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Application of Peizosurgery in Periodontics: An Update

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ABSTRACT
Piezosurgery has gained attention in periodontal therapy due to its precision and minimal invasiveness. Utilizing ultrasonic microvibrations, piezosurgery allows selective cutting of mineralized tissues while preserving soft tissues. This article reviews the principles, clinical applications, advantages, limitations, and future prospects of piezosurgery in periodontics. Emphasis is placed on its use in procedures such as osseous recontouring, crown lengthening, bone harvesting, and regenerative surgeries. Current literature supports its efficacy, improved healing, and patient comfort, although cost and operative time remain concerns.
KEY WORDS: Piezosurgery, Reverse piezo effect, Piezosurgery in Periodontology, Ultrasonic device and Cavitation effect.

I. INTRODUCTION:

Ultrasonics is branch of acoustics concerned with sound vibrations in frequency ranges above audible level. Ultrasound imaging, or ultrasound scanning or sonography, is a method of obtaining images from inside the human body through the use of high frequency sound waves. As ultrasonic beam passes through or interacts with tissues of different acoustic impedence, it is attenuated by a combination of absorption, reflection, refraction, and diffusion. The sound waves echoes are recorded and displayed as a real-time, visual image. Ultrasound uses the transmission and reflection of acoustic energy. A pulse is propagated and its reflection is received, both by the transducer, a device which can convert electrical energy into sonic energy. For clinical purposes, ultrasound is generated by transducers, which convert electrical energy into ultrasonic waves[1].

Ultrasounds was first introduced in periodontal procedure as ultrasonic scalers in 1955 by Zinner and have undergone many changes, and since then, simple compact devices have replaced large, heavy units. It has underwent a renaissance since then in the field of dentistry and has erupted in a today's era as an advantageous surgical modality called peizosurgery[2].

BASIC PRINCIPLE:

Piezoelectric system is based on the fact that certain crystalline structures such as quartz will be subject to a shape change when placed within an electrical Field. If an alternating voltage at an ultrasonic frequency is applied across a piezoelectric crystal, it will result in an oscillating shape change of the crystal at the frequency applied. This is then passed onto the working tip. Currently, the most widely used piezoelectric material is lead zirconate titanate (PZT). Piezoelectric generators are more efficient at frequencies in the MHz rather than the KHz range, although some have been developed for use in dentistry. However, the crystalline structure has poor shock resistance and such instruments are more fragile than their magnetostrictive counterparts. Piezoelectric unit operates in the 25,000-50,000 cps range and is activated by

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dimensional changes in crystals housed within the handpiece as electricity is passed over the surface of the crystals. The resultant vibration produces tip movement that is primarily linear in direction, and generally allows only two sides of the tip to be active at any time. Most current ultrasonic technology has advanced to include computer chips for regulating sustained power to the tip.[3]

MECHANISM OF PEIZOSURGICAL INSTRUMENT:

The Piezosurgery device was invented by Dr. TomasoVercellotti, uses a modulated functional working frequency. It is a sophisticated ultrasonic device which operates at a variable modulated frequency of 24.7 to 29.5 and is designed to cut or grind the bone but not damage the adjacent soft tissues.The mechanism of this device is based on the so called Piezo – Effect. French Physicists Jean and Marie Curie first mentioned the direct Piezo-Effect 1880, whereby certain crystals produce electrical current while under mechanical pressure. The reciprocal (or Reverse piezo) effect, by which the crystals are deformed when under electrical current, was then discovered a while later.This is the effect being used by the Piezosurgery Device®. Due to the deformation caused by the electrical current, a cutting – hammering movement is produced at the tip of the instrument. These micro movements are in the frequency range of 25 to 29 kHz and, depending on the insert, with an amplitude of 60 to 210 µm. This way only mineralized tissue is selectively cut. Neurovascular tissue and other soft tissue would only be cut by a frequency of above 50 kHz. In this device, the electrical field is located in the handle of the saw. Depending on the strength of the bone and the blade geometry, the efficiency of the cutting can be regulated by the frequency modulator and the power level. For cooling there is an integrated pump with five different working levels. This pump automatically washes physiological solution to the area being cut.[4]

PIEZOELECTRIC SURGICAL UNIT:

It has a Piezoelectric hand piece and a foot switch that are connected to a main unit which supplies power and a peristaltic pump for irrigation. The unit is controlled by an interactive key board. There are 2 programs, Bone and Root. In Bone program the power can be set to any of the four levels depending on the quality of the bone. In Root program the power can be set to either Perio or Endo. The Piezosurgery unit is controlled solely by means of an interactive keyboard. Each command is shown on an easy-to-read display.

