



Piezosurgery in Periodontics- an Update

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Abstract

Piezoelectric surgery was first explained by French Jacques and Pierre Curie in 1880. Since then ultrasonics have been widely known as a treatment modality for cutting bone. It was in 2006 that Tomaso Vercellotti developed an instrument for osseous surgeries in various dental procedures. The fine microvibrations produced by the piezoelectric instrument allows for paramount fineness, bloodless surgical field, minimal damage to the surrounding soft tissues, nerves, vessels and osteocytes. All this in turn adds to excellent healing with minimal postoperative complications. Angular defects formed as a result of periodontitis can be bridged by the use of bone grafts. Piezosurgery allows for clean and smooth harvesting of autogenous intraoral bone grafts during surgical procedure. Osteoplasties and various bone splitting procedures can be done precisely due to its highly selective action on soft tissues. This article aims to review the clinical calibre of piezosurgery in the field of periodontology and implantology.

Keywords: Autogenous; Microvibrations; Osteoplasties; Ultrasonic.

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INTRODUCTION

History of piezosurgery dates back to 1880, when Jean and Marie Curie first described that in piezoeffect certain crystals produce an electrical current while being under mechanical pressure which can be used to produce a cutting-hammering movement at the tip of instrument.¹ Piezosurgery, as an ultrasound device, was introduced by Pohlman in 1950 which was used for treating neuropathic pain and myalgias in humans.^{2,3} Initially, in the year 1952, it was used in dentistry for preparing dental cavities.² Since then it has been tried in various fields in dentistry like in periodontics it has been used for debridement of the root surfaces and for degranulation of

periodontal defects. It was in 2006, that Moigne et al¹ performed first ultrasound osteotomy in hand surgery using piezosurgery and in the year 2009, HappeA, gave a clean, precise technique of harvesting bone grafts from mandibular ramus. It was then that the real potential of piezosurgery was explored and has been exploited till now for its advantages. Nowadays, piezosurgery is used for various osseous surgeries performed in dental practice ranging from simple periradicular osteotomies for periodontal surgeries; implant surgeries^{4,5} etc to harvesting of bone grafts for bone regeneration and sinus lifts. Its ability to provide clean, exact, smooth cut geometries aids in low surgical trauma and a quicker healing response of tissues. Surgery consists of physical intervention of tissues. It alters the 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 wound heals by repair or regeneration.⁶ The piezosurgery device was developed with the main aim of enhancing the surgeon's ability to perform bone surgery, while reducing the risk of intraoperative and postoperative morbidity.⁷ Piezosurgery cuts mineralised tissue such as bone, it does not cut soft tissues such as vessels, nerves and mucosa.⁸

PRINCIPLE AND MECHANISM

Motor driven or manual instruments were conventionally used to perform bone surgeries. The use of manual instruments provided a good hold while cutting of less mineralised bone but their major drawback was osteotomies with precision could not be performed in case of densely mineralised bone. Motor driven instruments came to rescue in such cases but these instruments had less tactile sensitivity and problem of overheating. The problem of overheating was managed by lower rotational speed which necessitates increased manual pressure, increasing the macrovibration of the cutting tool and further diminishing the sensitivity.⁹ The noise and macrovibrations caused fear and stress in patient when surgery is performed under local anaesthesia.⁸ Piezosurgery is based on ultrasonic microvibrations. Ultrasonics are branch of acoustics concerned with sound vibrations in frequency ranging above audible level i.e. greater than 20 kHz.¹⁰ It works by producing piezoeffect which is derived from greek word "piezein" meaning to press or squeeze.¹¹ It works by producing electrical tension on some crystals such as quartz and then applying mechanical pressure on them. All this leads to expansion and then contraction of the material producing ultrasonic vibration. It is also known as pressure electrification.⁶ The shock waves also minimize bacteria in the field thereby disinfecting the area and are three times more powerful than conventional tips.¹²

APPLICATIONS

The applications of piezosurgery in the field of periodontics are vast and broad. It ranges from removal of supragingival calculus and stains to sinus augmentations, bone splitting and cystectomy procedures.¹³

Scaling and Curettage:

The piezoelectric device uses aligned ceramic discs to produce the straight micromovements of the tip through alternating expansion and compression of the ceramic discs when electricity flows over the surface of the crystal resulting in disruption of bacterial cell wall. The inserts are placed vertically parallel to the long axis of the tooth and the tip's lateral surfaces are most active.¹⁴ They can also be efficiently used to debride the epithelial lining of the pocket wall resulting in microcauterization. In vitro studies comparing ultrasonic scalers and hand curettes found that piezoelectric devices results in faster instrumentation.¹⁰

