Review Article

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PIEZOSURGERY – A REVOLUTIONARY APPROACH IN PERIODONTAL SURGERIES

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ABSTRACT:

Piezoelectric surgery, also known as piezosurgery, is an osseous surgical technique first described by Vercellotti (2004) utilizing an innovative ultrasonic surgical apparatus, known as the Mectron piezosurgery device. Piezoelectric device is an innovative tool developed as an alternative to the mechanical and electrical instruments that are used in conventional oral surgical procedures. Because of its highly selective and accurate nature, with its cutting effect exclusively targeting hard tissue, its use may be extended to more complex oral surgical procedures, as well as to other interdisciplinary problems. It can be used for selective cutting of bone depending on bone mineralization, without damaging the adjacent soft tissue (e.g. vessels, nerves or mucosa), providing a clear visibility in the operating field, and cutting with sensitivity without the generation of heat. Hence, user must be knowledgable and trained enough to adapt their operating technique in order to utilize the advantages of piezosurgery.

This review summarizes on the clinical importance of piezosurgery pertaining to its use in periodontal sugeries. Piezosurgery ensures the 3 'P's that is predictability, less post operative pain and increased patient's compliance in various disciples of dentistry.

Keywords: Ultrasonic, microvibrations, piezoelectric, osteotomies, macrovibration.

INTRODUCTION:

In periodontics ultrasound has been implicated since many years to remove tartar, debride root surfaces, and to degranulate periodontal defects. In the past few years ultrasonic powered devices have been developed that is revolutionizing periodontal surgeries and maxillofacial bone surgery. In 1997, Tomaso Vercellotti first introduced the idea to use an ultrasonic device for ablation fitted with a sharpened insert, such as a scalpel blade, to perform periradicular osteotomy to extract an ankylosed root of a maxillary canine. The implant positioned at the moment of the extraction worked perfectly and this gave rise to a series of experimental techniques using ultrasound for bone cutting.[1,2]

The most convincing characteristics of piezoelectric bone surgery are low surgical trauma, exceptional control during surgery, and a quick healing response of tissues. Clinical studies have demonstrated that the specificity of

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operation and the techniques employed with piezoelectric bone surgery makes it possible to advantageously exploit differences in hard and soft tissue anatomy. This not only increases treatment efficacy but it also improves postoperative recovery and healing. Ideally, surgical trauma should be minimized to obtain the optimal healing, which depends on gentle management of soft and hard tissues.[3] Surgery, by definition, alters normal physiology by interrupting the vascular supply of tissues. The extent of surgical invasiveness is extremely important for the quality of tissue healing and may affect whether wounds heal by repair or regeneration. Indeed, when surgical trauma is kept to a bare minimum it generates enough stimulation to favor healing mechanisms that lead to regeneration.[4,5]

The Piezosurgery device was developed with the aim of enhancing the surgeon's ability to perform meticulous bone surgery, while reducing the risk of intraoperative and postoperative morbidity.[6] The philosophy behind the development of Piezoelectric bone Surgery is based on two fundamental concepts in bone microsurgery. The first is minimally invasive surgery, which improves tissue healing and reduces discomfort for the patient.. The second concept is surgical predictability, which increases treatment effectiveness. Indeed, the ease in controlling the instrument during the operation combined with reduced bleeding, the precision of the cut, and the excellent tissue healing make it possible to optimize surgical results even in the most complex anatomical cases

The peizosurgery system consists of a main unit, peristaltic pump (for cooling and removal of blood and wastes), foot switch, handpiece and tool inserts (flat, blunt, scalpel and sharp saw tipped). The device can recognise changes in material density and deactivate itself when a change is encountered, unlike conventional tools. Piezosurgery uses a modulated ultrasonic frequency to permit highly precise and safe cutting of hard tissue.[7] the most peculiar feature of the piezoelectric device is selective cutting. The cutting of hard tissue with ultrasonic vibrations that are formed by the piezoelectric effect was first described by Catuna [8] in 1953 and then by Volkov and Shepeleva [9] in 1974. In 1981, its application was described by Aro et al.[10] in orthopaedic surgery, and Horton et al.[11] in oral surgery. Although piezosurgery cuts mineralized tissues such as bones, it does not cut soft tissues such as vessels, nerves and mucosa.[12]

Principle

French physicists Jean and Marie Curie in 1880 described the mechanism 'Piezo effect' on which this device works. The device operates at a frequency of 25-29 kHz, with the possibility of digital modulation up to 30 kHz as a "boost" and an advanced oscillation control module that introduces pauses in the high-frequency vibrations. These pauses help to avoid heating of the bone and maintain optimum sectioning capacity.

