ULTRASONIC TREATMENT ENDODONTICE

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***Abstract**: - The aim of this study is to demonstrate the ability of our ultrasonic endodontic dental device with rotary nickel-titanium alloy instruments for the root canal treatment. This study is aimed at investigating the cleaning and shaping efficacy with "Ultrasonic device for endodontic treatment of dental's canals. The purpose of root canal treatment is to get rid of the damaged pulp and the bacteria that are causing the infection. It involves removing inflamed or dead nerves and blood vessels' from the centre of the tooth whit an ultrasonic endodontic device. This is done by drilling a hole through the top of the tooth to the root canal and removing the dead tissue. The empty root canal is then cleaned, filled and a permanent seal is put over the top of the tooth. After the main requirements for an successful endodontic treatment and after the elimination of all debris, the need for root canal preparation has long been accepted as an essential step in root canal therapy. Our ultrasonic endodontic device use rotary instrument of nickel-titanium alloy actionated by an ultrasonic device. The endodontic files from a nickel-titanium alloy with a very low modulus of elasticity which have been shown to have two to tree times more elastic flexibility in bending and torsion, as well as superior resistance to torsional fracture.*

Keywords: ultrasound, endodontic, root canal.

1. Introduction

Ultrasound is a sound energy with a frequency of more than 25 kHz. the application of ultrasound in dentistry has been limited mainly to periodontics, until Richman, in 1957, introduced this technique to endodontics(1). Ultrasound is now used in endodontics for: improving root canal access (e.g. removal of pulp stones); irrigating root canals; removal of posts, broken instruments and other obstructions from the root canal; distribution of sealer around the root canal walls; condensing gutta-percha root fillings; periapical surgery; enhancing dentine permeability during bleaching. Root canal treatment aims to clean, shape and fill the entire root canal of a tooth. A root canal infection can be caused by several things, including decay, injury and possibly also gum disease. Root canal treatment can repair your damaged tooth without it having to be removed. The endodontist will take X-ray image of the tooth to check whether or not it definitely need root canal treatment. This can help to show how far any decay has spread, if there is an abscess and how many root canals the tooth has. If a dead tooth a one with severely damaged pulp, root canal treatment may be the only way to repair it. In the first step, the endodontist will make a local anesthetic. This completely blocks feeling from the area. The tooth will be separated from the rest of the mouth using a thin sheet of rubber called a dam. This keeps the tooth dry and protects the airways,[1],[2],[3],[5],[9]. It also allows effective cleaning of the root canal system and prevents it from becoming again, which can cause infection later. The endodontist will first make a hole in the top of the tooth through which the dead or diseased pulp is removed (Fig.1).

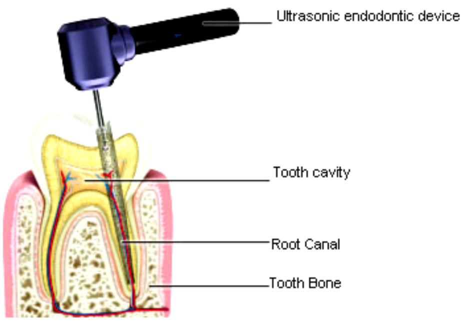

Fig. 1

The empty pulp cavity is then cleaned and the endodontist may also put in some medication to help get rid of bacteria. He will put a temporary filling on the tooth to keep it sealed until for further treatment. With a temporary filling, to the next visit, the endodontist will remove and fill the root canals with a suitable material. This is likely to be a putty-like substance called gutta-percha. A permanent filling or crown is then placed over the top of the tooth to protect the filled root canal and the vulnerable tooth structure. Teeth are hard calcified objects but their inner aspects are not completely solid. Inside every tooth there lies a hollow space which, when a tooth is healthy, contains the tooth's nerve tissue. Each tooth's nerve enters the tooth, in general, at the very tip of its root (s). From this entry point the nerve then runs through the center of the root in small "root canals" which subsequently join up with the toots's pulp chamber.[4],[7],[8],[10],[12].

