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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.

Keyword: 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 gave 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 cumulative effect of cutting edge in relation to the bone surface in a given period of time.[1]

In the late 90's many authors investigated the possibility of piezoelectric effect. In 1999 Dr. Thomas vercelloti in collaboration with Mectron spa invented piezoelectric bone surgery device and published a paper in 2000. The micro vibrations from piezoelectric ultrasonic transducer, drive cutting inserts and the cavitation effect gives 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

Main body has display and electronic touch pad 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 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. Pedal controls the handpiece. Handle transmits the ultrasonic vibrations from amplifier into the inserts. Specific types of inserts are used based on the functional needs.[4] The device uses a frequency of 25-50 khz and micro vibrations of 60-200 µm.[3][5]

Inserts of Mectron-Piezosurgery®.[4][6]

Osteotomy (OT)

OT1 - OT2- OT3- OT 4- OT5- OT6- OT7- OT7S4 - OT7S3- OT8R/L ·

Osteoplasty (OP)

OP1 - OP2- OP3- OP4- OP5- OP6- OP7 ·

Extraction (EX)

EX1 - EX2 - EX3

Implant site preparation (IM)

IM1 (OPs)- IM2A- IM2P- OT 4- IM3A- IM3P ·

Periodontal Surgery

PS2 - OP5 - OP3 - OP3A- PP1 ·

Endodontic Surgery

OP3- PS2- EN1 - EN2- OP7 ·

Sinus Lift

OP3- OT1 (OPs)- EL1 - EL2- EL3 ·

Ridge Expansion

OT7- OT7S4- OP5 (IM1)- IM2- OT 4- IM3 ·

Bone Grafting

OT7- OT7S4- OP1 - OP5 ·

Orthodontic Microsurgery

OT7S4- OT7S3

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 piezoelectric effect, which states that when ceramics or crystals are placed in an electric field, 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 transducer releasing ultrasonic energy.[9] These vibrations are subsequently transmitted to a resonance tip causing linear movements leading to mineralized tissue cutting. The cavitation effect produced by saline solution, alludes to fluids vibrating at intermediate frequency forming vapor bubbles which 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 usage 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 cellwall.[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, piezo device with appropriate inserts helps in proper debridement and manipulation of soft and hard tissues. Cavitation effect via saline solution reduces the risk of excess hemorrhage, gives good visibility of 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 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.[13]

Resective and Regenerative 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 accelerate the wound healing.[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 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 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 of saline solution, attributes 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 an 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 there are 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 for 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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