Piezosurgery devices are fitted with a cooling irrigation system with 0 to 60 mL/min of variable sterile solution flow. The amplitude of the micro vibrations has to be kept in the range of 60-210 µm, at an ultrasonic power of up to 16 Watts.[13] Piezosurgery units are some 3 times more powerful than conventional ultrasonic units (5 Watts), which allows them to cut highly mineralized cortical bone. The reduced range and the linearity of the vibrations allow for precise control of cutting corresponding to a handpiece power rating of 5W.[14]

The Piezosurgery device offers three specific therapeutic features attributable to the microvibrations and to specific modulation of the ultrasound frequency. Firstly, it allows micrometric sectioning, offering superior precision in cutting and with no bone loss. Secondly, the instrument selectively sections mineralized structures, without damaging the adjacent soft tissues, which remain intact even in the case of accidental contact with the device. Lastly, the physical cavitation phenomenon produced by the device ensures less bleeding.

Creation of piezoelectric effect and ultrasonic vibration

The piezoelectric effect is the creation of electrical tension on some crystal and ceramic materials such as quarts to which a mechanical pressure is subsequently applied. The material in question will expand and then contract leading to an ultrasonic vibration. Also known as 'pressure electrification', it has been defined by the term 'piezo' derived from 'piezein', meaning pressure in Greek language.

Mechanisms of action of piezoelectric devices [15]

The cavitation effect of piezoelectric surgery is crucial in bone surgery. Cavitation is the formation and the immediate implosion of cavities within a liquid (i.e. small liquid-free zones, 'bub-bles'). These bubbles are formed as a consequence of the forces that are acting upon a liquid. It typically occurs when a liquid is subjected to a rapid change in pressure, leading to the formation of cavities within the liquid where the pressure is relatively low. In piezoelectric surgery, the cavitation phenomenon describes the process of vapourization, bubble generation and subsequent implo-sion (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 ul-trasonic osteotomy, the cavitation phenomenon helps to maintain good visibility in the operative field by dis-persing 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. Walmsley et al.[16] has suggested that the cavitation effect fragments the cell walls of bacteria, and therefore has an anti-bacterial efficiency.

Cutting characteristics of piezoelectric devices

The cutting characteristics of piezosurgery are dependent upon the-

Degree of bone mineralization (density)- The degree of bone mineralization determines the frequency of vibration (Hz) that the device should be set to for an effectively cutting the bone and has a positive correlation on cutting efficiency of piezosurgery. Low frequency of vibrations may be chosen in low mineralized bone, whereas high frequency of vibrations, up to 30 Hz, may be chosen in highly mineralized bone.[15] In addition, alternating with pauses provides for optimal cutting in highly mineralized bone.

The design of the insert- Inserts (Tips) can vary in size, shape and material. Insert design may impact on the level of power (W) that should be set for an intended procedure. For the effective cutting of highly mineralized bone with a saw-shaped insert, high power levels are required

Sharp inserts: The sharp edge of the instruments enable gentle and effective cut on the mineralised tissue. They are useful in osteotomy procedures like implant site preparation, osteoplasty and other surgical techniques which require fine and well defined cut. **Eg: Design No: OT-7, EX1,OP-3,IM2A and IM3P**

Smoothening Inserts: They have diamond surface coating which enables precise and controlled work on bony structures to obtain the final bone shape. These inserts are specifically useful to prepare difficult and delicate structures such as sinus window or access to nerve. **Eg: Design no: OT5, OT-1, OT-4 and OP-4**

Blunt Inserts: They have blunt, dull and rounded non cutting tip. These tips play wonders in atraumatic elevation of the sinus membrane for grafting procedures.

