Review Article

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A NEW CONCEPT OF MANAGEMENT OF INTRACANAL SEPARATED INSTRUMENT BY ELECTROCHEMICAL DISSOLUTION: A REVIEW

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ABSTRACT:

Root canal treatment is a common procedure in dentistry. The success of RCT depends on the preoperative condition of the tooth, as well as the endodontic procedures. The presence of a separated instrument within a root canal represents an obstacle, which prevents effective cleaning and shaping of the root canal system. Several techniques for the removal of these instruments have been described. However, those techniques require removal of dentine, which may weaken the root and increase the risk of perforation in particular when the fragment is beyond the root curvature. A new method was proposed which promoted the active dissolution of fractured instruments to reduce the risks when removing fragments from the root canal. According to this method, two electrodes are immersed in an electrolyte: one acting as a cathode and the other as an anode. Contact between the fractured file and the electrode used as the anode is necessary to dissolve the fractured file.

This article enumerates various methods of removal of instrument and describes in detail about a new concept for retrieval of fractured files: Electrochemical dissolution of separated instrument in root canal.

Keywords: Electrochemical dissolution, Separated instrument, Instrument retrieval, Dissolution of instrument

INTRODUCTION:

One of the factors which forms the very foundation of successful root canal treatment is the manner in which the mechanical cleansing of the canal is carried out. Separation of instrument is one of the most commonly occurring mishap during this mechanical cleansing. [1] Fatigue and shear failure are found to be the main reason for fracture. [2] The real problem with separated instrument is that it prevents thorough cleaning, shaping, disinfection and canal obturation. In many cases a straight line access is not obtained. [3]

Many devices and methods have been proposed to accomplish the retrieval of fractured instrument. Few of them are Barbed broach and Cotton, Masseren kit, Hypodermic needles, Ultrasonic, Lasers, H-files, softened gutta percha points, mini forceps, chemical solvents, wire loops, extractors etc. [4] However these mechanical methods present some

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limitations related to canal morphology, reduction of root strength and operator ability, also the attempt to remove these fractured instruments might lead to excessive loss of dentin, risk of ledge formation and perforation, extrusion of instrument into periradicular tissue. Hence, a less complex retrieval method that causes minimum damage to dental structures is necessary and this might be possible by electrochemical dissolution. This method would enable the recovery of original canal path without damaging the root structure.

Method

In this in vitro method there is electrochemically induced active dissolution of fractured fragment which requires presence of two electrodes immersed in an electrolyte. Platinum (noble metal) is usually used as counter electrode (Cathode) whereas the electrode in contact with the fractured instrument will form the working electrode (Anode). This assembly is immersed in an electrolyte which completes the cell. The electrolyte may vary according to the metal to be dissolved, as it is essential for the metal to have susceptibility for the dissolution in this electrolyte.

Electrolyte used for NiTi instruments is a solution formed with sodium fluoride (5gm/L) and sodium chloride (5gm/L) at pH of 5 and for stainless steel is sodium hypochlorite. NiTi shows resistance to corrosion in most environments as it forms an oxide layer of titanium oxide on the surface. However this layer does not occur in presence of fluoride which helps in dissolution. An active potential difference is applied between the electrodes which causes the dissolution of instrument. [5]

In an in vitro study, Ormiga et al observed that time required to dissolve a K3 size 30, .06 taper file was 6 hours and hence the authors concluded that this time was not clinically practical and suggested to improve the dissolution conditions.[5] Modifications in the composition and pH of electrolyte and increase in potential values were found to be helpful in dissolution. Fluoride ions have a negative effect on corrosion resistance of NiTi, also an increase in temperature and decrease in pH favoured the corrosion of titanium based alloys. [6] Therefore, solution having higher concentration of fluoride will dissolve NiTi more efficiently .[7]

This concept of electrochemical process is based on the dissolution of metal alloy in aqueous environments, and requires presence of two electrodes and an electrolyte. The composition of electrolyte varies according to the metal to be dissolved. [5] The transfer of electrons from anode to cathode tends to occur even without the imposition of potential difference between the two electrodes, once the cathode is composed by an inert metal. However, this process would be too slow to be used during the endodontic treatment. Therefore to accelerate the transfer of electrons and release of metallic ion to the solution, a potential difference must be applied. This could be hazardous if

the electric current is conducted by human tissues. But cementum and dentin surround the root canal system, which act as insulators [8] ,consequently the only way the current can travel is through the external circuit.

The fractured file must be in contact with the anode through an inert tip that conducts the electrical current, to guarantee its dissolution. At these conditions used in the process, fractured file will be the only metal susceptible to dissolve. A microelectrode that combines anode and cathode (fig2) might result in efficient configuration, as the root canals have limited dimensions. To guarantee the transfer of electrons from anode to cathode isolation between the two electrodes is necessary.

