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Research Article

ENDODONTIC FAILURES IN ROOT CANAL TREATED TEETH - A SERIES OF CASES AND CLINICAL APPROACHES

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ABSTRACT

Endodontic treatment procedures in some teeth are still a challenge in clinical practice. Procedural errors, such as separated instruments, perforations, overfilling, under filling, ledges, apical zipping and so on are the direct cause of endodontic failures. In the most clinical cases, in which endodontic failures are diagnosed do not affect the treatment outcome unless a concomitant microbial infection is present. The biological factors of endodontic failures are closely related to microbial infections, which include: no rubber dam placement; application of incorrect irrigants; inability to prepare the canal to working length; missed canals; poor obturation; root fracture; unsatisfied coronal restoration, size of periapical radiolucency.

The purpose of this article is to discuss some reasons for the endodontic failure in contemporary clinical practice and minimally invasive treatment.

INTRODUCTION

Principles of modern preparation techniques and knowledge of the root canal morphology are all essential so that appropriate chemical cleaning and disinfection of the entire root canal system is achieved. Modern dental practice is related to the continuous improvement of clinical techniques and materials. But the problems related to the treatment process have not yet been completely eliminated. Last but not least the endodontic failures are strongly connected with correct diagnosis. Root canal therapy is considered failed in following cases:

1. Treated tooth is symptomatic or has an abnormal appearance;
2. Soft tissues response to palpation and tooth response to percussion;
3. When lesions remains the same radiographically or become larger in size after the definitive treatment - this indicate incomplete tissue repair;
4. When periapical lesion appears subsequently to endodontic treatment.

Intraradicular infection

Endodontic infection arises from normal oral microflora in the presence of predisposing factors (pulp necrosis, removal of the pulp tissue in the process of endodontic treatment, and microleakage). Microorganisms in root canal system play an essential role in the pathogenesis of endodontic failures - periradicular lesions (Fig.1). The dynamic relationship between microorganisms with macroorganism induces bone lesion of the periapical area in various histopathological stages. The aim of endodontic retreatment protocol is to ensure at maximum successful regeneration of periapical structures by effective instrumentation of the root canal at the first appointment. The frequency of chronic apical periodontitis (CAP) ranged from 2–10.5% in the study populations of several papers [Boucher *et al*., 2002; De Moor *et al*., 2000; Kirkevang *et al*., 2000]. Some authors reported that CAP was found in 67.5% of the total number of studied devitalized teeth. They noted that the most common reasons for endodontic failure were the influence of microleakage and the unsatisfactory obturation of root canals [Hommez *et al*., 2002; Tay *et al*., 2005]. *E. faecalis* is the most common microorganism isolated from the root canal in retreatment cases, against in primary lesions where 78.6% of samples were negative [Gusiyska and Peev, 2016]. Ricucci *et al*. published similar results by analyzing 50 cases of primary chronic apical periodontitis and microorganisms were not detected in 32 (64%) of those cases [Ricucci *et al*., 2006]. This high percentage demonstrates the microorganism's ability to

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penetrate into the dentin tubules (Fig.2), to adhere strongly to collagen, and to resist the irrigation solutions used in the endodontic treatment protocol. Some parts of the dentinal root canal walls often remains uninstrumented during chemo mechanical preparation, regardless of the technique and instruments used [Lin *et al*., 1991; Siqueira and Lopes, 2001]. Untouched areas may contain bacteria and necrotic tissue substrate even though the root canal filling appears to be radio graphically adequate [Nair *et al*., 1990; Lin *et al*., 1991]. Unsatisfied sealing of apical third and apical foramen creates niches where the microorganisms successfully develop (Fig.3a,b).

Although it has been suggested that nonmicrobial factors may be embroiled in endodontic treatment failures, the literature suggests that persistent secondary intraradicular infections, and in some cases extraradicular infections, are the main causes of failure of both poorly treated and well-treated teeth [Siqueira, 2001].

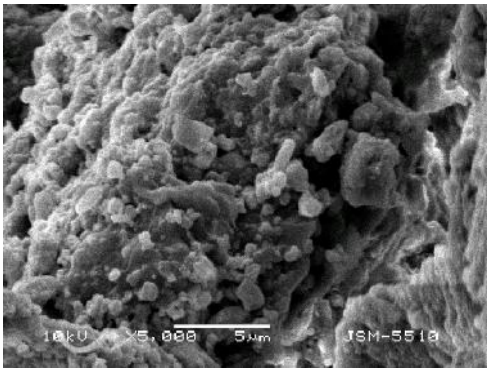

Figure 1.SEM image of microorganisms into apical endodontic biofilm (magnification x 5 000).