Insert Tip Color: Insert tips are color coded by either Gold or steel. Gold insert tips are used to treat bone. It is obtained by applying titanium nitride coating to improve the surface hardness which further increases longevity of the insert tip. Steel is used to treat soft tissue or delicate structures such as roots of teeth.

Pressure applied on the handpiece during use- According to Claire et al.[11] excessive pressure on the piezosurgery insert led to a reduction in oscillations and hence the cutting ability. The results of their experimental study recommended that a contact load of 150 g provide the greatest depth of cut.

Speed of movements during use- Piezosurgery inserts should be moved forwards and backwards continuously at a high speed with minimum pressure. Slow movements over the bone and excessive pressure on the handpiece will decrease the micro-movements and cause an increase in the bone temperature.

The frequency of ultrasonic vibrations (Hz), the level of power (W) and the water spray are three adjustable settings that should be set in accordance with the intended procedure.[10]

Applications of Piezosurgery in Periodontics

Routine scaling and root planning – Piezosurgery can be used efficiently for the removal of supra and subgingival calculus deposits and stains from teeth, periodontal pocket lavage with simultaneous ultrasonic tip movement, scaling and root planning. The piezosurgery device can be used for soft-tissue debridement to remove the secondary flap after incision through retained periosteum. By altering the power setting and changing to a thin, tapered tip the piezosurgery device can be used to debride the field of residual soft tissue and for root surface scaling to certain thorough removal of calculus. Piezosurgery also permits planning of the root surfaces and the removal of inflammatory tissues in periodontal operations.[17]

Osteoplasty and osteotomy

The piezosurgery device is used to develop positive, physiologic architecture of bone for pocket removal surgery.[17] The device enables for specific removal of bone, with minimal risk of injury to underlying root surfaces. Final smoothing of root surfaces and bony margins using a specific ultrasonic insert, PP1, creates a clean field, with ideal bony architecture ready for flap closure. Ultrasonic vibrating 'Syndesmotomes' have recently been developed tips for tooth and root extraction. The tip is inserted through gingival sulcus between the space occupied by periodontal ligament between the root and the socket. The periodontal fibres are cut upto or greater than 10 mm. Thus when the most apical fibres are severed, the coronal portion is not submitted to a violent'rip'. Therefore, in this way nearly atraumatic extraction can be achieved.[18]

Traditional forceps produce vigorous movements during tooth extraction which causes forceful tearing of Sharpey's fibres away from the bundle bone surrounding the socket. This causes disruption of blood supply and trauma to the extraction socket which in turn delays healing.[18]

The use of piezosurgery has advantages in procedures that require a meticulous preparation of a small bone or a piece of a tooth: for example, tooth sectioning of a tooth that has a close relationship with an important anatomical structure. In working around the mandibular canal or maxillary sinus, piezosurgery may prevent nerve damage; even in the case of accidental contact with the working insert tips.

Crown lengthening procedure

Piezosurgery helps the dentist in achieving better bone architecture with precise cutting of bone during crown lengthening procedures.

Resective and regenerative surgery.[19,20]

Piezosurgery has a vast array of applications in dentoalveolar procedures involving periodontal surgical procedures for e.g separating the tooth roots and hemi-section.

Harvesting of autogenously bone grafts

Autogenous bone chips can be harvested from intra-oral sources with the use of piezosurgery. In literature there is an disagreement with some authors favouring the use of piezosurgery with regards to the number of living cells, such as osteocytes [27], and others that scrutinize the use of piezosurgery owing to the lower percentage of living cells when compared with conventional techniques.[21,22]

In harvesting of mandibular ramus block bone graft [23]

In dental implantology procedures, the mandibular ramus area is commonly preferred as an autogenous bone graft. Mandibular bone block is usually used as an onlay graft with the aim of increasing the bone thickness. It has been suggested that the use of a piezoelectric device would provide distinct advantages in the harvesting of a ramus graft. For piezosurgical bone cutting, a standard saw-shaped insert is usually favoured in an easy to see area in comparison to a dual-angled insert that is preferred in deep areas, especially for lower horizontal bone cutting during ramus bone graft harvesting.

