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Causes of Endodontic Failure and Remedies

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Abstract: The ultimate goal of any endodontic treatment is to provide a correct diagnosis, optimal mechanical and chemical preparation, and to three-dimensional obturation of the root canal. Persistence of microorganism like bacteria in the apex and canals, poor obturation quality, over and under an extension of the root canal filling, inappropriate mechanical debridement, and coronal leakage noted as come of the commonly attributable causes of failure. Review of literature by collecting and retrieving information from a minimum of 47 articles. Articles were retrieved from search engines such as PubMed, Google Scholar, etc. Despite the high success rate regarding the endodontic treatment, failures also occur in a large no. of cases. The failures that occur most of the time can be attributed to the previously mentioned causes. Since several endodontic treatments are done every day, it has become essential to minimize or avoid the most fundamental of reasons leading to endodontic failure. This paper reviews and highlights the most common causes of endodontic failure.

Keywords: endodontic failure, bacterial persistence, improper coronal seal, vertical root fracture, perforation, retreatment techniques.

INTRODUCTION

The ultimate goal of any endodontic treatment is to provide a correct diagnosis, optimal chemical and mechanical preparation and obturation of the root canal which is three dimensional. Any endodontic treatment is equitably predictable with success rates which are averagely reported up to 86–98% (Song et al., 2011). The main purpose of root canal treatment is to fill up or block all root canal and to form a fluid-tight seal on the apical foramen of the tooth so that any possibility of a secondary infection occurs due to the mouth cavity or periarticular tissue leakage into the root canal system can be avoided (Sabir, 2005; Kim et al., 2018). The term failure and success in endodontic treatment must be defined severely, to be meaningful. A clear definition & agreement of what constitutes a failure following endodontic treatment does not exist among endodontists (Black and Hawks, 2009). Inflammation is the indication of the patient when they reach the dentist for any treatment (Teja, Ramesh and Priya, 2018).

Nowadays the dentist is frequently reducing the criteria for success of endodontic treatment to a very narrow extent to the absence of pain. Unfortunately, the persistence of the absence of pain is not completely a well-founded measure for good health or success in endodontic treatment. For obtaining a successful root canal treatment, an endodontically treated teeth must be checked clinically and radiographically (Tabassum and Khan, 2016).The factors which leads to the failure of endodontically treated teeth may be included as the persistence of microorganisms like bacteria which include intra canal and extra canal, overextensions of the root canal filling done by dentist, the filling of the canal which is inadequate that is poorly cleaned and obturation done, improper coronal seal which leads to leakage, iatrogenic causes, untreated major and minor canals (Bishop and Briggs, 1995; Iqbal, 2016). Sometimes postoperative pain is seen after using endodontic needles and endoactivator during root canal irrigation (Ramamoorthi, Nivedhitha and Divyanand, 2015). Sometimes the failure of providing standard treatment also causes endodontic failure (Pinto et al., 2019).

Traumatic changes that occur in the root canal also play an important role in determining the success rate of endodontic treatment (Rajakeerthi and Ms, 2019).It is found that factors such as color change, cracking, bedongind and fracture can lead to failure of porcelain laminate veneers (Ravinthar and Jayalakshmi, 2018). Checking of the dental pulse can be done using a dental pulse oximeter and thermal test and electric pulp test for the evaluation of pulp vitality (Ng, Mann and Gulabivala, 2010; Janani, Palanivelu and Sandhya, 2020). The goals of nonsurgical retreatment are to remove materials from the root canal space (Chalfin, Weseley and Solomon, 1990).Our team has rich experience in research and we have collaborated with numerous authors over

various topics in the past decade (Deogade, Gupta and Ariga, 2018; Ezhilarasan, 2018; Ezhilarasan, Sokal and Najimi, 2018; Jeevanandan and Govindaraju, 2018; J et al., 2018; Menon et al., 2018; Prabakar et al., 2018; Rajeshkumar et al., 2018, 2019; Vishnu Prasad et al., 2018; Wahab et al., 2018; Dua et al., 2019; Duraisamy et al., 2019; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Gheena and Ezhilarasan, 2019; Malli Sureshbabu et al., 2019; Mehta et al., 2019; Panchal, Jeevanandan and Subramanian, 2019; Rajendran et al., 2019a; Ramakrishnan, Dhanalakshmi and Subramanian, 2019; Sharma et al., 2019; Varghese, Ramesh and Veeraiyan, 2019; Gomathi et al., 2020; Samuel, Acharya and Rao, 2020)

