Piezosurgery & Its Implications in Dentistry

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Abstract

Periodontitis is a chronic inflammatory disease of the tooth supporting structures. The treatment of this condition is largely based on the removal of local factors and restoration of the bony architecture. Traditionally , osseous surgery has been performed by either manual or motor – driven instruments. However, both of these methods have their own advantages and disadvantages. Recently ,a novel surgical approach using piezoelectric device has been introduced in the field of periodontology, implantology and oral surgery. This article discusses about wide range of application of this novel technique in periodontology.

Keywords :-Osteotomy , Piezosurgery

Introduction

Over the last few decades , there has been rapid development in various dental surgical techniques , evolving a world of painless dentistry. Traditionally the osseous surgeries have been performed by either manual or motor driven instruments. Manual instruments provide good control when used to remove bone in areas of less dense mineralization but are difficult to control in cortical bone, particularly where precise osteotomies are essential. Therefore motor driven instruments were used in areas of dense bone, but these instruments generated significant amount of heat in cutting zone which needed to be minimized by irrigation.[1]

In order to overcome these shortcomings of the surgical techniques, 'Piezoelectric Device' was introduced in dentistry by Vercelloti et al. called 'Piezosurgery' , also known as 'Pressure Electrification', it has been defined by the term 'piezo' derived from 'piezein', meaning pressure in Greek language.[2]

Piezoelectric units provide clinicians with the ability to cut the mineralized tissue selectively. The units' low kHz frequency allows the soft tissue to “move” with the vibrating insert, thus preventing incision or damage to soft tissue. With higher ultrasonic frequencies, this tandem movement does not occur, resulting in incision or other damage to soft tissue. This “selective cutting action” is very desirable in bone surgery.[3]

The principle of PIEZOSURGERY is ultrasonic transduction, obtained by piezoelectric ceramic contraction and expansion.

Independent clinical studies have proved the benefits of piezoelectric bone cutting, such as:

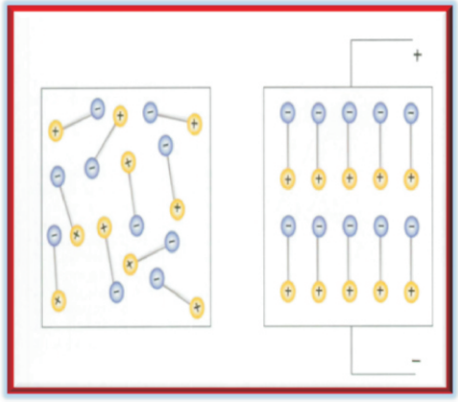
- No osteonecrosis
- Minimal intra-operative bleeding
- Less damage to the surrounding soft tissue
- Minimal postoperative swelling
- Better and faster healing.[4]

The Piezosurgery Device, is characterized by piezoelectric ultrasonic vibrations of a frequency of 29 kHz and a range between 60/200 Hz.[5]

Piezosurgery units use chilled saline as an irrigant, which serves several functions. Because the irrigant is chilled, it provides a cooling effect to the insert and mineralized tissue to help prevent overheating of the bone and bone cells. This cooling combined with the specific waveform of the unit's insert cutting edge causes minimal inflammation or necrosis of the bone.[6]

Mechanism of action

The piezo effect describes the interaction of mechanical pressure and electric potential in solids. It is based on the phenomenon that when certain materials are deformed, electrical charges appear on the surface. The "piezo effect" is based on physical interactions and phenomena of basic electric and mechanical dimensions, such as electric field strength, polarization and tension and extension in crystalline bodies. The passage of an electric current across certain ceramics and crystals modifies them and causes oscillations. Voltage applied to a polarized piezoceramic causes it to expand in the direction and contract



perpendicular to polarity.

Illustration of the basic principle of the piezo effect. In a piezoelectric material, the positive and negative charges are distributed randomly. Application of an electric field results in defined orientation of the charges.