Alveolar decortication and corticotomy and ridge augmentation

Piezosurgery can be successfuly used for performing alveolar decortications, corticotomy and micro- surgery. Piezosurgery has gained popularity among various applications in ridge augmentation procedures**.** It was reported that it performs bone cutting with great precision, thus facilitating ridge augmentation and easy ridge expansion (Palti and Hoch 2002).[24]

Ridge expansion is the surgical widening of a bone ridge in the mouth to allow for the placement of dental implants. It leads to a shortened treatment time and elimination of the issue of donor-site morbidity, as grafting is not required. Designed initially for augmentation in implant surgery, including sinus lifts and procedures such as ridge expansion (Eggers, et al., 2004).[25] piezosurgery can be used to cut the crestal and proximal facial cortices in a precise and tactile controlled manner. Motorized osteotomes are then used to widen the split ridge and create space. Using this technique expansion of narrow, anatomically limiting, atrophic ridges can be done creating space for immediate placement of implants. The facial and lingual cortices provide necessary support with vital osteocytes for osteogenesis (Kelly and Flanagan, 2013).[26]

Distraction osteogenesis

A piezoelectric device is used to treat alveolar bone defects and to provide for perfect osteotomy without palatal flap damage. Also, abundant vascularization from the palatal flap led to successful new bone formation. Furthermore, Piezosurgery is a very convenient device through which it is possible to get direct visibility over entire osteotomies. The only Limitation being the slightly longer time required for the operation.[27]

Distraction osteogenesis is used to regain both hard and soft tissues without grafting. It is the biological process of new bone formation through the application of graduated tensile stress by incremental traction. With ridges that require four to five millimeters of vertical height augmentation, or where the overlying soft tissue does not support osseous augmentation, distraction osteogenesis is a useful treatment alternative, with piezosurgery being an effective tool for distraction osteotomies [27]

With piezosurgery we can osteotomize as precisely as possible due to its micrometric and linear vibrations, and cause minimal damage to hard and soft tissues.[28] When performing distraction osteo-genesis in certain areas, it is essential to complete the osteotomies delicately, because they are performed close to dental and periodontal structures, and to soft tissues that provide vascularization. Piezosurgery permits ideal osteotomy preparation without flap damage, providing abundant vascularization that leads to successful new bone formation. Also, it is possible to get direct visibility over entire osteotomies. slightly longer time is required for the operation which is the lone limitation of this process.

Piezosurgery for surgically-assisted rapid maxillary expansion (SARME)

Robiony et al. (2007) [29] described the use of the piezosurgical instrument as a minimally invasive device, to allow surgeons to perform all the steps of SARME under local anesthesia.

In a recent research Rana et al. (2013) [30] divided their 30 adult patients who were with an indication for SARME into two groups according to the treatment modality performed. Patients of the first group were treated conventionally with an oscillating saw, while patients of the second group were treated with a piezoelectrical saw. It was found that it is possible to conduct a SARME with the help of an ultrasonic-saw, piezosurgery. Also it preserves the mucous membrane of the maxilla and is as effective and good as the conventional method. The high performance in terms of frequency and power of the piezosurgical device allows it to be used without the aid of any other osteotome, and with the same atraumatic effect on critical vascular structures. The very low amount of bleeding observed during surgery, lack of damage to the main vessels and reduction of postoperative consequences (hematomas and swellings) for patients were striking.

In maxillary sinus bone grafting surgery:

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

In maxillary sinus bone grafting surgery

Another intra-oral use of piezosurgery is in sinus bone grafting surgery [11]. Piezosurgery can be used during the preparation of a bony window and in atraumatic dissection of a sinus membrane with a lateral approach .Perforation of the sinus membrane is the most common complication of sinus bone grafting and Wallace et al [31] reported that piezosurgery could minimize sinus perforation rates.

It was reported that the incidence of severe complications can be reduced and the entire process can be completed during a single surgical procedure using a piezoelectric device and elevating the sinus membrane.