METHODOLOGY

Relevant articles were identified via PUBMED, GOOGLE SCHOLAR MeSH, Cochrane, bioRxiv, Semantic scholar search engines using the keywords endodontic procedure, mishaps, failure of treatment, obturation failure, and failure correction. The period of duration considered was from 2000 to till date. Out of the searched article, 52 articles were selected, out of which 47 are of known concept and 5 articles with the recent concept.

Persistence of bacteria:

The presence of microorganisms like bacteria is considered to be one of the important factors that lead to failure of endodontic treatment (Endo et al., 2013; Herrera et al., 2015). The presence of periodontitis and the radiographic lesion depicts the presence of bacterial infection in the teeth. The organism such as Enterococcus species are more likely to be found in infections. Enterococcus faecalis is the most commonly found microorganism in infections comparing all other bacteria (Sakamoto et al., 2008). There is also a presence of fungi in some cases, but it is most prevalent in secondary or persistent endodontic infections and teeth which have root canal treatment failure. Another organism which is most found in infection is Candida albicans. Various recent studies prove that the presence of cytomegalovirus and epstein-barr virus is present in periapical lesions (Sabeti et al., 2003). Many literature proves the relationship between presence of microorganism in the teeth and its associated infection caused by them. Even presence of microorganism can be found after the endodontic treatment is completed and root canal obturation is done (Sjögren et al., 2003). Bacteria can be found in areas such as isthmuses, ramifications and dentinal tubules may lead to infection (Lin et al., 1991). The negative cultures for bacterial organisms in the root canal have higher chance of presence if infection (Ng et al., 2007). The microleakage in the canal after the sealing is done may also be a reason for endodontic failure comparing the opportunity other than the improper debridement of the canal. In microbiological analysis, escaping of the bacteria can cause disintegrated root canal obturation materials (Karygianni et al., 2015).

Presence of inadequate and overextended root canal filling:

The important factor depends on the quality of root canal obturation in the success of any endodontic treatment in a study carried out on 1001 endodontically treated teeth (Trope, Maltz and Tronstad, 1985). The other scientific studies proved that 65% of the reported cases showed poor quality of obturation done which causes failure of endodontic treatment whereas 42% of the teeth had major untreated canal. Due to the inadequate and overextended root canal filling, success rate of the treatment decreased and mostly it is highest in case if end flush or within 2 mm if the apex (Kojima et al., 2004). It is confirmed that, according to some studies, comparing inadequate and overextension of the root canal. The latter has more chance about 4 times to cause failure if the treatment (Swartz, Skidmore and Griffin, 1983). The overextension may cause worse prognosis of the disease in case of existence of periradicular lesion (Metzger et al., 2000). Moreover in a study, it is found that there is an association between the increased incidence of periapical periodontitis and the inadequate root filling done (Jiménez-Pinzón et al., 2004). Even the calcified canal and negotiation causes endodontic failure (Kumar and Antony, 2018). Preliminary radiographic testing should be done to avoid this. Chloroform and xylene are commonly suggested for removing root canal fillings. Although chloroform is a better solvent than xylene, for this procedure the fact that xylene does not evaporate as fast and takes longer to penetrate the gutta-percha make it preferable. Flooding the canal with an aqueous sodium hypochlorite solution makes the softened gutta-percha less messy to remove. Only the first file is covered with dissolved gutta-percha and neither the H-files nor the pulp chamber or canal walls were covered with such mass. Maintaining the apical part of the gutta-percha in its original consistency is the key for success in this procedure because it allows the Hedstrom file to firmly engage this segment and remove it as a unit. This may not occur if the apical part is softened or partially dissolved.

