ORIGINAL THEORETICAL AND EXPERIMENTAL CONTRIBUTIONS REGARDING THE USE OF ULTRASOUNDS IN ENDODENTISTRY

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Abstract. *Applications of the ultrasounds in endodentistry and the spectacular leap of their use, were possible due to the evolution of the theoretical research in the endodentistry studies and the today's innovations in technology and the endodental tools. In order to find the hidden and calcified channels and to perform an easier access to the radicular channels, it is suggested an endodental tool with an active specific part and a central channel which allows the penetration of a cooling liquid into the work area and the creation of the ultrasound cavitation phenomena.*

Keywords: ultrasounds, endodentistry, magnetostrictive transductor, radicular channel

1. General considerations

After analyzing the current state of research regarding the achievements and possibilities of classical endodentistry and the current state of research regarding the possibilities of using ultrasounds in endodentistry, several important conclusions were reached [1]:

- ultrasonic energy can be an adjuvant in various fields of endodentistry, with efficiency and clear advantages, but it requires a professionally well-trained clinician, a lot of experience, skill, a lot of patience and a high level of precision of execution;
- there are a lot of fields of endodentistry in which spectacular results can be obtained by using ultrasonic energy, but by using special endodontic instruments, that through their ultrasonic action allow the modifications desired with their respective advantages and by an employment which is accessible to any clinician;
- any modification within the biological tissue of the dental system caused by the action of ultrasound waves must be permanently monitorized and recorded with aiding methods (thermography, radiology, holography etc.) in order to lead the treatment process to obtain the desired target;
- the spectacular leap in the field of using ultrasounds in endodentistry and applying ultrasonic endodentistry on a large scale will be made possible gradually as new technological progress is made in the field of materials technology , materials science, eletronics and informatics;
- some phenomena connected to the characteristics of ultrasound waves and some effects connected to their propagation through the living tissue can not be explained yet, that is why they still require theoretical and experimental research in order to explain the modifications within the living tissue, caused by ultrasonic energy [2,3,4].
- according to these studies and research concerning all possible uses of ultrasonic energy within endodentistry we should be able to solve the following problems: setting the parametres of the ultrasound field applied for the established purpose (finding and access of the calcified channels, removing the interchannel obstacles, accelerating the irrigation process, washing and cleaning, preparing the silver cones, apical endodentistry surgery, etc.) the most important being: ultrasound frequency; type of ultrasound wave, the duration of ultrasound activation generated in the tissue

(longitudinal, transversal, torsional, shredding, etc.); the geometrical shape of the ultrasound beam; the duration of the ultrasound impulse; acoustic impedance, etc.;

- the study of the alterations which happen within the ultrasound irradiated tissues and which have an immediate medical importance (their capacity to regenerate the cells as a consequence of the lesion, the alterations appeared within the cells after removing the lesions, etc.);
- the accurate setting of the corresponding threasholds for the cell modifications . The „ultrasound dose" is set (the minimum and maximum value of the ultra-acoustic parametres to which the suggested cell modifications appear);
- the scientific explanation of the mechanisms of the appeared modifications, at least from the physical, chemical biological point of view;
- improving the means necessary to specify the irradiation conditions, giving a special attention to the parametres that define the ultrasound field (conditions for exposing to the irradiation; the ultrasound intensity; the deformation amplitude, the width and the shape of the ultrasound beam, the shape of the impulse, an index for the beam un-uniformity, an index for the cavitation activity, etc.);

The theoretical and experimental research contained in this work are the result of the long collaboration between the Endodentistry Department within the University of Medicine and Pharmacy „Carol Davila" in Bucharest and the Department of the Materials Technology within the Politechnical University in Bucharest, for a collaboration protocol concluded in 1997[5,6].

2. Ultrasound devices and the endodontic tools activated by ultrasounds, used in research[3,9,10].

Generally, the ultrasound equipment used for different applications in dental medicine is made of an electronic generator with variable frequency and automatic granting on resonance frequency, an ultrasound system which transforms the electric oscillations of the generator into mechanic oscillations which are higher to 16 kHz, the endodontic tools which lead, concentrate and focus the ultrasonic energy into the tissues which are to be treated by ultrasounds and the auxiliary tools which allow the introduction of irrigating substances, cleaning, washing or medicine substances and the suction of the substances which must be removed from the activity place, of the endodontic tool activated by ultrasounds (remains of tissues, dentine, microorganisms, endotoxines, etc.) the most important part which is specific for the endodentistry applications is made of the ultra-acoustic system or the ultrasound device and the endodontic tools which are activated by ultrasounds.