Atrophy of the maxilla and progressive pneumatization of the maxillary sinus can compromise implant placement in the posterior maxilla. Atrophy can lead to inadequate height, width, and quality of bone restricting ideal implant positioning and risking perforation of the sinus floor (Muñoz-Guerra, et al., 2009).[32] There can often be as little as a few millimeters of bone between sinus and the oral cavity.

Piezosurgery can be used as an alternative or adjunct to standard instrumentation during a sinus lift procedure (Figure 4). The sinus is accessed through a window prepared in the lateral wall of the sinus, conventionally made using a diamond bur and then infracturing of the bony window.

However, a round piezosurgery tip may be used to prepare the window instead, which brings the advantage of being able to touch the sinus lining without tearing it. This eliminates the need to leave a thin layer of bone around the window and tap it in (and thus further reduces the chance of perforation).

A blunt inverted cone tip can then be used to raise the sinus lining, reducing the risk of damage to the membrane even further. In cases of sinus lift, studies have shown it can reduce the membrane perforation rate from 30% with the conventional approach to 7% with the piezosurgery.

Le Fort I osteotomies

In severely atrophic alveolar ridges, both the maxilla and mandible can present a jaw discrepancy, with a skeletal Class III tendency and a loss of vertical dimension that may hinder treatment with dental implants (Muñoz-Guerra, et al., 2009).[32] Severe atrophy of the edentulous maxilla can cause insufficient bone volume and an unfavorable vertical, transverse, and sagittal relationship, due to the tri-dimensional resorption pattern of long-term maxillary edentulism.

Maxillary sinus augmentation and onlay grafting procedures can allow the correction of bone defects, but are often insufficient to correct severe maxillary retrusion and increased interarch distance. Le Fort I osteotomies allow for forward or downward repositioning of the maxilla to correct intermaxillary vertical and transverse discrepancies. Correction of osseous deficiencies using this technique permits ideal implant placement and creates a more natural soft tissue profile that impacts on the overall prosthodontic outcome.[33]

The precise nature of piezosurgery provides exact, clean, and smooth cut geometries. This is an extremely important attribute, considering an atrophic maxilla is likely to present with a thin and fragile bone structure that may increase the risk of accidental fracture.

The application of piezosurgery in these instances is advocated over other mechanical instruments because it minimizes the chances of accidental damage (Muñoz-Guerra, et al., 2009). The risk to critical anatomical structures, such as the palatine nerve and artery, is also minimized because the surgical action stops when the piezosurgery insert comes into contact with demineralized structures.

However, it must be noted that the success rate of implants placed in a reconstructed maxillae following a Le Fort I technique and bone grafting is significantly lower than that of implants placed in an edentulous, but non-reconstructed, maxillae (Chiapasco, et al., 2007). Piezosurgery has also been used in various other craniofacial surgical procedures in addition to Le Fort osteotomies, including calvarian bone grafting and mandibular sagittal splits.[34]

Guided bone regeneration

Piezosurgery can also be used for harvesting bone chips, which are produced at the optimum grain size for effectiveness and remain on the bone surface ready for collection. Two surgical tips are available for removal of cortical bone, eliminating the need for bone traps. For guided bone regeneration purposes these bone chips can be used all alone or in combination with other graft materials. Assessment of bone chips collected using piezosurgery and conventional burs, established that no difference in the detrimental effect on the viability and differentiation of cells occurs. Piezosurgery was found to be more economical in regard to quantity of bone harvested.[36]

Dental implantology

Peizosurgery has extensive implementation in the field of implantology. It can be used in hard tissue procedures, such as implant site preparation, alveolar ridge splitting and expansion, re-contouring of alveolar crest, and ridge split, and in soft tissue procedures such as maxillary sinus lifting. Repositioning of mental nerve and also in harvesting bone chips for use in guided bone regeneration.[37]

With this technique, implant site preparation can be performed with a specifically designed set of piezosurgery inserts. Piezosurgical site preparation enables for the selective enlargement of only one socket wall. This is called ‘differential ultrasonic socket preparation’. Site prepared by piezosurgery provides the same primary stability and short-term survival rate of an implant when compared with conventional site-preparation techniques.

Stelzle et al.[38] emphasized that the applied load on the handpiece may increase the preparation speed but may also increase the negative thermal effect on the bone. Therefore, during implant site preparation a maximum load of 400g is recommended.