Excessive hemorrhage and Improper coronal seal:

Small hemorrhages that occur during the endodontic procedure are repaired without incident. But, when excessive hemorrhage occurs due to extirpation of an inflamed pulp along with instrumentation beyond the apex of the tooth. It results in mild inflammation which occurs due to formation of hematoma by local accumulation of blood (Alcalay, 1981). Extravasated blood cells and fluid are found in these cases. If it is not resorbed by macrophages, delaying repair in the presence of infection of the extravasate blood which acts as a nidus for bacterial growth occurs. Root canal filling material is sometimes accidentally forced out beyond the apical limit of the root canal, which ends in the periradicular bone, mandibular canal, or sinus or even protruding through

the cortical plate (Manohar and Sharma, 2018). The presence of coronal leakage should be taken as an important factor which leads to failure of endodontic failure (Bayram et al., 2013). It is important to consider the completion of the obturation since it provides prevention of iggress of any presence of microorganism (Madison, Swanson and Chiles, 1987; Swanson and Madison, 1987). Salivary microleakage with bacterial penetration can be considered a major cause of loss of coronal seal. A contaminated pulp chamber acts as a reservoir of bacteria and their endotoxins. Coronal leakage can occur in instances for example, compromised or inadequate temporary filling, leakage during post placement, recurrent decay at restoration margins, delay in placement of coronal restoration following root canal treatment, tooth fracture, failure of final restoration. The quality of root canal filling is more important than the quality of coronal restoration which determines the success rate of the treatment. (Hussainy et al., 2018; Rajendran et al., 2019b). A pre endodontic buildup of the coronal structure, i.e., building up the missing walls of the tooth has many advantages. It strengthens the tooth, provides better isolation, limits microbial ingress, helps better stabilization of rubber dam clamps, and thus helps in limiting coronal leakage. However, care should be taken that the restorative material does not clog the root canals (Moloney, Feik and Ellender, 1993).

Perforation and vertical root fractures:

Accidental overextension of filling material during endodontic treatment can cause chemical and mechanical irritation of the adjacent tissue. It is well established that endodontic materials should be limited to root canals without extension into periapical tissues during root canal treatment (Kim et al., 2016). However, overextension of these materials may take place accidentally through over instrumentation or perforation of the root canals, allowing passage of dressing agents, sealers, or filling material to neighboring structures (Siddique et al., 2019). Careful attention is needed in such cases of overextension because the patient may experience complications such as pain or tissue necrosis. Vertical root fractures are associated with less common vital teeth and endodontically treated teeth which represent one of the most difficult clinical problems to diagnose and treat. It is difficult to diagnose the vertical root fracture since there is a minimal symptom. A vertical root fracture is an important threat to the tooth's prognosis during and after root canal treatment. CBCT has been used in recent studies with high accuracy and sensitivity in detecting vertical root fracture (Wang et al., 2012). It is important to preserve a vertically fractured tooth which helps improve esthetics, function, and maintain the integrity of the arch by preserving the alveolar bone height. Radiographic diagnosis of vertical fracture of the root is also felt difficult because the presence of vertical root fracture is almost present in every case with classical radiographic signs. The accuracy of radiographic diagnosis also depends on the proper radiographic angulation, contrast, density, and sensitivity of the clinician in interpreting the radiographic findings (Jose, P. and Subbaiyan, 2020). There is a requirement in the development of a diagnostic strategy that depends mainly on the patient's dental history, clinical signs, and radiographic observations.

Complications of the instrument:

Cone-beam computed tomography is used for the evaluation of root canal preparation using a rotary instrument (Ramanathan and Solete, 2015). Limited strength and flexibility of intracanal instruments which in combination with improper use may result in an intracanal instrument separation. Removal of a small size file with a blunt tip from a canal and subsequent loss of patency to the original length are the main clues for the presence of a separated instrument. After a fracture, the access to the apical portion of the root canal will be decreased and this could result in a deleterious effect on canal disinfection and obturation later (Simon et al., 2008). Most of the studies done on the effect of fractured instruments have demonstrated a minimal influence on the success rate of the treatment (Kerekes and Tronstad, 1979). The stage of instrumentation at which the instrument breaks can affect the prognosis. The obturation and disinfection of the part of the canal which is distal to the fractured instrument become very difficult possibly which leads to the presence of persistent infection in that particular area. Mostly, the fractured instrument itself has less function to do with failure because the success is only affected most of the time when a concomitant infection is present. A clinical investigation on the relationship of broken rotary instruments with endodontic case prognosis confirmed that in the absence of any periradicular changes and preoperative infection, a separated instrument will not mostly affect the prognosis (Crump and Natkin, 1970).