2.1 The ultrasounds device

The ultrasounds device represents the main component of an ultrasound device because it transforms the electric oscillations of the electric generator into mechanic oscillations with ultrasound frequency. From the point of view of the principle used to change the electric energy into mechanic energy, two types of devices are used:

- Devices like the transductor made of metalware of magnetoscrictive material; which use the property of magneticstriction of certain materials (magnetite, alfer, permalloy, nickel, feroxcub, etc)

- Devices with ultrasounds transductor made of piezoceramic materials, which use the piezoelectricity property of certain materials (zirconate titanate of barium, zirconate led titanium, ceramics, quartz, terfenol etc);

The ultrasounds devices with magnetostrictive transductor are more robust, need cooling, have a lower efficiency but are more resistant during handling, to sterilization and stress. The principle chart of such a model device DEU-01 AM special for use in the dental medicine si presented in Figure 1.

The ultrasound devices with piezoceramic transductor are lighter, do not necessitate cooling after a relatively short use duration, have an increased efficiency and are easy to handle.

They present the risk of cracking and breaking the piezoceramic plates in case of shock and stress use such as handling during sterilization.

The principle chart of an ultrasound device with piezoceramic transductor, model DEU-03 AP is set in Figure 2 and a constructive, more simplified variant

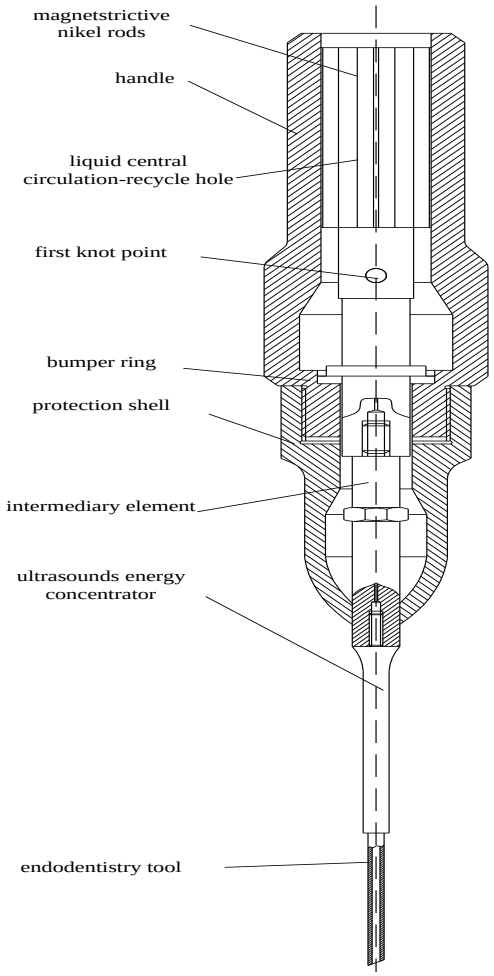

Fig. 1. *Principle chart of an endodontic ultrasound device with magnetostrictive transductor, model DEU-01 AM*