There are two basic programs, BONE and ROOT.

- In the BONE program, it is possible to adapt the power to any of four levels depending upon bone quality.
- In the ROOT program, the power can be set to either PERIO or ENDO.It has an automatic feedback system for constant control of the power of the ultrasounds, which can be adjusted in case of need. With this system, any interferences present in the unit, in the handpiece or in the electronics are recognized and highlighted on the display.The CLEAN function is activated by pressing a button and the footswitch together to start the cleaning cycle of the unit's main tubes.

PARTS OF THE SYSTEM:

- THE SURGICAL TRAY: Contains all the components necessary for surgery utilizing the Piezosurgery system.
- THE DYNAMOMETRIC WRENCH:The insert tips are tightened to the handpiece with the dynamometric wrench.The wrench applies a pre-defined force to obtain optimum energy transmission.
- THE LIQUID:Liquid is drawn from a bag or bottle which hangs from the rod provided.All parts of the unit through which the liquid passes, including the handpiece cord and the handpiece itself, are fully sterilizable.
- THE PERISTALTIC PUMP:The sterile tube is simply inserted into the pump which is then closed. The quantity of liquid may be adjusted using the continuous + and – buttons.
- THE HANDPIECE:The handpiece is connected permanently to the handpiece cord and the two are sterilized together.

THE APPLICATION MODE OF PIEZOSURGERY:

Piezo surgery works through the following ways which makes it an accessible technique for oral surgical therapies:

- **Micrometric cuts for** maximum surgical precision and intra-operative sensitivity
- **Selective cuts for** minimal damage to soft tissue,maximum safety for surgeon and patients
- **Cavitation effect for** maximum intra-operative visibilityand a blood-free surgical site

APPLICATION OF PEIZOSURGERY IN DENTISTRY:

Piezosurgery finds diverse applications across various dental specialties. In oral surgery, it

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proves useful for extractions, bone grafting procedures involving both block and chip grafts, and orthognathic surgeries.Endodontic surgery benefits from piezosurgery in periapical surgeries and root canal treatments. Implantology utilizes this technology for sinus lift and ridge expansion techniques. Orthodontic surgery employs it in osteotomies and corticotomies.Periodontal surgery leverages piezosurgery for crown lengthening, as well as resective and regenerative procedures. Beyond these specialties, piezosurgery is also employed in apicectomies, cystectomies, removal of inclusions and foreign bodies, complicated extractions, bone sampling, raising of the maxillary sinus floor, crest expansions, osteo-distractions, periodontic osteo-plastic surgery, orthodontic surgery, and implant site preparation.[5]

APPLICATION IN PERIODONTICS

Most dental implants are positioned using a drilling surgery technique. However, dentistry recently experienced the implementation of piezoelectric surgery. This technique was introduced to overcome some of the limitations involving rotating instruments in bone surgery.

When used correctly, the device virtually cannot cut the Schneiderian membrane, nerves, or periosteum, so the device is recommended in cases where avoiding contact with such structures is considered vital. Nonetheless, because the mechanical energy of the device is not used to completely cut mineral structures, the energy can be passed to the soft tissue as heat. As well, mechanical damage to the soft tissue is possible (e.g., injuring the schneiderian membrane due to high pressure). However, cooling is ensured via the device's pump system. For effective cooling, the solution is refrigerated at 4°C.

The flow rate and the intensity of the oscillation can be regulated. The handpiece can be fitted with different tips for osteoplasty, osteotomy, separating soft tissue from bone, and cutting bone. For example, osteoplasty for the collection of bone particles can be executed through the use of handpiece insert osteoplasty No. 1 or insert osteoplasty No. 3. Combining 2 settings creates the working frequency of the instrument tips: 1 modulated horizontal setting of 60-200 mm and 1 vertical modulated setting of 20-60 mm.[5]

When compared to oscillating micro-saws, the movement ofthe Piezosurgery-scalpel tip is very small. The cutting is more precise andcauses less discomfort for the patient.When using conventional microsaws,the clinician must apply a certaindegree of pressure. By contrast,the Piezosurgerydevice needs only avery small amount of pressure, whichenables a highly precise cut. Toomuch pressure limits the movement ofthe tip, and heat is generated. At maximumpressure, when the tip of theinstrument does not move and onlyheat is generated, a tone warns thatbone damage is imminent. The translationspeed (the speed from the tip ofthe instrument in contact with thebone) and the form of the tip material(diamond headed, sharp, with irregularities)have an effect on the cuttingpower.