Diagnosis and correction:

Treating the wrong tooth includes appropriate treatment of both teeth i.e.; the one tooth incorrectly opened and the one with the original pulpal problem(Nandakumar and Nasim, 2018). For the missed canal, Retreatment is appropriate and should be attempted before recommending surgical correction (Frank and Bakland, 1987). Optimal shaping and cleaning are necessary to obtain proper outcomes (Teja and Ramesh, 2019). Several materials have been recommended for perforation repairs such as cavit, amalgam, calcium hydroxide paste, super ethoxy-benzoic acid (EBA), glass ionomer cement, gutta-percha, tricalcium phosphate or hemostatic agents such as gel foam and mineral trioxide aggregate (MTA) which has shown convincing results in apical

cavity perforations(Noor and Pradeep, 2016). An effort to repair apical perforations may be to attempt to renegotiate the apical canal segment or to consider the perforation site as the new apical opening and then decide what treatment the untreated apical root segment will require (Alhadainy and Abdalla, 1998). Crown fractures are treated by extraction unless the fracture is a "chisel type" one in which only the part of the crown or cusp is involved. In such cases, the loose segment can be removed, and treatment completed. Ultrasonic fine instruments have proven most effective in loosening and "flushing out" broken fragments. Using special fine diamond tips and microscopy a tunnel can be created around the separated instrument, which can then be vibrated and dislodged. Canal blockage corrections are accomplished using recapitulation. Chelating agents are also helpful. Treatment that is recommended for treating tissue emphysema varies from palliative care and observation to immediate medical attention if the airway or mediastinum is compromised.

Retreatment techniques:

There are several techniques available for the retreatment of the root canal technique. Generally negotiation of the root canal is not interfered by the sof setting pastes, thus the removal of the soft-setting aste does not require any specific techniques. In those cases, instrumentation of the root canal with use of copious irrigation leads to success of removal of the soft-paste (Stabholz, 2010). With the use of Beutel-rock or engine reamers, or by using bur, Hard cement may be drilled out. Gutta- percha is found soluble in methyl chloroform, carbon disulfide, benzene, xylene, halothane (Smith and Nortjé, 1980). Automated Instrumentation techniques can also be used. For preventing over instrumentation, the canal finder system can be used. Only in case of straight canal, the removal of gutta-percha is useful (Krell and Neo, 1985). Files and several reamers can be used to cross the obstructing object in the root canal. Even solvents can be used for softening purposes. In case of silver cones, hand files can cross, thus canal finder is used. A thin steel wire is inserted into a 25- gauge hypodermic needle in case of wire loop technique. The free ends of the wire are pulled to tighten the loop. The needle is placed so that the broken instrument is tightened and removed. Our institution is passionate about high quality evidence based research and has excelled in various fields ((Pc, Marimuthu and Devadoss, 2018; Ramesh et al., 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Ramadurai et al., 2019; Sridharan et al., 2019; Vijayashree Priyadharsini, 2019; Mathew et al., 2020)

CONCLUSION:

The cause of endodontic failure can be due to anatomy of the teeth, the presence of additional root canal or lateral canal. It depends on the technical, biological, and iatrogenic factors. The causation of technical failure in endodontic treatment is due to the calcified chambers, calcified, seere root curvature, lodging, perforations, resorptive defects and canal blockage due to separated instruments. Using an operating microscope, enhanced magnification can be done. This was accomplished using direct lightning, NiTi instruments, use of ultrasonics, multiple delivery systems for obturation. Almost all the errors during when the procedure is done is minimised to provide a successful treatment. Knowing and understanding the relationship of the above mentioned factors will definitely improve the quality of endodontic treatment and minimize the failure of endodontic treatment.

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