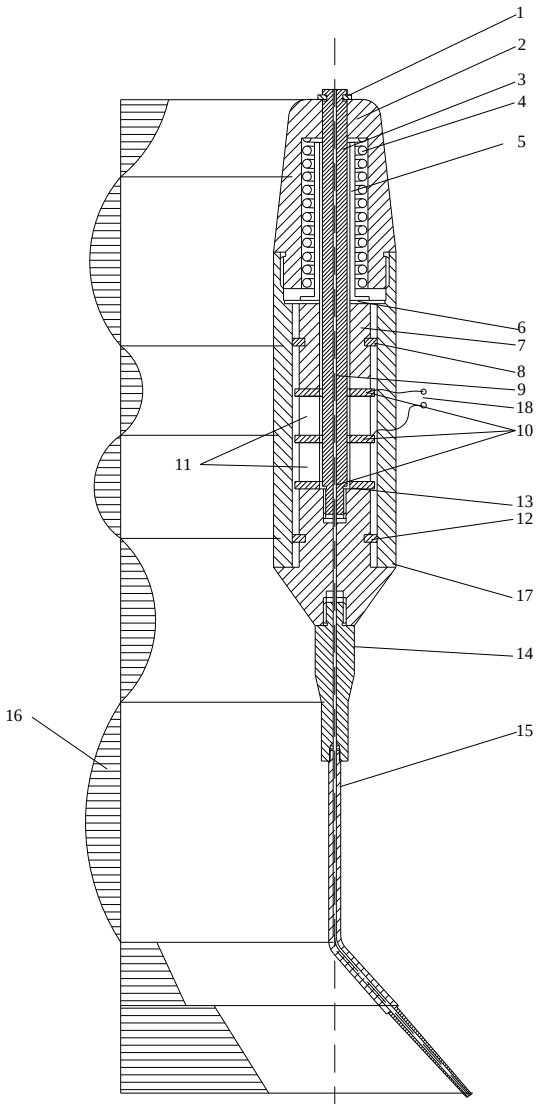

Fig. 2. *Principle chart of an ultrasounds, model DEU-03 AP*
1 – pretension rod; 2 – special screw nut; 3 – pretension shell; 4 – tension spring; 5 – insulation cylinder; 6 – pressing washer; 7 – reflector; 8, 12 – rings; 9 – aspiration hole; 10 – electrods; 11 – piezoceramic plates; 13 – exteriour shell ; 14 – ultrasounds energy ***concentrator; 15 –*** *endodontic tool; 16 – speed amplitude variation diagrame lengthwise*

The ultra-acoustic system but with a central irrigation-suction channel, model DEU-02 AP-CC is presented in Figure 3.The most important part of an ultrasound device used in endodentistry is the ultra-acoustic system which thus must be designed and built that it exercises a certain type of ultrasound wave which is to be used in that application.

Generally, these systems are calculated as to work in resonance programme if in them some ultrasound longitudinal, transversal, torsional or surface waves are stimulated [3,7,8].

There are certain applications for which the use of ultrasound stationary waves is necesary, and in this case, the ultrasound system has a certain shape and certain dimensions. An ultra-acoustic system used for irrigation-cleaning-washing, disinfecting the area activated by ultrasounds is presented in Figure 4.

2.2 The endodental tools activated by ultrasounds

The endodental tools activated by ultrasounds are essential for every endodentistry application because they are those which introduce the ultrasounds energy into the dental system tissue. The efficiency of the suggested treatment depends on the modality it is designed, made and handled within the intervention area. There is no endodental tool activated by ultrasounds with multiple applications, for each application there is a specific endodental tool, with the corresponding shape and sizes asked by the modifications which are to be performed into the biologic tissue.Several types of endodental tools activated by ultrasounds are presented in Figure 5. They are calculated in such a way that they work in resonance regime and must have a good ressistance during application.

