the lateral dentin.

Solvents are used to chemically soften the gutta-percha and thus loosens the carrier for removal.[17]

E. POST REMOVAL: In order to facilitate successful nonsurgical retreatment, root canal treated teeth that contain posts need to be removed. There are many factors that influence successful post removal such as operator judgment, training, experience, and utilizing the best technologies and techniques.[4] Other factors influencing post removal are the post type (figure 6), cementing agent and sufficient access so that all restorative materials from the pulp chamber can be eliminated. [18]

Fig.6: a) Parallel post Fig.6: b) Screw post

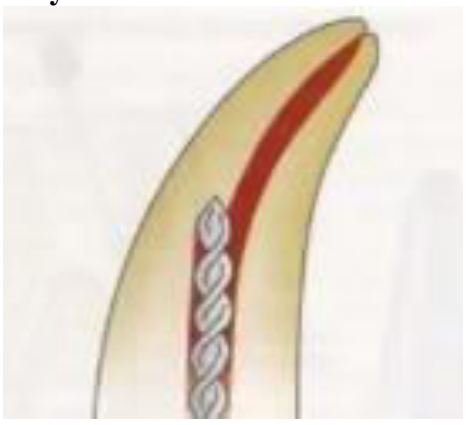


Rotosonic vibration: Rotosonics is a straightforward method to potentially loosen and remove a fully exposed post.[18] Ifrotosonics efforts are unsuccessful, the clinician should select a specific ultrasonic instrument, such as the CPR-1, because its superb energy transfer will dislodge most posts. [4]

PRS Option: The Post Removal System (PRS) kit (SybronEndo; Orange, California) was developed to provide significant improvements in simplicity, versatility and sizing during post removal procedures. The PRS is designed to mechanically to engage and remove different kinds of post or other intracanal obstructions. [18]

F. BROKEN INSTRUMENT: The major obstruction in the cleaning and shaping procedures of the root canal system, is the separation of the endodontic instruments which has crucial impact on the outcome of treatment.(figure 7)[19] "Broken instrument" generally indicates a separated file, but the term could also apply to a sectioned silver point, a segment of a lentulo, gates glidden drill, a portion of a carrier-based obturator, or any other device obstructing the canal.[18] The mishap of instrument separation is an annoying situation for the clinician as it may prevent access to the apex and most of the time, impedes full length instrumentation and obturation of the root canal. [20] With an increase in use of rotary NiTi files, there has been an unfortunate expansion in the occurrence of broken instruments as these files break mostly in narrow canals in the apical one third or curved canals because of its superelastic property. [21]

Fig.7: Ledge formation caused by use of stiff instruments in a curved canal.



Role of separated instrument in prognosis of root canal treatment: In maximum number of cases, the separation of instrument does not directly compromise the prognosis, unless an infection is already present.[22]The prognosis of leaving, versus removing broken instruments from the canal have been discussed in the literature. Today, separated instruments can usually

be removed due to technological advancements in vision, ultrasonic instrumentation, and micro tube delivery methods. [18]

Factors influencing broken instrument removal: The potential for safely removing a broken instrument is limited by complexity of root morphology, including the circumferential dimensions and thickness of dentin and the depth of an external concavity. [18]

The following are treatment modality described in the literature for management of separated instruments in root canals:

Retaining the separated instrument in the canal followed by management of the remaining portion of canal, bypassing the separated fragment and managing the canal, retrieving separated fragment and cleaning and shaping of the canal, retrieving by surgery of separated fragment followed by management. [23]

G. BLOCKS, LEDGES, AND APICAL TRANSPORTATION: Procedural accidents can interrupt the sequence of steps during root canal treatment at any time and stage as all steps are interdependent and equally susceptible to iatrogenic errors. [4]

CANAL BLOCKAGE

Blockage by dentin chips and/or tissue debris is an obstruction in a previously patent canal that prevents access and complete disinfection of the most apical part of the root canal. The blocked canal may contain: compacted dentinal mud (most frequently infected); and/or, residual pulp tissue; and/or, remnants of filling materials (in cases of retreatment).

CAUSES OF CANAL BLOCKAG

Canal blockage is caused when: pulpal tissue is packed and solidified in the apical constriction by the use of instruments and there is no copious irrigation; or instruments are not cleaned before reinserting them into the canal.