The operator can intuitivelylearn how fast a certain tip can bemoved. The power of the device is 5W (ultrasonic scaler 2 W). Morepower increases the cutting ability, butthe device requires thicker tips, whichcause thicker and more imprecise cuts.The 5-W power is the ideal compromisebetween speed and precision.The bone harvest site remains almostfree of blood during the cuttingprocedure. The reason lies in the cavitationeffect created by the coolingfluid distribution and by the kind ofvibration the instrument generates. Bycontrast, in a micro-saw, blood ismoved in and out of the cutting area.However, with the piezo-instrumentand its high frequency vibration in alldirections, blood is essentially washed away. The consequence is an ideal visibilityof the operating field. Thus, whenused properly, Piezosurgerycausesless damage to the bone at the structuraland cellular level compared with othertechniques. No other system on the market fulfills these criteria.[4,5]

HARVESTING BONE CHIPS

Bone chips have the role of spacemaking and guides for bone regeneration(through osteoconduction), andalso for support of growth factors at the recipient site in order to speed upbone healing. The chips are technicallynot transplants because the osteocytes,lacking a blood supply, donot survive.

During the healing period,the chips are replaced by bone viaremodeling. Autogenous bone chipsare easy to harvest from the drill surface,but this bone powder is resorbedtoo fast, and cannot fulfill its role as aspace maker and guide. Particles withsufficient volume are needed. Clinically,particles of 500 µm show bestresults. This particle size can be obtainedwith bone mills. However,bone mills have the disadvantage of ahigh price and loss of bone material.The Piezosurgery device is welladapted for bone chip harvesting.The osteoplasty No. 1 to osteoplastyNo. 3 tips can be used with gentlescraping movements along the surfaceof the bone in order to obtainsufficient bone chip volume.The bone is accumulated in the frontof the instrument and then removed.[6]

Acomplication-free region for bone chipharvesting is the lineaobliqua in themandible. The incision is similar tothat used for the extraction of aneighth crestal incision retromolar anda mesial paramarginal incision. It ispossible to harvest also in the vicinityof the operating area, eliminating theneed for a second, surgical site.

In periodontology, there are certain indications for autogenous bone transplants, considered the gold standard. In large flat defects around teeth, autologous bone provides better chances for healing. The success probability of regenerative measures in certain defects is low because of the anatomical conditions. Treating the defect with bone chips has advantages. The bone can be harvested with the osteoplasty No. 3 instrument from the lineaobliqua and inserted in the defect.[6]

BONE BLOCKS

The success of bone healing can be limited when particulate grafting material is used in nonstable spaces. In bone-surrounded spaces, particulate material works well, especially when membranes are used.[7] However, the particulate materials show their limits in horizontal or vertical augmentation procedures. In these cases, bone blocks give the best results. Classic donor areas are the chin, lineaobliqua, and crista iliaca.

Piezosurgery makes the linea oblique approach easier. The low amplitude of the instrument tip, the optimal cooling effect, and the selective cut ensure that no injury occurs to the neighboring structures. A small access that allows undermining preparation is sufficient, and no direct visibility of the deep horizontal cut and no preparation of the N. mentalis are necessary.