Periodontal surgery

The introduction of piezoelectric devices have streamlined and improved the handling of soft and hard tissues. The cavitation effect produced by the coolant resulted in efficient scaling. The mechanical action of ultrasonic microvibration together with cavitation of irrigation fluid eliminates bacteria, toxins, dead cells and creates a clean physiology for healing.¹⁵ There is minimal drying of the adjacent soft tissues thus favouring tissue healing

Crown lengthening

It basically involves apical repositioning of the periodontal bone and soft tissues to aid in prosthetic restoration of the crown. The osteotomy is simple to perform using piezosurgery in direct contact with the root surface because of control of instrument during surgery is precise. The root planning phase can be performed very effectively using blunt ultrasonic inserts.¹⁶

Osteoplasty and bone grafting

Piezoelectric devices can be used for grafting infrabony defects.³ The device enables gentle scrubbing of the bone surface to obtain sufficient quantities of graft material. The function of the obtained bony chips vary with size (i) Small sized chips aid in early remodelling and (ii) Larger particles provide mechanical support and act as scaffold for bone formation.¹⁷ In literature there is a disagreement with some authors favouring the use of piezosurgery with regards to number of living cells, such as osteocytes¹⁸ and others scrutinize the use of piezosurgery owing to the lower percentage of living cells when compared to the conventional technique.⁶

Bone graft harvesting

Bone blocks harvested using traditional rotary cutting instruments to reduce the width of the

cortical bone by at least 1 mm circumferentially and are unable to effectively cut the internal cancellous bone. So the block has to be detached using scalpels and this makes the margins irregular.¹⁰ Mandibular ramus area is most commonly preferred site for harvesting graft and is generally used as onlay graft.¹⁹ Piezo surgery provides high precision and operating sensitivity and easy differentiation between cortical and cancellous bone while removing blocks of monocortical cancellous bone.²¹

Implant site preparation and peri-implantitis

Specifically designed set of piezosurgery inserts are used for implant site procedure. It enables selective enlargement and preparation of socket wall which is also known as differential ultrasonic socket preparation. Piezosurgical site preparation provides similar primary stability and short-term survival rate of an implant when compared with conventional site-preparation techniques. Stelzle et al.¹² emphasized that the applied load on the handpiece may increase the preparation speed but it may also increase the negative thermal effect on the bone. Therefore, it is recommended that a maximum load of 400 g is used during implant site preparation.¹⁰ Periimplantitis is an inflammatory reaction resulting in loss of supporting bone in the tissue surrounding implant.²¹ The overall frequency was reported to be 5%-8% for selected implant system.²² The piezosurgery instrument allows for removal of calculus from titanium osteosynthetic surface quickly. Debris and infected bone can be removed from the implant surfaces without damaging the implant.²³

DISCUSSION

Piezosurgery is a relatively new surgical technique for periodontology and implantology that can be used to complement traditional surgical procedures and in some cases can replace traditional procedures.²⁴ Piezosurgery instruments allows for increased operator sensitivity and control allowing the clinician to have a better grip and hence an increased precision while cutting. The cutting action is less invasive, producing less collateral tissue damage, which results in better healing.²⁶ Owing to the cavitation effect produced as the oscillating tip moves the irrigation fluid, there is bloodless field of surgery and also chances of postoperative necrosis are less. The risk of subcutaneous emphysema is also reduced due to the aerosol effect that the ultrasonic device

produces unlike the effect of air-water spray generated by osteotomy with rotary instruments. There is less noise production and only microvibrations are produced in comparison with a conventional motor, so the fear and psychological stress of the patient are reduced.⁶ The effects of mechanical instruments on the structure of bone and the viability of cells are important in regenerative surgery. Relatively high temperatures, applied even for a short time, are dangerous to cells and cause necrosis of tissue. There have been studies about the effect of piezoelectric surgery on bone and the viability of cells. Not only is this technique clinically effective, but also histological and histomorphometric observation of postoperative wound healing and formation of bone in experimental animal models has indicated that the response of tissue is more favourable after piezosurgery than after conventional bone-cutting techniques with diamond or carbide rotary instruments.²⁷ Piezoelectric bone surgery seems to be more efficient in the first phases of bony healing; it induces an earlier increase in bone morphogenetic proteins, controls the inflammatory process better, and stimulates remodelling of bone as early as 56 days after treatment.²⁴ Every coin has two sides. Piezosurgery is also associated with certain limitation. Operating time for osteotomies is slightly longer than with traditional saws, and increasing the working pressure impedes the vibration of devices that transform the vibrational energy into heat, so tissues can be damaged.²⁶ The use of irrigants is helps in cavitation and also to avoid overheating. The intensity of the cooling liquid can be adjusted depending on different preparations. Cooling solution is used at 4 degree centigrade.¹⁰

CONCLUSION

Piezosurgery devices are taking a leading edge in the field of periodontal surgery by providing guarded and effective ways for osteoplasties and osteotomies. They are easy to use, more patient friendly compared to conventional surgical instruments.

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