

Piezoelectric Surgery In Periodontics: A Review

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ABSTRACT

Ultrasonic has been used in periodontics for many years to unfasten tartar, root surface debridement, and to degranulate the periodontal defects. In the past 10 years revolutionizing maxillofacial bone surgery have been carried out by a novel family of ultrasonic powered devices that have been developed. Comparatively, Piezo surgery is a modern technique that was introduced by Tomaso Vercellotti in 1998 with the idea to use an ultrasonic device for abscission fitted with a sharpened insert, like a scalpel blade, to perform peri radicular osteotomy and to extract an ankylosed root. To achieve an optimum recovery, that mainly relies on gentle soft and hard tissue handling, the surgical damage has to be minimal. The degree of the surgical invasiveness is very consequential for the tissue healing consistency and it may be influential on whether the wounds heal by the reconstruction or regeneration. Secondly, more traumatizing surgeries commonly conduct greater inflammatory responses with slow healing and this may pilot repair and scarring instead of regeneration. Therefore, it is recommended for any surgical procedure to use the least traumatic surgical instruments and methods for any surgical procedure.

Key Words – Piezo Surgery, Ultrasonic Vibrations, Degranulation, minimally invasive, Osteotomy

INTRODUCTION

Since two decades, Ultrasonic vibrations have been used to cut tissues^[1,2] But, it is recently that the applications of ultrasonics have been used in routine for usual clinical applications in various different areas of surgery. It diminishes the risk of destruction to the near by soft tissues and critical structures (vessels, mucosa and nerves), especially in osteotomy procedure

[3,4]. Micro Abrasions are created using ultrasonic devices which are generated by the piezoelectric effect. The most enthralling characteristics of piezoelectric bone surgery are less surgical trauma and a quick-healing response of tissues. This enhances the effectiveness of the treatment and postoperative recovery and healing. The micromechanical cutting action of piezoelectric bone surgery sequels to micronization of the bone that is and inhibits lamellar fracturing in adjacent bone, which might favour exposure and release of bone morphogenetic proteins and be accountable for the early onset of osteogenesis at these sites. Also, there may be a reduced inflammatory response because there is either little or no need to eliminate the surgical debris and damaged bone as compared to conventional rotary drilled sites. Piezoelectric bone surgery is developed and conceived to overcome the boundaries of conventional bone cutting instruments and to carry off the most effective treatment with the minimum morbidity. A rigorous literature review^[5] showed that between 1960 and 1981, five articles were published that presented experimental studies for cutting bone using various instruments that included ultrasound produced by a magnetostriction.^[5-9] post 18 years in 1998, a note was published by Torella et al describing a method osteotomy (bone window) wherein, using an ultrasonic device the maxillary sinus is lifted.^[10]

PARTS OF PIEZOELECTRIC DEVICE

Piezoelectric devices mostly consist of a foot switch and a hand piece that are connected to the main power unit. It has a holder for the hand piece that has irrigation fluids that make an adjustable jet of 0–60 ml/minute via a peristaltic pump. (Figure 1) It eliminates debris from the cutting area and guarantees precise cutting.

MAIN BODY

There is a display on the main body, a touchpad that is electronic, a pump (peristaltic), two stands out of which one is for the handle and the other one holds the irrigation fluid contained bag. The interactive touchpad has four keys – one which selects the specific program, feature mode and the flow of the flowing cooling liquid. Display shows every command.

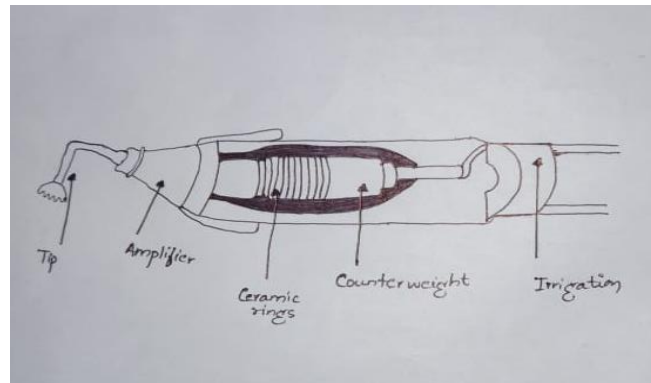


FIGURE 1 – PARTS OF PIEZOELECTRIC DEVICE

Piezosurgical Unit

Bone mode and Root mode are the two main primary modes.