NiTi alloys have susceptibility to dissolve in fluoride containing environments. [9] Therefore use of aqueous fluoride containing solution might favour the dissolution of NiTi files. The use of fluoride in endodontics is possible because it has been largely applied in dentistry. [10] The main mode of action of fluoride in dentistry is the inhibition of demineralisation of the dental structures by a physiochemical mechanism. [11] Fluoride causes occlusion of the dentinal tubules by precipitation of insoluble calcium crystals. [12]It was demonstrated by Saunders and McIntyre [10] that the 12.3g/l APF gel can provide a high level of protection against erosive damage of root dentin by gastric reflux. So a 5.0g/L concentration of sodium fluoride can be considered acceptable for endodontic use.

To permit the retrieval of other types of fractured instruments from the root canals, different composition of aqueous solution in which the specific alloy is susceptible to dissolve should be used. In case of stainless steel fractured file, the aqueous sodium hypochlorite solution could be an effective electrolyte to promote its dissolution. In any event, a factor that cannot be neglected is the dissolution susceptibility of the metal in the specific electrolyte. Also, the solution must be renewed during the entire retrieval procedure to eliminate the metallic ions discharged to the solution and the resultant material generated on the surface of the fragment. If not eliminated, the nickel ions generated might be toxic to human tissues and the resultant material might act as a barrier between the anodic electrode and the fragment.

CONCLUSION:

The concept of fractured file retrieval by electrochemical process is feasible. [5] This concept represents a consistent basis to the development of a method to remove fractured instruments. This method might enable increased security for retrieval of metallic fragments from the root canals in relation to the mechanical methods. It avoids the loss of mechanical resistance of the root as it does not require removal of dentin. Also the retrieval of instruments from curved canal tends to be possible as it is not

necessary to obtain a straight line access to the fragment. A simple contact between the anode and the fragment helps to enable the dissolution of the alloy, resulting in a less complex procedure. However further in vitro and in vivo studies are necessary to develop the technique of fractured file retrieval from the root canals on the basis of this concept.

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FIGURES:

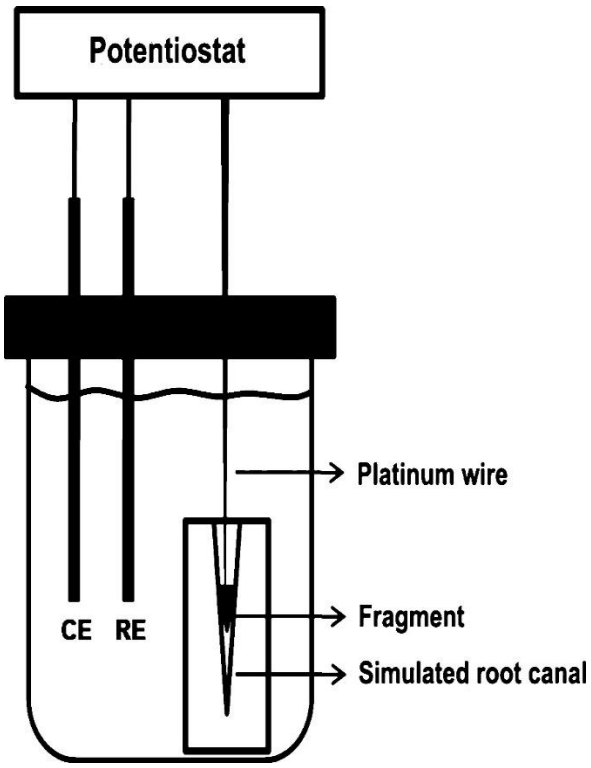

Fig.1 Schematic diagram of the intracanal fragment dissolution test. Counter electrode (CE); reference electrode (RE).

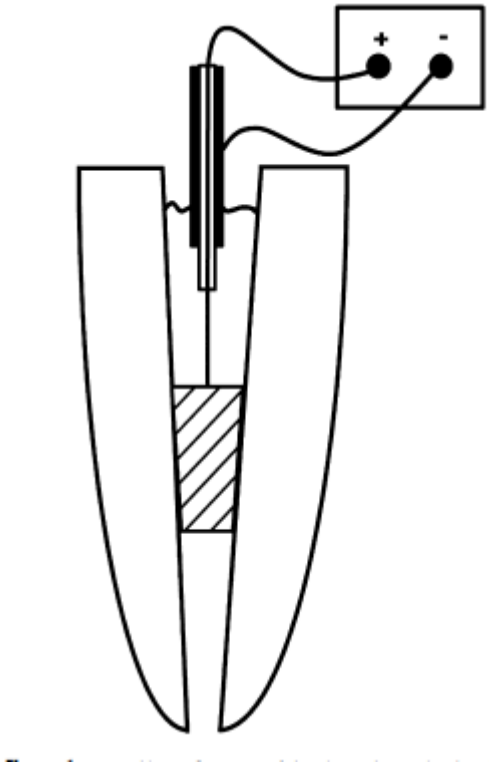

Fig. 2 A possible configuration of the electrochemical-induced dissolution of a fractured file. The microelectrode combines anode and cathode, both immersed in the solution. The contact between the fractured file and the anode is promoted (5).