2.The use and the design of the ultrasonic endodontic device

The design of the ultrasonic endodontic device is special made for treating the root canal by cleaning, introducing ²the medication through an irrigation instrument through ultrasonically vibrated endodontic files. For root canal treatment to be effective, all the canals within the tooth must be cleaned with an antiseptic solution, which helps to treat the sourse of the infection. The basic aim of the root canal is to clean the root and eliminate tissue debris and microorganisms with an ultrasonic endodontic apparatus. Furthermore instrumentation produces a smear layer and dentine debris in the root canal, which has to be removed by irrigation(2). Our ultrasonic endodontic device is working by converting electromagnetic energy to mechanical energy. A stack of magnetostrictive metal strips in a handpiece is subjected to a standing and alternating magnetic field, as a result of which vibrations are produced.[13],[14],[15],[16].

2.1.Irrigation of the root canals

Therefore irrigation remains an essential aspect of root canal treatment (3). During passive ultrasonic irrigation, a small ultrasonically oscillating file or smooth wire (e.g. size 15, 20) is placed in the centre of the root canal, following canal shaping, to transmit the energy of the file as efficiently as possible to the irrigant. As a result, acoustic micro-streaming and/or cavitation can occur(4)(5)(Fig. 2).

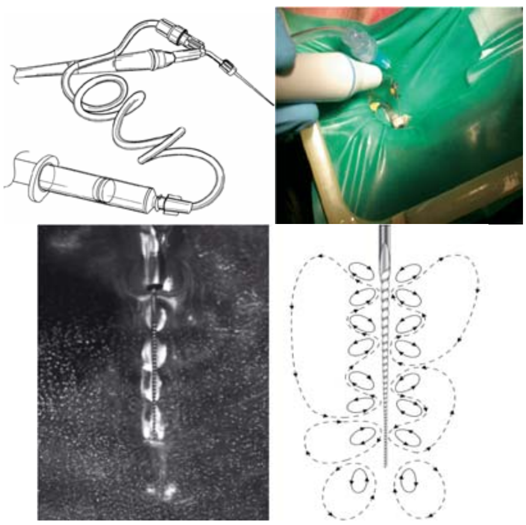

Fig. 2

As the root canal has already been enlarged, the irrigant can flow through the canal and the file or wire can vibrate relatively freely. The file has a nodal and antinodal pattern, which also occurs on a pre-curved file, partly explaining the efficacy of passive ultrasonic irrigation in curved canals [6] (See Fig. 3)

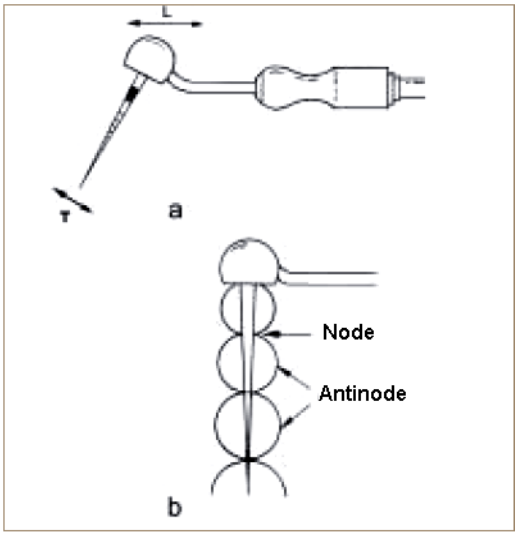

Fig 3 (a) Node- and anti-node pattern of a sonically activated file. The node is where the file is attached to the hand-piece, and the antinode is at the end of the file. The arrows show the direction of oscillation: L, longitudinally along the main axis; T, transversely along the file. (b) Node- and anti-node pattern of an ultrasonically activated file. Reproduced from Stock[1] with permission.