ROOT MODE - The characteristics of root mode is that vibrations generated are characterized mainly by average ultrasonic power with the absence of frequency over modulation.

BONE MODE – Characteristics of bone mode ultrasonic power is very high compared to root mode. Monitoring the performance by many complex software and hardware controls. The unique nature of ultrasonic mechanical vibrations for cutting different kinds of bone is given by frequency over modulation. The following the is recommended selection -

Quality 1: for cutting high-density spongy bone or the cortical bone.

Quality 3: for cutting low density spongy bone.

MECHANISM OF ACTION

The main principle on which the piezoelectric effect is based on is of physical the event of basic mechanical and electric dimensions like electric field strength, polarization, tension and extension in crystalline field which says that the deformation in crystals on flowing of electric current results in oscillations of ultrasonic frequency and physical interactions. The flow of an electric current through certain crystals and ceramics alters them and creates oscillations. Voltage applied to a polarised piezoceramic result in its expansion and contract perpendicular to polarity.

BIOLOGICAL EFFECTS ON BONE CUT

The mechanical instruments effect on the feasibility of cells and structure of bone are of value in regenerative surgery. The effects of piezoelectric devices on cell viability and chip morphology are confirmed in previous studies, while the bone chips are harvested. [6,7] Bone that the round bur harvests on low and high speed, a safe scraper or spiral implant bur, is unfit for grafting because of the reason of predominant bone that is non vital and there are no osteocytes present. Autologous bone that a piezoelectric device harvests from the zygomaticomaxillary region can be useful in augmentation for aesthetic and stable placements of oral implants post 5-month's healing.

PIEZOSURGERY IN PERIODONTICS- ITS IMPLEMENTATION

Following are the applications of piezosurgery in the area of periodontology - Supragingival and subgingival scaling and root planning, Periodontal pocket lavage ,Crown lengthening, Soft tissue debridement, Resective surgeries, Regenerative surgeries - To obtain autogenous grafts for treatment of periodontal intrabony defects.

In Implantology

To harvest Block (bone) grafts and implant placement eventually in the recipient sites, Osteotomy procedures, Implant placement prior to Distraction Osteogenesis, blade implants retrieval, Ridge Expansion and implant placement, sinus lift procedures, osteotomy procedures, and for insertion of implants.

CLINICAL CHARACTERISTICS OF PIEZOSURGERY CUTTING ACTION

PRECISE CUTTING ACTION

The mechanical vibrations whose linear oscillations runs from 20-80 microns is responsible for cutting action accuracy. This microscopic spread gives a cutting that has microsurgical precision and the limit depends only on the use of degree of expansion by the operator. Regardless of vibration's linear dimensions, their cutting efficiency is substantial.

SELECTIVE CUTTING ACTION

This physical property, that warrants better cutting of the mineralized tissues than the soft tissues, relies on the less frequency of the ultrasonic waves and on the instrument sharpness.

CLINICAL ADVANTAGES OF USING PIEZOSURGERY IN PERIODONTIC SURGERIES

Surgical Flap Removal - The inflamed tissue and secondary flap is detached easily using OP3 and PS2. Also, effect of saline solution's cavitation allows haemostasis and results in maximum visibility.

Ostectomy and Osteotomy - The ostectomy with OP3 is more beneficial and there is no risk of root surface damage. It does not injure root cement. OP4 is used for interproximal actions, that is an ultrasonic version of the file by Dr.Schoulerger. Osteoplasty with piezo surgery has several advantages. One of the main advantages is that it enables very accurate cortical bone remodelling without bleeding. Secondly, work is possible even when the root is in contact. This is the sole reason because of which unwanted spikes are not unformed like it happens while using the bur.