BONE SPLITTING

The previous techniques often have the disadvantage of requiring a second surgical (donor) site, usually requiring membranes. Additionally, implants usually cannot be simultaneously inserted after particulate or bone block grafts are used, so a second surgery follows. While particulated materials can be used combined with implant insertion, micromovement of the graft material can compromise the final result. In cases with sufficient bone height but insufficient width, bone splitting may be indicated. No membranes are needed, and many complications are avoided (e.g., no transplants or biomaterials are used). In order to avoid bone resorption, a split thickness flap is elevated. The bone-splitting procedure respectively lingual separates the buccal from the palatal plate. The resulting space between the 2 plates has ideal regenerative and implant integrating conditions. Augmentation materials are surrounded by bone, they have 2 directional blood vessel supplies and cell migration. There is no micromovement. These are the ideal conditions for low-risk healing. The risk of bone splitting, however, is pressure trauma, especially in D1 bone. Fractures represent no problem because the periosteum is not elevated. This greenstick fracture normally heals with no complications. Bone splitting has been used primarily in the maxilla, where bone elasticity is greater.[8]Piezosurgery is used in dense mineralized bone because the vertical dimension of the bone is maintained while the width permits no implant insertion. In order to perform the case in 1 stage, bone splitting is performed. Because the alveolar crest will be larger after splitting, a split thickness flap is needed to cover the bone. A tension-free suture is possible in such cases. The periosteum, with itsblood vessels, remains attached to the bone. An incision is made with a saw form tip (osteoplasty No. 5). Because the bone is elastic, no releasing incision on the buccal side is needed. The bone can be extended with osteotomes, and implants can be inserted in a combined drill-split technique. The remaining bone chips from the drills are sufficient for filling the space between the 2 lamellae. A tension-free suture can be performed without the use of membranes.

SINUS FLOOR ELEVATION

The sinus floor elevation is now a routine procedure for the treatment of vertical deficiencies in the posterior maxilla [9]. Lateral access is most common. The schneiderian membrane is prepared via a modified Caldwell-Luc technique. Membrane perforation is a risk with this procedure during the preparation of the window or during the elevation stage. In cases of recent closures of sinus-mouth communications, because of the presence of septae or for other reasons, the possibility of membrane perforation is high. Often, this perforation becomes a rupture that makes closure impossible, even with microsutures or membranes. An intact membrane is a precondition for stabilizing the graft. Several of the risks associated with sinus lift procedures are reduced with Piezosurgery. The instrument's selective cut makes it virtually impossible for the clinician to injure the membrane while preparing the window. In cases of a thin bone wall, the osteoplasty No. 5 tip is indicated, and in cases with thick bone, the Osteoplasty No. 1 tip is used for reduction, and only then the osteoplasty No. 5 tip. The remaining bone chips are collected for the graft procedure. Manual instruments are used for the membrane preparation and can lift the membrane 2 mm around the limits of the window. After this procedure, the Piezosurgery EL2 and EL3 elevation instruments are used. These instruments perform as conventional sinus instruments, with micro-saw settings and hydropneumatic pressure applied through the cooling saline solution. Use of Piezosurgery reduces the chances of membrane rupture during sinus lift from 30% to 7%[9].

ADVANTAGES:

1. Because the instrument's tip vibrates at different ultrasonic frequencies, since hard and soft tissues are cut at different frequencies, a "selective cut" enables the clinician to cut hard tissues while sparing fine anatomical structures (e.g., schneiderian membrane, nerve tissue).
2. An oscillating tip drives the cooling irrigation fluid, making it possible to obtain effective cooling as well as higher visibility (via cavitation effect) compared to conventional surgical instruments (rotating burs and oscillating saws), even in deep spaces. As a result, implantology surgical techniques such as bone harvesting (chips and blocks), crestal bone splitting, and sinus floor elevation can be performed with greater ease and safety.
3. The instrument can be moved in all directions comparable to a pen.
4. The tip of the instrument is exchangeable. Using the fine tip enables multiplanar as well as curved cutting.
5. Because of the automatic water cooling during the whole procedure, there is always a clear view onto the object.
6. Allows for minimal invasive surgeries with limited retraction of soft tissue and minimal stripping of the periosteum, saves time and might have a positive effect on the healing process[1,4].
7. Piezoelectric bone surgery appears to be more efficient in the first phases of bone healing; it induced an earlier increase in BMPs, controlled the inflammatory process better, and stimulated bone remodeling as early as 56 days post-treatment.[10]

DISADVANTAGES:

1. The downside of the device is the relative slow sawing process.
2. We needed about 30 seconds for one cut of the relatively small bone.
3. This is about 20 seconds longer than the time needed for cutting with the usual saw.[12]

OSSEOUS HEALING AFTER PEIZOSURGERY:

As the surgical force for using a piezoelectric scalpel is very low the surgery becomes effortless comparing to the rotational burs. So, in peizosugery there is increased surgical sensitivity and decreased pressure on the hard and soft tissues resulting in less compromise of the tissue and a better healing. As the vibration speed is 60-200mm there is less heat generated as compared to rotational burs hence eliminating the bone damage. Also the frequency is optional for the mineralized tissue as compared to the rotational burs hence sparing the soft tissues and causing them little damage in comparison to the conventional therapy.[13]

Thus there is an overall improvement in the bone remodeling and repair through peizosurgery as compared to the routine rotational diamond and carbide burs and its use for osteotomy and osteoplastic processes can be helpful to both clinician and the patient.