Fig. 3

Passive ultrasonic irrigation with sodium hypochlorite (NaOCl) as irrigant, removes more dentine debris, planktonic bacteria and pulp tissue from the root canal than manual syringe irrigation[7]. NaOCl is very effective in combination with passive ultrasonic irrigation and more effective than water [8]. Ultrasonic activation canals enhance the antibacterial and organic tissue dissolving potential of NaOCl through temperature increment [9]. The diameter of the root canal has an influence on the effectiveness of dentine debris removal during passive ultrasonic irrigation. For a root canal of size 20, taper 0.10, the dentine debris can be removed more easily than from a root canal size 20, taper 0.08 or 0.06 [10]. With careful maintenance and by using NaOCl at concentration no higher than 5%, most of the currently available equipment will function trouble free. Clinical advice on ultrasonic irrigation: use NaOCl as the irrigant; continuous flush method: 3 minutes of irrigation per canal, the canal flushing can be reduced to 15 ml/min; intermittent flush method: 1 minute of irrigation per canal with three ultrasonic activation sequences of 20 seconds each and refreshed with 2 ml of NaOCl three times; use a thin (size 15 or 20) non-cutting file or wire; in a curved canal, pre-bending of the instrument is advised.[15],[16],[17],[18].

2.2.Root canal obturation.

The obturation is realized in 3 steps. First, is the preparation: a X-ray action to assess the damage, Local anesthesia may or may not be needed depending on whether or not infection is present. To prepare the tooth, the area is first kept dry and saliva-free with a dental dam. A access hole is than drilled in the crown, or the top layer of the tooth. Root canal files, increasing in size, are than used to clean the inside of the tooth [11]. (Fig.4). The second step of the root canal obturation is sealing of the hole. This may be the decision if there is an infection present, and medication is usually given to speed the healing process. If the tooth is not sealed immediately, a temporary filling is necessary [12]. After the tooth is sealed the inside of the tooth must be filled.

The inside of the tooth is filled with a rubber substance called gutta-percha.[17],[18],[19].

Fig. 4

2.3.Ultrasonic condensation of gutta-percha.

Ultrasonically activated spreaders have been used to thermoplasticize gutta-percha in a warm lateral condensation technique. Initial placement of a gutta-percha cone to the working length is followed by lateral condensation of two or three accessory cones using a finger spreader [13]. The ultrasonic spreader is then placed into the center of the gutta-percha mass 1 mm short of the working length and activated at intermediate power. After activation, the ultrasonic spreader is removed, and an additional accessory cone is placed, followed by energizing with the activated ultrasonic spreader. The spreader must be in a canal only 10 sec. Using a sealer with ultrasound gives the best results [14, 15].. In Fig. 5 is illustrated an X-ray image of root canals filled with gutta-percha and sealer. [2],[3],[4].

Fig. 5

2.4.Root canal preparation.

Using rotary burs in a micro handpiece is faced with several problems, such as a cavity preparation not being parallel to the canal, difficult access to the root end, and risk of lingual perforation of the root. Furthermore, the inability to prepare to a sufficient depth “retention”. Several studies have shown that ultrasonically or sonically prepared teeth prepared by hand instruments. There is a relative inefficiency of ultrasounds in debridement of the canals, so we can used it not as initial instrument but with handle files to give the best results. Elimination of micro-organisms and their products form the root canal system and to shape it to receive an inert filling material. Micro-organisms are found to a variable degree up to the apical foramen in three modes: as a suspension in the root canal, colonizing the canal walls and colonizing the dentinal tubules. From the preoperative radiograph, estimate the average length of the tooth. Select a reproducible coronal reference point. It should not be part of a portion of tooth or restorative material that is likely to break off. It is chooses a file large enough to be visible on the radiograph (at least size 10). Insert a file into the root canal, 1-2 mm short of the estimated length and take a parallel view radiograph. An average distance of 1 mm short of the radiographic apex is widely accepted as a reasonable estimate of the terminal portion of the canal. Remember, at times, this may be inaccurate by up to 3 mm. (Fig. 6).