Bony Spikes removal - Post ostectomy with OP3 the bony spikes on the root surface are very minute and can be only visualized by magnification. They are removed root smoothing with insert PP1, that ensures a high degree of precision and speed

Bone Healing – From clinical and histologic point of view, Bone healing post crown lengthening procedures using Piezo surgery technique is more efficient. A Histological study that was conducted in Harvard University that compared bone healing post crown lengthening using burs and using piezo surgery resulted in favourable bone healing after the osteotomy performed using piezo surgery rather than burs.

CLINICAL ADVANTAGES OF USING PIEZOSURGERY FOR ULTRASONIC PREPARATION OF IMPLANT SITE

Thin Crest – Preparation of implant site using Piezo surgery does not result in any dehiscence even if there is thin crest. By using diamond coater insert, preparation of pilot osteotomy can be optimized. The thickness of the lingual cortical bone can be decreased from the inside using this technique. This technique is also known as "differential preparation of the implant site.

Soft Bone - The integrity of the trabeculae around the implant site is conserved by the micro vibrations generated when using Piezo surgery

Proximity of Alveolar Bone - Preparation of the implant site using Piezo surgery in the presence of mineralized bone needs light pressure on the handle (about 500 g). there is excellent Surgical control. There is appreciable reduced risk of neural damage.

Sinus Lift - Enough primary stability is ensured by using piezo surgery for implant site preparation even if the crest thickness is 2-3 mm. It is really advantageous to placing the implants and lift sinus in the same surgical procedure, for both the patient and the surgeon performing the operation.

Intra Alveolar Preparation – It is very convenient to change the surgical alveolus direction using Piezo surgery with respect to the natural one. Appropriate use of the IM2 and OT4 makes it possible to optimize implant placement according to priorities of the prosthesis

Process of osseous integration – early histomorphometry and biomolecular studies that compared Piezo surgery with twist drill on the same type of implant surface have given much better healing of bone in sites that were prepared using an ultrasound.

Immediate Loading - The anatomical characteristics can be exploited to gain primary stability. In addition to this, bone healing is faster, especially in post-extraction for immediate implant placement.

NEW CONCEPTS AND NEW SURGICAL TECHNIQUES USING PEIZOSURGERY

Tomaso and Giuseppe Vercellotti proposed the new classification of bone that has universal application and can be used in all areas of bone surgery. It allows simple and highly accurate definition of the anatomy of every surgical site and its dual application for quantitative classification of density of spongy bone. Best cutting instruments and fixation systems for all anatomical areas can be chosen by preoperative analysis based on this classification

Application in Implantology

In implantology, bone crest's preoperative analysis is done by evaluating the paraxial images from a CT scan. The classification show case the quantitative characteristics of the cortical crest and separately, the density of spongy bone mineralization.

Qualitative Classification Clinically

This classification defines the Density of Spongy Bone. Spongy bone density is evaluated based on the radio transparency or radio-opacity of the CT scan images.

- **HIGH Density**, to indicate high density of spongy bone.
- **MEDIUM Density**, to indicate medium density of spongy bone.
- **LOW Density**, to indicate low density of spongy bone.
- **CONCLUSION**

Piezoelectric devices are an innovative and useful ultrasonic technique for a safe and an effective osteoplasty or osteotomy while comparing to regular soft tissue and hard tissue methods that incorporate the use of rotary instruments. Its mechanical and physical properties have numerous clinical advantages such as precise cutting, saving the vital neurovascular bundles, and also provides better vision of the surgical field. In the first phase of bone healing, Piezoelectric bone surgery can be more efficient; increase in bone morphogenetic proteins is initially induced, inflammatory responses are controlled better and stimulation of remodeling of bone is as early as 56 days after treatment.

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