The cavitation effect of piezoelectric surgery is crucial in bone surgery.In piezoelectric surgery, the cavitation phenomenon describes the process of vapourization, bubble generation and subsequent implosion (growth and collapse of bubbles) into many minute fractions of its original size (microscopic gas bubbles) that will occur in a flowing liquid as a result of the decrease and increase in pressure that is caused by the ultrasonic vibrations. In ultrasonic osteotomy, the cavitation phenomenon helps to maintain good visibility in the operative field by dispersing a coolant fluid as an aerosol that causes the blood to essentially be washed away. Furthermore, the cavitation effect will bring about haemostasis, which results in a bloodless surgery. The cavitation effect fragments the cell walls of bacteria, and therefore has an anti-

bacterial efficiency.[7]

Piezosurgery hand-piece with a saw-shaped insert while working with the water spray shows a contemporary picture of novel piezosurgery principles. Cavitation effect and constant irrigation provide a bloodless surgery that ensures a clear visibilityof the

Title of Implication In Dento-alveolar Procedures:

- Separating the tooth roots.
- Hemi-section, root amputation.
- Periodontal surgery.
- Apical resection.

In Dental Implantology:

- Implant socket preparation.
- Alveolar ridge splitting and expansion.
- Re-contouring of alveolar crest.
- Mental nerve reposition.

In Maxillary Sinus Bone Grafting Surgery:

- Preparation of bone window with lateral approach.
- Atraumatic dissection of sinus mucosa.
- Internal sinus floor elevation.

In Maxillofacial Bone Surgery:

- Harvesting of autogenous bone grafts.
- Alveolar decortication and corticotomy.
- Orthognathic surgery.
- Alveolar distraction.
- Removal of cystic and tumour-like lesions

Orthodontic Micro-surgery.

- Temporomandibular joint ankylosis resection.
- Jaw resections.

In Other Surgical Disciplines:

- Craniofacial surgery.
- Plastic and reconstructive surgery.
- Head and neck surgery.
- Neurosurgery.
- Ophthalmology.
- Traumatology.
- Orthopaedics.

Advantages Of Piezosurgery

- Clear vision of the surgical area from the pressurized irrigation and cavitation effect.
- Haemostasis is ensured through the cavitation effect.
- Bone sectioning can be performed with micrometric sensitivity.
- Avoiding the risk of damage to adjacent soft tissue while cutting through hard tissues.
- Healing occurs fast, because no damage is inflicted on the living osteocytes and it induces an earlier bone morphogenetic protein release.
- Piezosurgery provides the ease of harvesting intra- or extra-oral autogenous graft. Due to its inserts with various angles, it can be easily used in areas where it is difficult to see and reach.
- Due to the absence of macro-vibrations, patients feel very comfortable during surgeries under local anaesthesia.

Disadvantages Of Piezosurgery:

- Use in patients with pacemakers is not recommended.
- Purchase of a device may initially be a financial burden.
- The duration of the surgical procedure is longer with the application of piezosurgery.

Advantages Of Piezosurgery Device Over Conventional Surgical Equipments

Compared with traditional rotary instrumentation, piezosurgery requires much less hand pressure. This result in enhanced operator sensitivity and control , indicating that clinician can develop a better 'feel' and precision for the cutting action because of microvibration of cutting tip.[8]

The cutting action is less invasive , producing less collateral tissue damage which results in better healing.[9] Moreover , the lack of necrosis in the cut area accelerates bone regeneration , soft tissue damage is not noticed.[10]

Conclusion

Piezoelectric devices are an innovative ultrasonic technique for safe and effective osteotomy or osteoplasty compared with traditional hard and soft tissue methods that use rotating instruments because of the absence of macrovibrations, ease of use and control, and safer cutting, particularly in complex anatomical areas. Its physical and mechanical properties have several clinical advantages: precise cutting, sparing of vital neurovascular bundles, and better visualization of the surgical field.

Thus concluding that piezosurgery transforms critical operations in simple and fully executable procedures allowing effective surgeries to be performed in difficult access areas with less risk of damage to soft and neurovascular tissue.

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