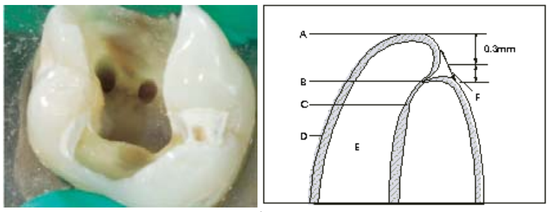

Fig. 6

Using the electronic apex locator of the ultrasonic endodontic device, we will appreciate the working length. It is very important this measurement for chose the right taper. Mechanical preparation refers to controlled removal of dentin by manipulating root canal instruments [16]. To avoid procedural errors resulting in loss of working length, it is used smaller instruments (No. 20 or smaller) for sufficient time until the larger sizes pass in the canal without force. You can even create intermediate files as suggested by Weine, by trimming 1m from the tip of the file and rounding off sharp edges on a diamond nail file [17]. This way you can convert 10, 15 and 20 files to 12, 17 and 22.

2.5.Operating mode of the ultrasonic endodontic device.

An ultrasonic endodontic dental handpiece has an elongated housing supporting a coil connected for establishing an alternating magnetic field, the housing having a cooling fluid inlet at one end and being open at the other for receiving and supporting a removable insert. The insert includes an elongated hollow body having one end adapted to be insertably mounted in the open end of the housing in fluid communication with the interior of the handpiece, and an elongated tool support assembly telescoping received in the body. The tool support assembly includes an elongated shaft member having a vibrator rigidly mounted on one end in position to be vibrated by the electromagnetic field and a seal located between the body and shank outboard of the housing to prevent the flow of cooling liquid through the body past the seal. A cooling fluid outlet is provided in the body between the housing in the seal to permit cooling fluid to flow through the handpiece, and an irrigation f luid passage is provided in the shaft outboard of the housing to permit the flow of irrigation fluid along the shaft to the terminal end of the insert assembly[18]. A mounting head on the end of the shaft supports an endodontic instrument to be vibrated by the vibrator, with the head including a fluid flow passage for discharging irrigation fluid longitudinally of the endodontic instrument. An ultrasonic endodontic apparatus is presented in Fig. 7. Fig. 7a is a real view and Fig. 7b. is a longitudinal section trough our ultrasonic endodontic apparatus.[16],[17],[18],[19].

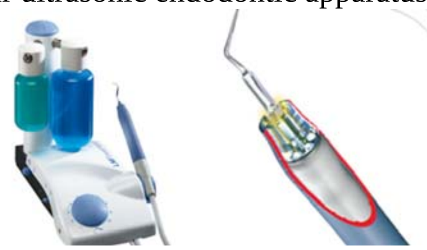

Fig. 7a.

