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[Mini Review Article] Practicality of Piezo Surgery in Periodontics

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Abstract

The ongoing advances in periodontics, have led to the introduction of Piezosurgery, which has been rejuvenating in the field of osseous surgeries. Piezosurgery® device is based on the piezoelectric effect by ultrasonic vibrations. The linear vibrations and cavitation effect gives blood free zone for clear visibility and operating accuracy. The display unit guides the user to choose from a variety of operational settings that optimize the ultrasonic frequency for desired procedures. It has various applications in periodontics particularly in osteotomy procedures and implant dentistry.

Keywords: Periodontics, Piezosurgery, Ultrasonics, Ridge splitting, Differential cutting, Osseous surgeries.

Introduction

The evolving leaps in periodontics, led to many recent advances in ultrasonic instruments. One of which, fostering to lead role is piezoelectric surgery. Although rotary instruments give more edge when compared to manual instruments, there may not always be enough surgical control, particularly when it comes to the neurovascular structures next to the osteotomy site. The cutting action of the rotary instruments depends on the cumulative effect of the cutting edge concerning the bone surface in a given period.[1]

In the late 90's many authors investigated the possibility of the piezoelectric effect. In 1999 Prof. Tomaso Vercellotti in collaboration with Mectron spa invented a piezoelectric bone surgery device and published a paper in 2000. The micro-vibrations from piezoelectric ultrasonic transducer, drive cutting inserts and the cavitation effect give good visibility, hemostasis, and deterioration of microbial cell envelope.[2]

This invention has been revolutionizing the use of ultrasonics in osteotomy and osteoplasty procedures. Apart from osseous surgery, it is also used in other procedures like oral prophylaxis, root planning, crown lengthening, atraumatic tooth extractions etc.[3]

Piezoelectric Bone Surgery Unit

Piezosurgery® unit parts include

a. Main body
b. Pedal
c. Handle
d. Inserts

The main body has a display and electronic touchpad which has access to 2 modes: Root mode and Bone mode. In the Root mode, the ultrasonic vibrations are moderate and there is no over-modulation of frequency, it has ENDO program and PERIO program. In the ENDO program, the power is minimal and used in endodontic surgeries. In the PERIO program, power is intermediate when compared to bone mode. In the Bone mode, the ultrasonic vibrations are extremely high and there is over-modulation of frequency. Qualities recommended in this mode are quality 1 for high-density spongy bone and quality 3 for low-density spongy bone. The pedal controls the handpiece. The handle transmits the ultrasonic vibrations from the amplifier into the inserts. Specific types of inserts are used based on functional needs.[4] The device uses a frequency of 25-50 khz and micro vibrations of 60-200 µm.[3][5] Inserts are different for each system based on the company. There are many systems available like mectron-piezosurgery®[4][6], NSK(Nakanishi International), etc.

Principle & Mechanism of Action

A subfield of acoustics called ultrasonics, studies sound waves with frequencies higher than human hearing i.e., >20 kHz.[7] At 25-50 kHz ultrasonics produce the piezoelectric effect, which states that when ceramics or crystals are placed in an electric field, a deformative effect is imposed upon them creating oscillations.[8]

Piezoelectric crystals compress when electrical charges are applied to them. when the electric charge is reversed, the crystal expands. An alternating electric field can cause piezoelectric crystals, such as quartz or ceramic discs, to alternate between compressing and expanding, which will result in a sequence of vibrations in the transducer releasing ultrasonic energy.[9] These vibrations are subsequently transmitted to a resonance insert, causing movements leading to mineralized tissue cutting. The cavitation effect alludes to fluids vibrating at an intermediate frequency, forming vapor bubbles that collapse and generate a shock wave. [4] This effect promotes hemostasis in the operating field, maintains pH and oxygenation of tissues, and better visibility.

Applications in Periodontology

There is a wide array of uses for piezo surgery in periodontics.

Scaling and Root Planning

Vibrating inserts and cavitation have been proven successful in eliminating supra and subgingival deposits. Cavitation also disarticulates the plaque microbiome and bacterial cell wall.[10][11] The Piezo surgery device is also capable of pocket depth reduction by removing the epithelial tissue lining and diseased granulation tissue contributing to microcauterization.[9][12]

Periodontal Surgery

There are numerous advantages of employing ultrasonics in periodontal flap surgery when compared to manual instruments. After the primary flap reflection with conventional instruments, a piezo device with appropriate inserts helps in the proper debridement and manipulation of soft and hard tissues. The cavitation effect via saline solution reduces the risk of excess hemorrhage, gives good visibility of the operating field and irrigation removes debris providing better healing.[10] The micro-vibrations of piezo inserts create pits in the defect base which triggers cellular response, this also helps in improved healing.[9]

Crown Lengthening

Traditionally rotary burs are used for osteoplasty in surgical crown lengthening. By using a piezo surgery device, better efficiency and precision can be achieved with nary undesired soft tissue injury along with enhanced visibility and protection for vascular units. According to a comparative study done by Dayoub ST and Yousef MA, Piezosurgery offered a great advantage in both minimally invasive techniques and also open flap techniques in the treatment of gummy smiles. [13]

Resective and Regenerative Surgeries

Even though piezo surgery has advantages in non-surgical therapies its main glimmer lies in bone surgeries. Piezo surgery is an excellent choice to obtain autogenous bone grafts. It assists in differentiating compact bone from porous bone, enabling precise cutting action.[14][15] This helps in improved regeneration in intra bony defects. In resective surgeries, succeeding primary flap elevation, piezo inserts assist in successfully reflecting the secondary flap and aid in debridement, saline irrigation removes debris and toxins which in turn accelerates the wound healing. According to a split-mouth clinical trial by Aimetti M et al, in osseous resective surgery, the use of piezoelectric surgery resulted in a mild inflammatory response initially when compared to rotary instruments.[16]

Implantology

Piezo surgery plays a vital role in implant site preparationby using precise insert tips, it promotes better osteogenesis,

stability, and osseointegration of implants.[17] In conditions where the width of bone is less for implant placement, ridge expansion using a piezo device promotes better control and ease of operation.[18]

In ultrasonic implant site preparation, a new technique came forth with the invention of piezo surgery, with this it has been proven that osseointegration was also increased with piezo device compared to conventional methods.[19][20]

Schneiderian membrane perforation is the main complication in the sinus floor elevation procedure. Due to the differential cutting of hard tissues, piezo surgery has the benefit of performing meticulous sinus lift procedures, particularly in techniques like lateral window preparation.[21] This distinguishment in hard and soft tissues also helps in sparing other prime anatomical structures like nerves and vessels during various bone augmentation procedures like splitting, expansion, and distraction osteogenesis.

Advantages

- The selective cutting action of piezo surgery insert, makes it ideal to utilize near neurovascular tissues and maxillary sinus.
- The cavitation effect and saline irrigation, are attributed to reduced risk of bone necrosis, improved visualization, and asepsis from the removal of debris.
- In comparison to conventional drills for osteotomy, piezo surgery has the added advantage of decreased overheating.[22]
- It also has less operative bleeding and good post-operative healing.

Limitations

- The drawbacks of piezo surgery include, increased operating time and chances of insert breakage.[23]
- It is not economical
- It is skill dependent.

Conclusion

In conclusion despite a few disadvantages, so far piezo surgery can be considered as one of the best choices for osseous surgeries due to its added advantage of precise osteotomy in sites with close relationship to vital structures. Less invasiveness is the key to good healing in surgical procedures, the conservative nature of piezoelectric bone surgery makes it ideal for such better outcomes. Adequate skill training with this equipment has made previously challenging treatments simple and feasible.

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