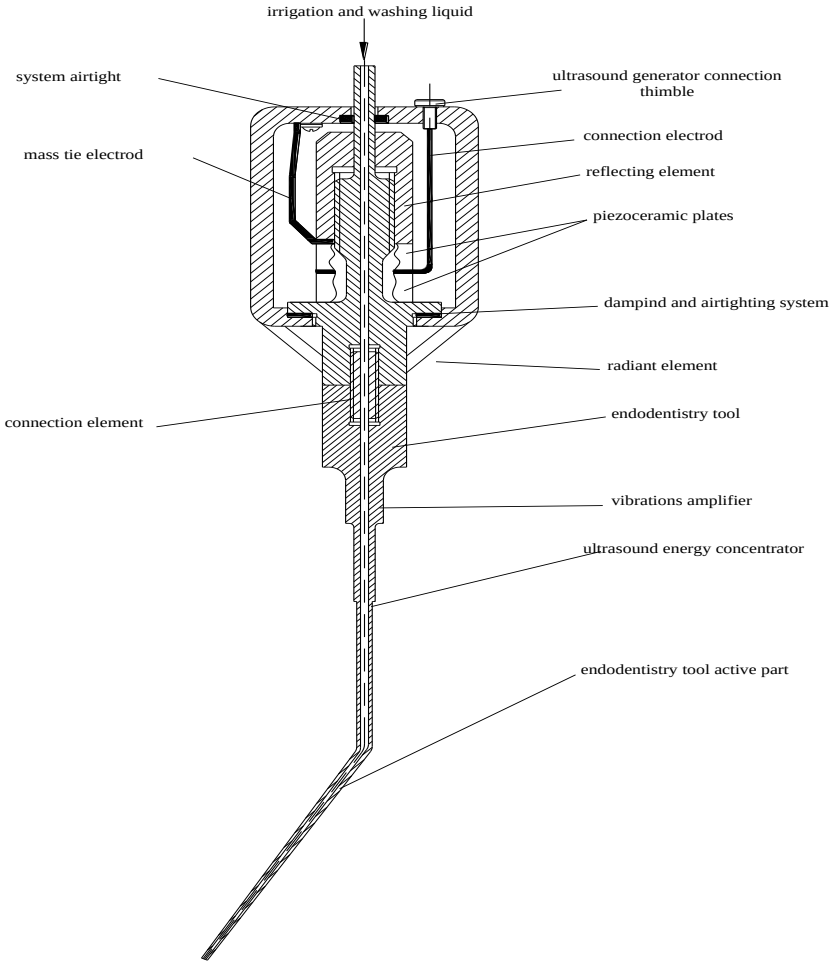

Fig. 3. *Principle chart of an endodontic ultrasound device with piezoceramic transductor and central channel, model DEU-02 AP-CC*

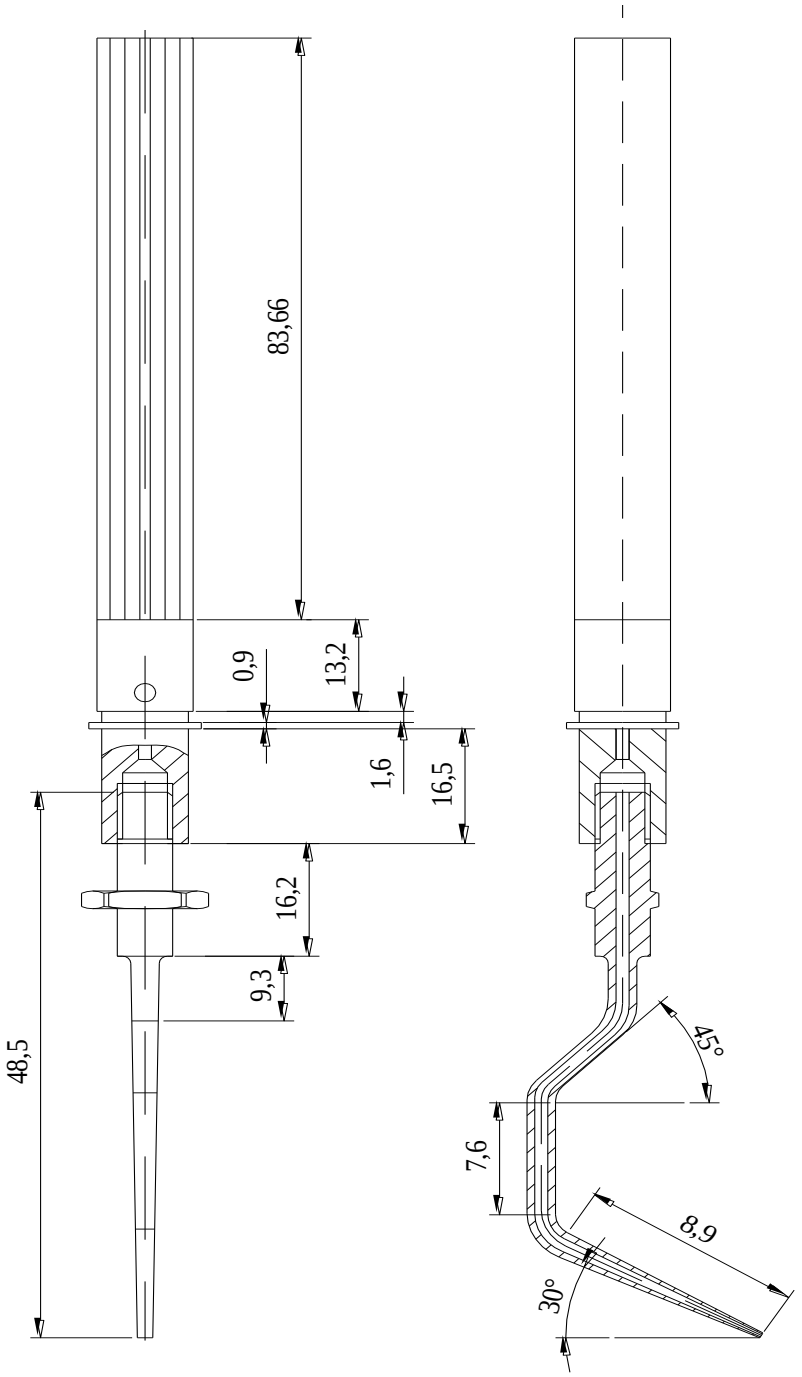

Fig.4. *The device for irrigation-cleaning-washing-disinfection of the radicular channel using ultrasounds*