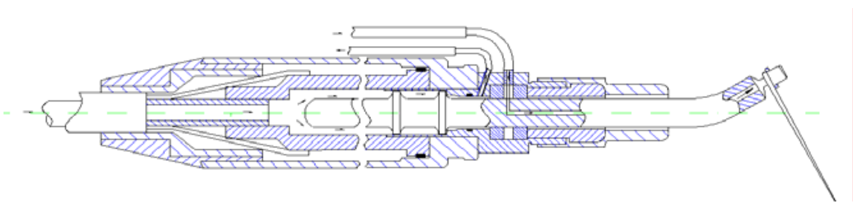

Fig. 7b

Ultrasonic endodontic device illustrated in Fig. 7 utilizes ultrasonic energy and, preferably, includes a shaft assembly and a stainless steel hypodermic needle which directs and concentrates the ultrasonic energy at the tip of the needle. In the ultrasonic device including a handpiece having an elongated hollow housing, coil means in said housing adapted to be connected to an external energy source for establishing an alternating electromagnetic field within said housing, said housing having a cooling fluid inlet at one end and being open at its other end, and an insert adapted to be removable mounted on the other end of said handpiece, said insert comprising(19). An elongated hollow body having one end adapted to be insertably mounted in said open end of said being in fluid communication with the interior of the housing whereby cooling fluid admitted into said housing can flow into said body. A tool support assembly telescopingly received in said body, said tool support assembly including an elongated shank havinf vibrating means rigidly mounted on one end, said vibrating means projecting from the open end of the said body in position to be vibrated by the electromagnetic field when said body is mounted in said housing. Seal means provided within said insert between said body and said shank outboard of said housing for directing the flow of cooling fluid through said body between said seal means, cooling fluid outlet means in said body between said seal means and said one end of said body providing a flow path for cooling fluid from said handpiece, the another end of said shank projecting outward from said body and terminating in mounting means for supporting an endodontic instrument, said shank having a fluid flow passage extending longitudinally therein from said mounting means and terminating at a location within said body. Irrigation fluid inlet means for admitting an irrigation fluid into said fluid flow passage to be discharged from said mounting means in a direction substantially parallel to the endodontic instrument mounted in said mounting means, whereby said irrigation fluid and said cooling fluid may be separately controlled. [1],[2],[3].

2.6 Surgical endodontics.

A root canal surgery, also known as apicoectomy is an endodontic surgical procedure whereby a tooth's root tip is removed and a root canal cavity is prepared and filled with a biocompatible material. State of the art procedures make use of microsurgical techniques, such as a dental operating microscope, micro instruments, ultrasonic preparation tips and calcium-silicate based filling materials. A conventional endodontic treatment is indicated if the dental pulp (nerve) of a tooth becomes non-vital (dies) or is likely to be put at risks due to the type or size of restoration needed to repair the tooth. During endodontic treatment, it is removed the dead remnants of the dental pulp and replaces it with an inert filling material which is visible on an X-ray. A tooth that must be assumed to an endodontic surgical procedure is given in Fig. 8. In this procedure, the endodontist opens the gum tissue near the tooth to see the underlying bone and to remove any inflamed or infected tissue. The very end of the root is also removed. (See Fig. 9)

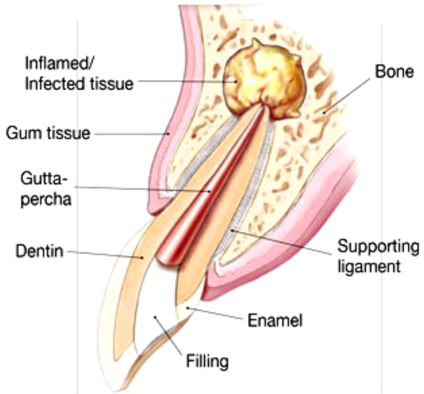

Fig. 8

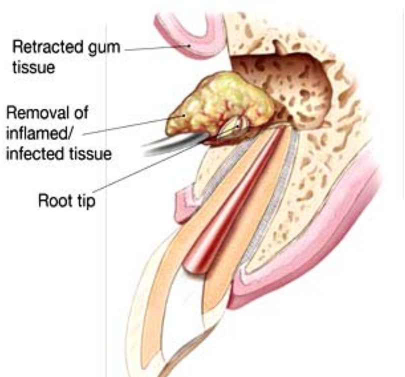

Fig. 9

A small filling may be palced in the root to seal the end of the root canal, and a few stitches or sutures are placed in the gingiva to help the tissue heal properly. (see Fig. 10). Over a period of months, the bone heals around the end of the root. (See Fig. 11)