II. CONCLUSION:

Piezosurgery is a relatively new surgical technique for periodontology and implantology that can be used to complement traditional oral surgical procedures, and, in some cases, replace traditional procedures. The low pressure applied to the instrument enables a precise cut; additionally, the selective cut characteristically protects soft tissues.This new surgical technique that, thanks to the use of modulated-frequency piezoelectric energy scalpels, permits the expansion of the ridge and the placement of implants in single-stage surgery in positions and also allow for other periodontal procedures.

Nerve transpositioning, sinus floor elevations, distraction osteogenesis, and a number of other sensitive procedures are easier and safer to perform with Piezosurgery. As a result, even less experienced, though\properly trained, surgeons can perform these techniques more effectively with Piezosurgery[14].

The advantage of piezosurgery is that it can precisely cut hard tissue, while precluding injury to soft tissue. Minimal heat is generated during cutting, thus maintaining vitality of adjacent tissue. It provides substantial improvement in dental/implant surgery, benefiting the surgeon by ease of use and the patient by minimizing surgical trauma and promoting rapid healing.

REFERENCES:

[1]. Zinner DD. Recent ultrasonic dental studies, including periodontia, without the

use of an abrasive. J Dent Res 1955;34:748-9.
[2]. Watmough DJ. Role of ultrasonic cleaning in control of crossinfection in dentistry. Ultrasonics 1994;32:315-7.
[3]. Pattison, Anna & Pattison, Gordon. Scaling and Root Planing. 2012;(10): 45-7.
[4]. Vercellotti T. Piezoelectric surgery in implantology: A case report: A new piezoelectric expansion technique. Int J PeriodontRestorat Dent 2000;20:359.
[5]. Tanzer M, Harvey E, Kay A, Morton P, Bobyn JD. Effect of noninvasive low intensity ultrasound on bone growth into poruscoated implants. J Orthop Res 1996;14:901-6.
[6]. El-Bialy T, El-Shamy I, Graber TM. Repair of orthodontically induced root resorption by ultrasound in humans. Am J Orthod Dentofacial Orthop2004;126:186-93.
[7]. Hokugo A, Ozeki M, Kawakami O, Sugimoto K, Mushimoto K, Morita S, Tabata Y. Augmented bone regeneration activity of platelet-rich plasma by biodegradable gelatin hydrogel. Tissue Eng. 2005 Jul-Aug; 11(7-8):1224-33. PMID: 16144458
[8]. Vercellotti T, Kim DM, Wada K, Fiorellini JP. Osseous response following respective therapy with piezosurgery. Int J Periodont Restorative Dent 2005;25:543-9.
[9]. Kaufman, E. Maxillary Sinus Elevation Surgery: An Overview. Journal of Esthetic and Restorative Dentistry.2003; 15: 272-283.
[10]. Laird WR, Walmsley AD. Ultrasound in dentistry: Part 1 biophysical interactions. J Dent 1991;19:14-7.
[11]. Schortinghuis J, Ruben JL, Raghoebar GM, Stegenga B, de Bont LG. Does ultrasound stimulate osteoconduction? A placebocontrolled single-blind study using collagen membranes in the rat mandible. Int J Oral Maxillofac Implants 2005;20:181-6.
[12]. Lynch JE, Hinders MK. Ultrasonic device for measuring periodontal attachment levels. Rev Sci Instruments 2002;73:2686-93.
[13]. Eger T, Muller HP, Heinecke A. Ultrasonic determination of gingival thickness. Subject variation and influence of tooth type and clinical features. J Clin Periodontol1996;23:839-45.
[14]. Markus Schlee et al. Piezosurgery: Basics and Possibilities.Implant Dent 2006;15:334 –340.