Piezosurgery is a predictable method that can be used to perform split-crest procedures without the risk of bone thermo-necrosis; also it carries a reduced risk of damage to the adjacent soft tissues. Bone cutting efficiency is satisfactory with the current devices because of the enhanced vibration power, especially in soft type IV bone. In implantology, piezosurgery can be used in implant socket preparation, mental nerve repositioning, recontouring of alveolar crest, mobilisation of inferior alveolar nerve and simultaneous implant placement and, immediate implant placement after extraction.[39]

Piezosurgery with its symbolic role, precisely helps in critical procedures like alveolar ridge expansion which involves separation of palatal and vestibular bone flaps and subsequent implant placement.[7] Sinus elevation with traditional burs is often allied with complications such as perforation of membrane, intra operative bleeding and surgical trauma. To avoid such mishap, piezosurgical insert with blunt tip is useful in atraumatic elevation of the membrane, followed by successful grafting procedure.[40]

Piezosurgery is efficient at preparing implant site osteotomies due to its selective cut, micro-streaming, and cavitational effects, which preserve and maintain the soft tissue — essential for the overall healing and esthetics of the implant.Micro-streaming is the continuous whirling movement of fluid created by a vibrating insert that favors a mechanical action of debris removal. Intraoperative visibility is enhanced with piezosurgery by the implosion of gas bullae into blood vessels during the osteotomy, which have a hemostatic effect — the cavitational phenomenon (Sortino, et al., 2008).[40]

Primary implant stability and osseo-integration are directly indicative of implant prognosis. Primary implant stability can provide an early indication of future osseointegration. Authors have suggested that there are no statistically significant differences between primary implant stability provided by using the piezosurgery in comparison with a conventional rotary unit. However, due to the study being ex vivo in nature and the relatively small sample size, further studies are recommended.[39]

In a minipig model, bone healing at intervals of 1, 2, 4, and 8 weeks in sites prepared with piezosurgery was compared to sites prepared with conventional drills. The study (Preti, et al., 2007) concluded that piezosurgery was more effective in stimulating implant osteogenesis, promoting more osteoblastic activity around the implant sites compared to sites prepared conventionally with drills.

Another randomized control trial suggested that piezosurgery implant site preparation has the potential to modify biological events during the osseo-integration process, resulting in a limited decrease of implant stability quotient values and in an earlier shifting from a decreasing to an increasing stability pattern in comparison with traditional drilling technique (Stacchi, et al., 2013).[41]

Peri-mucositis, peri-implantitis, and calculus removal

Piezosurgery can be used in the treatment of peri-implantitis. It can be used for soft tissue debridement to remove the secondary flap after incision through retained periosteum. Using a thin tapered tip and altering the power setting, the piezo-surgery device can also be used to debride the field of residual soft tissue and for root surface scaling to ensure thorough removal of calculus. The piezosurgery system also allows removal of calculus from titanium osteosynthetic material quickly. Debris and infected bone can be removed from implant surfaces without damaging the implant.[29] This feature can also be beneficial when hard tissue has ingrown into screw slots, as it allows safe removal without damaging the screw itself to allow for screwdriver application .

Advantages

1. **Precise cutting and safety**

The ultrasonic device implies micrometric cutting that depends on the micro-oscillation of the handpiece. It varies from 20 µm to 200 µm, which is smaller than the width achievable with rotary instruments,thus offering superior precision in cutting accompanied with no bone loss.

2. **Great control of the surgical device**

The piezosurgical handpiece reaches its highest efficiency when applying a load of 0.5 kg as compared to conventional drills thatmust be loaded with a force of 2 kg to 3 kg.

3. **Bleeding-free surgery site**

There is no bleeding of bone tissue when cutting with the ultrasound, and thus provides good visibility of the operating site and enables one to conduct the procedure very precisely. The reason for this is that the cavitation effect creates bubbles from the physiological salt solution and these lead to implosion and generate the shock wave causing microcoagulation.