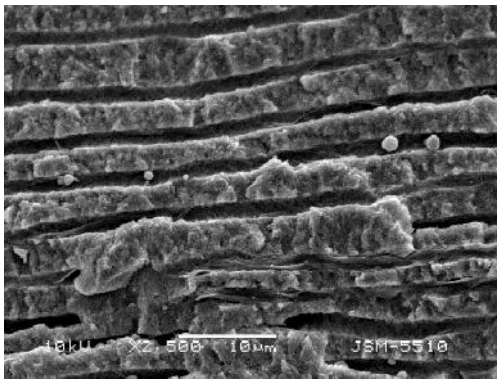

Figure 2 SEM image of longitudinal section of root canal -penetration of *E.faecalis* was seen into the dentine tubules (magnification x 2 500).

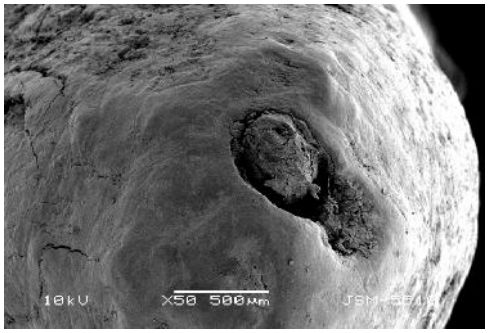

Figure 3a.SEM image of apical zone - unsatisfied sealing of apical foramen (magnification x 50).

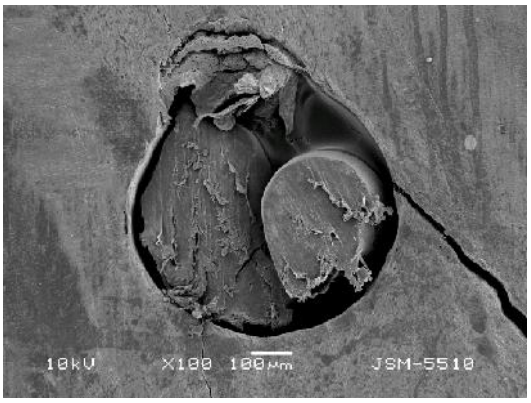

Figure 3b SEM image of apical section at 3mm - unsatisfied adaptation of sealer around gutta-percha point (magnification x 100).

Extraradicular infections

Gram-positive anaerobic bacteria and extraradicular biofilm seem to participate in the maintenance of persistent periapical pathologyin teeth with satisfy endodontic treatment [Kiryu *et al*., 1994; Sunde *et al*., 2002; Sunde *et al*., 2000; Tronstad *et al*., 1987]. The extraradicular infections are associated with or independent of the presented intraradicular infection. The dominant microorganisms in extraradicular infections are: *Actinomyces spp., Propionibacterium propionicum, Treponema spp., Porphyromonasendodontalis, Porphyromonasgingivalis, Treponema forsythia, Prevotella spp., and Fusobacteriumnucleatum.*

This clinical situation describes a case of persistent chronic apical periodontitis in an asymptomatic maxillary first molar, which was endodontically retreated and failed, followed by the surgical approach - extraction (Fig.4). Microbiological analysis was done after the extraction.

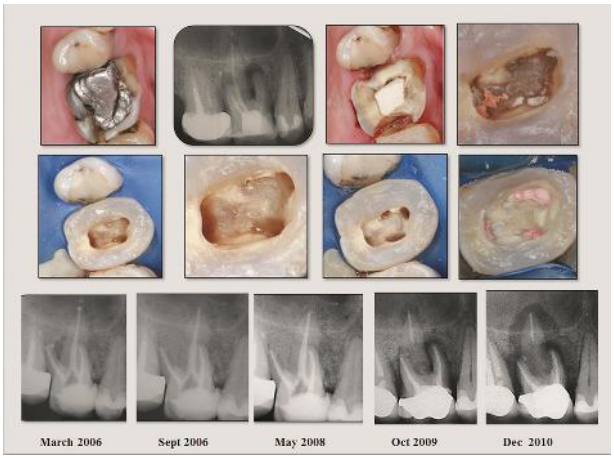

Figure 4.A clinical case of periapical actinomycosis. The endodontic retreatment was failed 4 years after the definitive obturation of root canals. The tooth was extracted 4 years after the retreatment.