Recognition: Dentin chips and/or tissue debris block the canal and it is recognized when the instruments can no longer be advanced to the working length.

Prevention: The need for copious frequent irrigation is of utmost importance, preferably ultrasonically activated, wiping of instruments before their reinsertion into the canal, and recapitulation during the entire instrumentation procedure. Patency filing also facilitates removal of most of the calcium hydroxide dressings from the apical third of the root canal. Thus, the foramen remains unblocked and patent. [24]

LEDGES

Ledging of curved canals is a common instrumentation error that usually occurs on the outer side of the curvature due to excessive cutting and careless manipulation during root canal instrumentation. (figure 7)[25]

Recognition: The endodontic instrument cannot be inserted into the canal to the entire working length. There might be a loss of normal tactile sensation of the tip of the instrument binding in the lumen of the canal. This feeling is supplanted by that of the instrument point hitting against a solid wall, that is, a loose feeling with no tactile sensation of tensional binding.[25S]

A radiograph taken with an instrument placed against the ledge provides additional information and verifies its formation when the instrument tip is directed away from the canal lumen.[24]

APICAL TRANSPORTATION

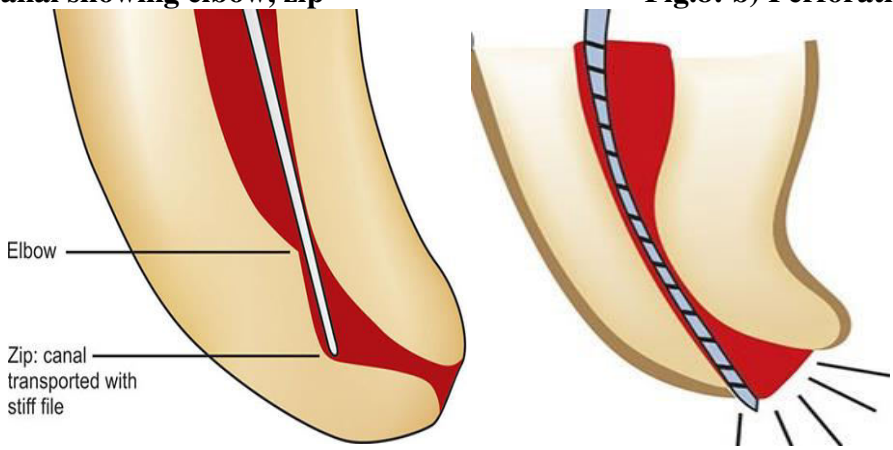
According to the Glossary of Endodontic Terms of the American Association of Endodontists, canal transportation is defined as follows: ‘Removal of canal wall structure on the outside curve in the apical half of the canal due to the tendency of files to restore

themselves to their original linear shape during canal preparation; may lead to ledge formation and possible perforation.' The curved root canal's long axis gets changed and the angle of curvature will decrease due to asymmetrical suspension of material during shaping, thus resulting in straightening of the original curvature of the root canal. [26]

The possible results of apical transportation are: damage to the apical foramen, zip formation, elbow formation, perforation, ledging (figure 8)

Risk factors for Apical Transportation:Improper design of the access cavity, operator related factors, degree and radius of canal curvature, insufficient irrigation, use of stiffer instruments above No.20 files, instruments with sharp cutting tips, error in the interpretation of radiographs for canal curvature. [27]

Fig. 8: a) Canal showing elbow, zip **Fig.8: b) Perforation**



CONCLUSION

Clinicians who seek endodontic excellence appreciate the elements that comprise success and use these criteria to evaluate the cause of failures. Endodontic failures may generate confusion, anxiety, and exasperation for clinicians and patients. There are several essential elements that, in concert, contribute to predictably successful endodontics. Accurate diagnosis is fundamental not only for correct identification of pulp pathology but also may play a paramount role to prevent the subsequent failure during the treatment. Properly performed, endodontic treatment is the cornerstone of restorative and reconstructive dentistry. The adherence to the meticoulous principles of endodontic management and timely evaluation of the predisposing factors may improvise the endodontic procedures and reduce the chances of subsequent failures in future.

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