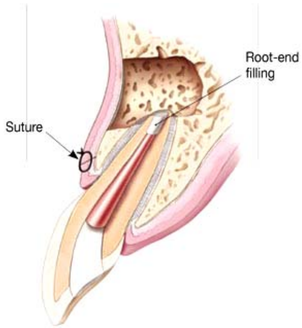

Fig. 10

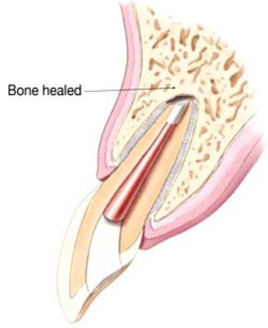

Fig. 11

3.Problem Solution: FEM

Ultraacustic system is the most important unit of an ultrasound processing plant because he made acoustic parameters (sound intensity, sound energy density, the amplitude of oscillation, wave type, frequency of oscillation) and mechanical parameters (static pressure and pressing force). The ultraacustic system used in this study consists of a piezoceramic set: 1 – reflector, 2 – piezoceramics pills, 3 - speaker, 4 - booster) intermediate item), 5 – concentrator. (See Fig. 12). Ensemble piezoceramic components, given the frequency of 20 kHz, generates ultrasonic oscillations (mainly longitudinal). Ultrasonic energy concentrator is coupled with all piezoceramic components through a booster (intermediate element). Booster is a ultraacustic system which is interposed between the transducer and the concentrator and a certain factor increases mechanical vibration amplitude transmitted by the transducer supported within the concentrator. [4],[5],[6].

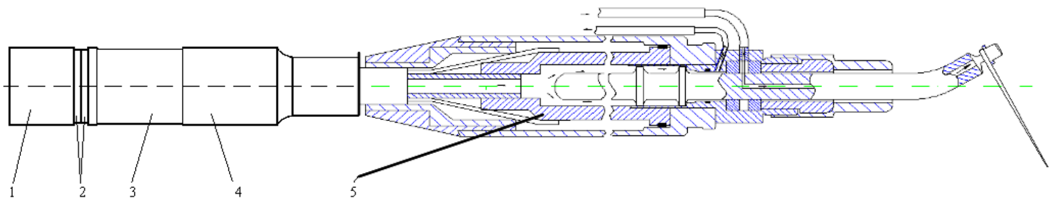

Fig. 12

All active elements of the ultraacustic system are piezoceramic's pills PZT4 with geometric dimensions shown in Fig. 13.

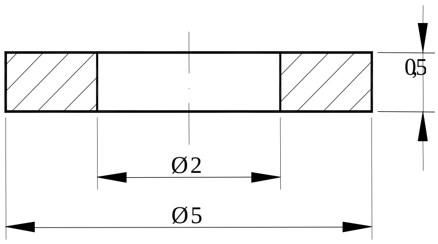

Fig. 13

Meshing (Fig. 14) is done with SOLID 98 item (3D with 10 tetrahedron solid knots).

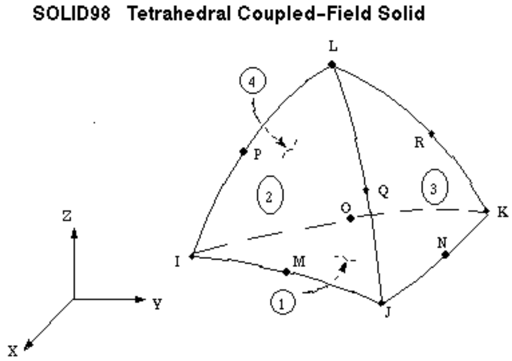

Fig. 14.

Volumes of two piezoceramic pills coupled with opposite polarization directions are represented in fig. 15. In Fig. 16 is given the meshing of pills with selected element mesh. Respecting the physical reality, nodes placed in common areas of the volumes they are taken all the degrees of freedom, corresponding symbols are represented in Fig. 17. Symbols corresponding to electrical charges applied to nodes in areas that are deposited electrodes with values in the range allowed (0-2000v) is illustrated in Fig 18.

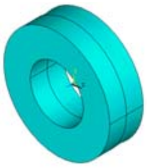
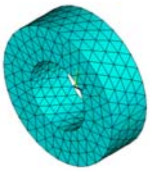
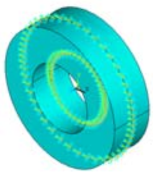


Fig. 15 ***Fig. 16*** ***Fig. 17*** ***Fig. 18***

In Fig. 19 are reprezented two piezoceramice pills deformed and non-deformed in frontal position and in Fig. 20 the same thing in isometric situation where the external electrodes appear with negative charge and the mass focal plane.