It was proven presence of *Actinomyces israelii*. Different *Actinomyces species* have been reported in association with persistent extraradicularinfections, which may be asymptomatic in most of the cases [Lomcali *et al*., 1996; Siqueira *et al*., 2002; Tronstad *et al*., 1990; Xia and Baumgartner, 2003]. *Actinomyces species* are normally presented in the oral cavity, but they have been reported to cause persistent endodontic infections [10, 25, and 30]. Actinomycosis in periapical zone

is a nonresolving lesion associated with actinomycotic extraradicular infection and the treatment approach in most of the cases is extraction [9, 16, 26, 31, and 38].

Overfilling& underfilling

European Society of Endodontology (ESE) regarding the quality guidelines for endodontic therapy, clearly recommended that: *The objective of any (endodontic) technique used should be to apply a biocompatible hermetically sealing canal filling that obdurate the prepared canal space from pulp chamber just to its apical termination* [ESE, 1994]. Our knowledge regarding the importance of the variation in the position of three main apical points (foramen, cement-dental junction and physiological constriction) has created the contemporary controversy in endodontics concerning the answer of question where to finish the preparation [Dummer *et al*., 1984; Olson *et al*., 2008; Wu *et al*., 2000]. The endodontic treatment in cases of irreversible pulpitis the small overfillings around apical portal of exit are positive. It was a radiographic sign of three-dimensional obturation of apical delta.

Chronic periapical lesions are characterized by changes in the adjacent bone structure and periodontal ligament, as well as the cement and dentine. In a large percentage of the cases with chronic periapical lesions, the anatomically separated physiological constriction is ether absent or expanded. The absence of a physiological constriction is challenging to the chievement of satisfactory early and late therapeutic results. It makes probable either the overpressing of necrotic, infected material when preparing the endodontic space or the overfilling of the sealer when sealing the root canal [Lemon, 1992].

In overfilled canals it was achieved a three-dimensional obturation of endodontic space. In cases there was used a sealer with biocompatibility which would not affect the healing process it was observed a satisfied outcome (Fig.5).

The overfilled canals with formaldehyde containing sealers formatted a “foreign body reaction” and the resolution of the periapical lesion would not be realized (Fig.6). Unless underfilled root canals in which periapical pathosis is in progression (Fig.7).

Figure 5 a-d. Follow-up of healing process in periapical zone on tooth 45 - Exacerbated chronic apical periodontitis. The root canal was filled with bioceramic sealer - TotalFill® BC Sealer™ (FKG, Switzerland). The repair processes in periapex was satisfied and the new bone formation was observed after 9 months.

Figure 6. Formation of a “foreign body reaction” around palatal root of tooth #26. The root canals were obturated with formaldehyde containing sealer.

Figure 7.A/ pre-operative radiograph - underfilled root canal on tooth #15 in which periapical pathosis is in progress; **B/** post-operative radiograph in which it is visible the obturation of apical constriction and also apical foramen.

Root Fractures

Postoperative root fracture is a common cause of failure in endodontic ally treated teeth. The importance of cusp coverage restorations in posterior teeth is discussed in the literature [Valizadeh *et al*., 2011; Zou *et al*., 2011; Khedmat *et al*, 2012; Toure *et al*., 2011]. A periodontal probe may be used to assess the possible position of a longitudinal root fracture. A deep narrowpocket may indicate a fracture line (Fig.8).Radiographic image with gutta-percha is also helpful when establishing the final diagnosis (Fig.9). Similar pockets on opposite sides of a tooth are pathognomonic. If a patient continually complains of pain when chewing or pain with horizontal tapping of the crown, a vertical fracture should be suspected. These symptoms can develop at anytime before, during, or after endodontic therapy. A tooth with a periapical lesion that fails to resolve after proper root canal therapy and apical surgery should be suspected of having a vertical root fracture.

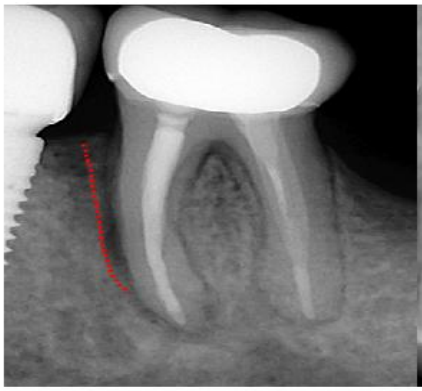

Figure 8.A bone lesion of mesial rooton tooth #36 indicated a longitudinal root fracture.