From the technological point of view, the endodental instrument/tool which is to be activated by ultrasounds, according to the desired application, is the most important challenge for the technology specialist engineer, because is it very difficult to achieve the shapes demanded by the radicular channels, with ressistance to stress, considering the sizes of the radicular channels and the circumstances of the apparition of the ultrasound cavity, the stationary waves and heat.

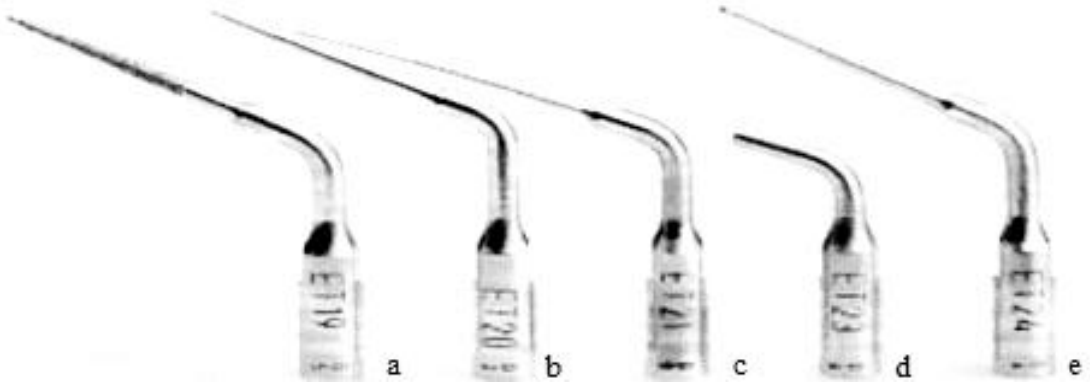

Fig.5. *Endodentistry tools activated by ultrasounds used in endodentistry:*
a – with diamond tip used to remove the infected dentine or to have access at the calcified channels; b – with sharper tip and central channel for the irrigation-washing sollution; c – with feather-like tip to remove the coronary or inter-channel obstacles; d – with special tip to remove the pivots;e – with diamond-tip ball to eliminate calcifiation, temporary or permanent ciments and pivots;

In this work, new endodental tools activated by ultrasounds, demanded by the cinematics necessary to modify the living tissue, for an easiness to handle and to increase the efficiency of the ultrasound activation method for that specific process, are to be suggested [3,9].

3.Conclusions

As a consequence of the theoretical and experimental research performed, we can state the following conclusions :

1^o Applications of the ultrasounds in endodentistry and the spectacular leap of their use, were possible due to the evolution of the theoretical research in the endodentistry studies and the today's innovations in technology and the endodental tools;

2^o Generally, ultrasound devices used for different applications in dental medicine, and specifically in dentistry, is made of an electronic generator with variable frequency and automatic granting on resonance frequency, an ultra-acousitic system which transforms the electric oscillations of the generator into mecanic oscilaltions with ultrasounds frequency, the set of endodental instruments which lead, concentrate and focus the ultrasounds energy into the tissues which are to be treated and the auxiliary elements which allow the introduction of irrigating substances, which clean, wash or medicate, and the suction of the substances which must be removed from the activity place of the endodental tool activated by ultrasounds;

3^o For the ultrasounds treatment, two categories of ultrasounds devices are used, which work by the principle of magnetostriction phenomena or the piezoelectricity principle;

4^o The most important part of an ultrasounds endodental device is the ultra-acoustic system which must be calculated, designed and made in such a modality that it exercises a certain type of ultrasound wave (demanded by the specific application) and which, together with the endodental tool activated by ultrasounds, worked in resonance regime;

5^o In order to find the hidden and calcified channels and to perform an easier access to the radicular channels, it is suggested an endodental tool with an active specific part and

a central channel which allows the penetration of a cooling liquid into the work area and the creation of the ultrasound cavitation phenomena.

4.References

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