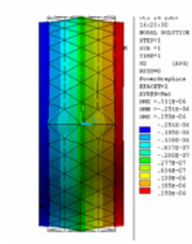
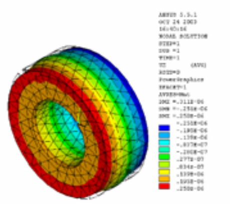

Fig. 19 ***Fig. 20***

In Fig. 21 (geometry volumes piezoceramic assembly) and Fig. 22 (finite element mesh volumes piezoceramic assembly) are represented all stages of construction of piezoceramic model. In Fig. 23 is represented deformed/non-deformed state in isometric and vertical view of piezoceramic assembly for resonant frequency of 20kHz. In Fig. 24 is represented the deformed/non-deformed state in vertical view of an piezoceramic assembly for resonant frequency of 20k Hz.[16],[17].

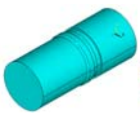
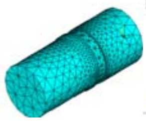
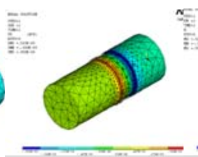
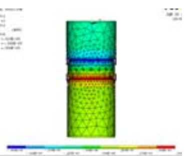

Fig. 21 ***Fig. 22*** ***Fig. 23*** ***Fig. 24***

Graphical representation of the variation in amplitude across ao piezoceramic assembly is given in Fig. 25.

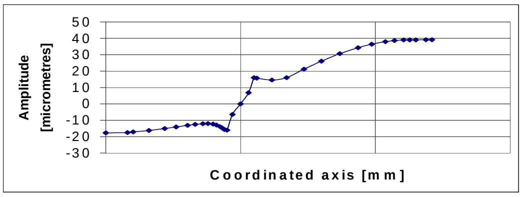

Fig. 25

In this study it has also been proposed to use ultrasonically vibrated endodontic files in the performance of root canal therapy by supporting the file for axial or longitudinally ultrasonic vibrations and mounting the file in a rigid clamping means and ultrasonically vibrating the file in a transverse, wave-like motion to enhance the debriding action. It is also known to provide an irrigating fluid directed from an ultrasonically vibrated endodontic file longitudinally of the axis of the file to enavle irrigation of the root canal while the debriding action is proceeding; however the known ultrasonically vibrated ndodontic file supports and root canal irrigating devices have not generally been capable of selectively separately and controllably applying fluid medication or other irrigationg liquid other than the cooling liquid circulated through the dental hanpiece. Finally, integration of new technologies such as ultrasound, leading to improved techniques and use of materials, has changed the way endodontic is being practiced today.[12],[13],[14].

4.Conclusion

The ultrasound was introduced in dentistry about 50 years ago, when it was discovered that it was able to cut the dental material with the aid of an abrasive slurry composed of aluminum oxide. During the decade of 1950 dentists uncovered the following advantages of the dental cavity preparation with ultrasound: cutting of the tooth with very light pressure; absence of pain in the majority of the procedures; absence of harmful effect on the pulp; precision of cut and excellent quality of finishing. The most important advantages are: minimum noise; absence of pain in the great majority of the cases, preventing the use of anesthesia; total visibility and access; cutting precision; minimally invasive preparation; selective cutting of hard materials; it does not cut soft materials, as gingive or tongue; it minimizes the bleeding; it does not add residues on the tip, facilitating the cleanness; it minimizes the smear layer. is the modern age of the dental cavity preparation with ultrasound, which gives superior quality and efficiency. Disadvantages: it cannot be used in patients who use pace-maker, handpiece is large and heavy.

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