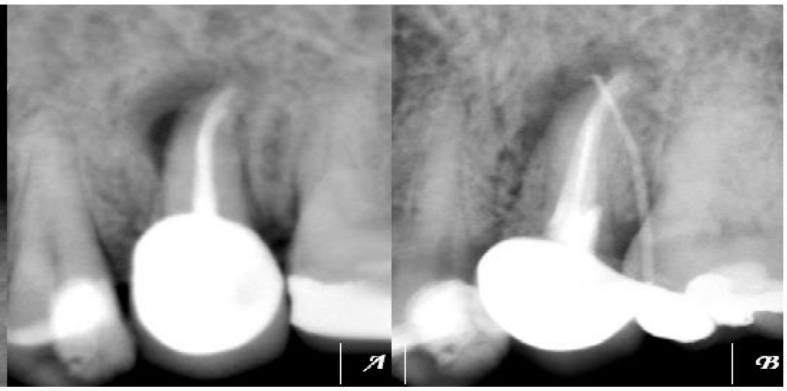

Figure 9 A, B. A radiograph with gutta-percha is very helpful when haveto establish the final diagnosis with two-dimensional image of the area.

Figure 10 A/ Perforation on the distal part of the root of mandibular right lateral incisor; **B/** Obturation of the root canal and sealing the perforation with MTA; **C/** 12 months after the final restoration with all-ceramic crowns; **D/** 24 months after retreatment.

Perforations

The perforations are iatrogenic complications during the endodontic treatment, exception of these which are result of the resorption. Successful treatment of perforations depends on the size and ability to seal the defect and prevent re-infection; the position and time of perforation all affect successful treatment. Large perforations are most difficult to seal *(>0.5 mm*), and are associated with more tissue destruction. Location is probably of greatest importance - coronal, middle and apical part of the root. Close proximity to the gingival sulcus can lead to contamination by bacteria from the oral cavity. Perforations located below crestal bone have a better prognosis, as do those in the floor of the molar pulp chamber away from canal orifices. The introduction of Mineral Trioxide Aggregate (MTA) has improved the outcome of perforation repair (Fig.10).Correction the perforations is very difficult and the key is to prevent them from happening in the first place. Some studies indicate that the crown-down technique is a safer method due to the fact that bigger files have lower penetration depth and prevent over-removal of the dentin. Wu *et al*. discussed that using Gates Glidden (GG) drills in mandibular molars the furcation area is weakened regardless of the size of the instrument used [Wu *et al*., 2005].

Carvalho-Sousa *et al*. contrary to Wu *et al*. reported that the use of GG drills is as safe as ProTaper rotary files with respect to perforation on the distal wall of the mesial canals of mandibular molars when using a size consistent with the clinical situation (treated root) [Carvalho-Sousa, *et al*., 2011].

Separation of endodontic instruments

The reporting of success in endodontic literature can be confusing because of the definition of "success&failure". One useful measure of success is the survival of a tooth after root canal treatment. Successful root canal treatment depends on consistent procedures including effective cleaning, optimal shaping and maximum sealing of the root canal system.

Separation of endodontic instruments is a procedural error during root canal treatment of teeth with pulpal and periapical diseases. Instruments that have been fractured coronally are easier to remove than those in apical zone [Weine, 2004]. If the instrument is visible with good illumination and magnification then removal is probably possible. Nickel titanium instruments are more difficult to be removed than stainless steel files as the material tends to shatter when ultrasound is used to vibrate the separated part [Martin *et al*., 2003]. These cases are best managed by a specialist. The separation of endodontic instruments changes strongly the outcome of the procedure. Some studies have reported a high success in removing separated files using the most contemporary techniques [Suter *et al*., 2005; Ward *et al*., 2003].