4. **Selective cutting and minimal operative invasion**

It reduces the risk of perforating the Schneider membrane due to the selective cutting that is limited only to the mineralized structures – bone. This is because of the ultrasonic frequencies that are used (25–29 kHz), as the hard tissues and soft tissues are cut at a different frequency.

5. **Faster bone regeneration and healing process**

Oxygen molecules released during cutting have an antiseptic effect and ultrasound vibration stimulates cells' metabolism. Moreover, the lack of necro- sis in the cut area accelerates bone regeneration. Soft tissue damage is not noticed.

6. No risk of emphysema

The risk of subcutaneous emphysema is reduced due to the aerosol effect that the ultrasonic device produces unlike the effect of air-water spray generated be osteotomy with rotary instruments.

7. Decrease in post-intervention pain

Owing to the action being less invasive and producing less collateral tissue damage, it results in better healing.

8. Reduced traumatic stress

The device produces less noise and only microvibrations in comparison with a conventional motor, so the fear and psychological stress of the patient are reduced.

Disadvantages

1. The largest disadvantage of the procedure using the piezosurgery unit is the increased operation time that is required for bone preparation.
2. Not recommended in patients with pacemakers.
3. Purchase of a device may initially be a financial burden.
4. Duration of the surgical procedure is longer with the application of piezosurgery.
5. For gaining experience with piezosur- gery,more practice time might be required for clinicians.

Precautions

The piezosurgery technique immensely lessens the risk of damaging soft tissues, such as sinus floor membrane, nerves, and vessels, but nevertheless precautions must be taken as the ultrasonic waves have mechanical energy, and this energy can be converted into heat and pass into adjacent tissues. For this reason the use of irrigation is essential, not only for the effect of cavitation, but also to avoid overheating. The intensity of the cooling liquid can be adjusted depending on different preparations.

Contraindications

There are no absolute contraindications, but one such is electrical pacemakers, in either the patient or the operator, which is a contraindication for piezosurgery. Age factor is a relative contraindication for any surgery.

Biological effects and bone response to piezosurgery

Effect of mechanical instruments on the structure of bone and the viability of cells is important in any type of osseous surgery. Alterations in temperature is injurious to cells and may cause necrosis of bone.[42] Erikson et al.[43] showed that local bone necrosis would occur in cases where the temperature exceeds 47°C for 1 minute due to the contact of rotating tools. Piezosurgery not only selectively cuts the hard tissue but also produces the haemostatic effect on the surrounding tissue.[44] Because this technique preserves the surrounding soft tissues, it can be applied in areas where bone is in close proximity to vital and delicate structures such as nerves, blood vessels or the sinus mucosa

Microtopographic and histomorphometric studies have shown that piezosurgery is preferred over other tools for harvesting vital bone.[43,44] Perfect integrity of the osteotomized surfaces with a cut which is clean, regular and without imperfections or pigmentation is achieved. The bone surface which was cut using the piezoelectric device showed no sign of lesions to the mineralized tissues and presented live osteocytes with no sign of cellular suffering. Recently, Stubinger et al.[45] showed that autologous bone from the zygomatico-maxillary region that had been harvested with a piezoelectric device, could be used in augmentation for stable and aesthetic placement of oral implant after a five months healing.

Another histomorphological study reveals that the piezoelectric surgery increases the concentration of bone morphogenic protein (BMP-4), TGF beta-2, tumor necrosis factor and interleukin-1, and decreases some of the pro-inflammatory cytokines in the bone. Thus, neo osteogenesis was proven to be consistently more active in cases where piezosurgery is used. It has been observed that the critical temperature rises only when the irrigation volume is as low as 20 ml per minute. Piezosurgery, therefore has a potential role in osseous surgery.[45]

CONCLUSION:

The piezo device provides a great facility during some surgical procedures, and even to some extent becomes indispensable. The ultrasound unit allows for precise removal of bone with minimal risk of injury to underlying soft tissues. It allows a more successful and more complication-free surgical result for a less experienced surgeon that could be especially beneficial for preparation of the Schneider membrane during sinus lift procedure or relocating or preparation of the inferior alveolar nerve. Not only does it give minimal operative invasion, but also it decreases post-intervention intervention pain and reduces traumatic stress, accompanied with minimal bleeding postoperatively.

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