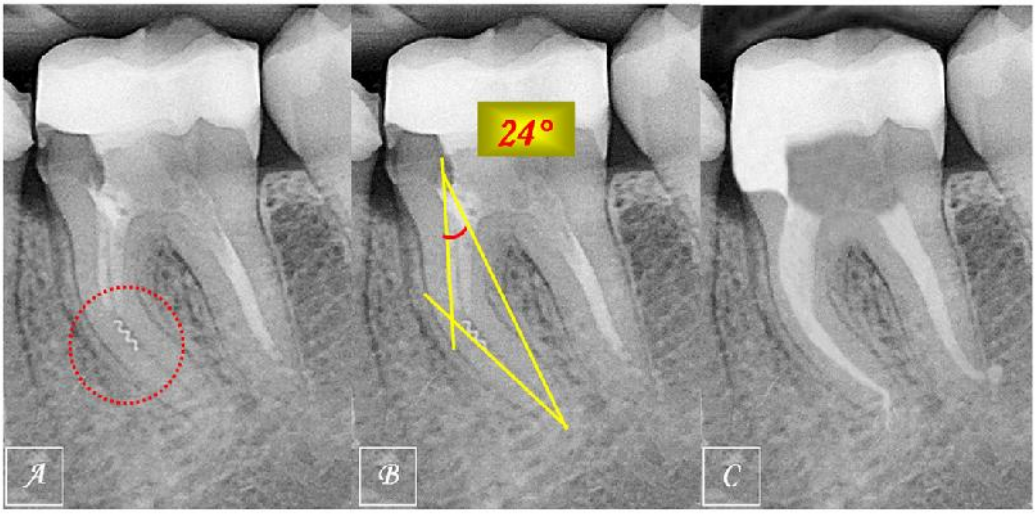

Figure 11 A/separated 3mm's fragment of endodontic instrument - a lentulo, on tooth 46; **B**/analysis and measurement of angle curvature and radius of curvature; **C**/ Postoperative x-ray - definitive obturation of root canals and elimination of separated fragment.

First of all the treatment planwas controlled from file type separated - K-file, H-file, rotary file, lentulo, barbed broach. And second it is of great importance to analyze the degree of curvature in canals and the radius of curvature (Fig.11). These two parameters are independent, because canals with equal canal's curvature may have different radii of curvature. This means that the same canal curvatures are sharper than others [Booth *et al*., 2003; Gunday *et al*., 2005; Patino *et al*., 2005]. In order to avoid the occurrence of instruments fracture, it is always necessary to respect the instruments' kinematics of use, avoiding sudden movements inside root canal [Parashos *et al*., 2006]. The instrument fracture caused by fatigue presents high occurrence rates and could be avoided byprofessionals. The removal of separated instruments is always a challenge for the clinician, but with the use of adequate techniques and tools, such removal can be successful. The treatment options have to be discussed with a patient in cases with separated instruments: 1.No treatment; 2. Non-surgical root canal re-treatment attempting to bypass or retrieve the instrument; 3. Surgical treatment (periapical microsurgery) and 4.Extraction.

The combination of factors influences the decision to treat the case by surgical or non-surgical approach. The position of the separated endodontic instruments in the canal is of a great importance. If the instrument is positioned at the apical third or in the root curvature beyond the straight portion of the canal, it is unlikely to be removed on-surgically. However, this does not mean that the case should immediately be treated surgically. Orthograde retreatment approach should always be completed first (Fig.12). In practical terms, if the instrument cannot be removed and disease or symptoms persist after good quality root canal retreatment a surgical approach can be considered.

Orthograde removal of separated instrument must be as conservative as possible. The minimal invasive treatment is in the basis of long-term outcome. Not estimated preparation may cause weakening or perforation of the treated roots. When removing instrument's part with ultrasonic tips, care should be taken not to widen the root canal preparation however, this is not always possible.

Prevention of instrument separation is critical as retrieval is time-consuming and may result in weakening of the tooth. In order to prevent fracture, it is important to consider the reason for file separation.

Figure 12 A/ Pre-operative radiograph on tooth withseparated file at the apical zone and periapical bone lesion;
B/ Post-operative radiographwith removed separated fragment and definitive root canal obturation.

In summary, to minimize the risk of fracture in clinical practice, the following guidelines are recommended:

- Always create a glide path and patency with small files (#006,008,010).
- Straight line access has to be achieving.
- Crown-down shaping technique is recommended.
- Light touch only should be used, ensuring to never push hard on the instrument.
- Replace files after use in narrow and curved root canals.
- Examine files regularly during the preparation with magnification.
- Endodontic instrument should be moving in a chamber filled with sodium hypochlorite.

Over the last 15 years nickel-titanium rotary instruments have become a part of the standard armamentarium in endodontic treatment. They are used extensively by general dentists and specialists to facilitate the cleaning and shaping of root canal system and it appears that with the increased application of these instruments in endodontic practice, fractures have become more prevalent.

CONCLUSION

Endodontic treatment usually fails when it is carried out inadequately. In most of the treated cases, the endodontic failure results from persistent or secondary infection. Intra- and extraradicular infections may also be observed in some cases years after first treatment. Procedural iatrogenic errors should be eliminated with usage of new methods and technologies. The current scientific literature suggests that intraradicular and extraradicular infections are the main causes of failure of both poorly treated and well-treated teeth.

In conclusion, the aim of contemporary dental medicine is to treat all complications minimally invasive, in order to preserve the tooth for maximum retention time and function.

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