

## Piezosurgery and its Clinical Applications in Periodontics

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### ABSTRACT

Use of ultrasonics vibrations for cutting bone was used two decades ago. Piezosurgery is a novel surgical approach, gaining popularity in periodontology, oral implantology, and oral surgery. Piezosurgery is a sophisticated ultrasonic device introduced by Dr. Tomaso Vercellotti. It is minimally invasive osteotomy device to achieve unparallel precision, patient comfort, intra-operative sensitivity, intra-operative visibility, blood free surgical site and reduced damage to the surrounding soft tissues, osteocytes and important structures like nerves, muscles and mucosa. Due to the minimal damage to the osteocytes, survival of bone after harvesting is excellent compared to conventional cutting of bone. Periodontal disease often leads to attachment loss and osseous defects. Angular bone defects can be regenerated using bone grafts. Autologous bone grafts holds lot of importance in regenerating periodontal defects. Piezosurgery is very useful in harvesting autogenous bone for regenerating periodontal defects. In modern dentistry osseous support is important for successful implant placement. Piezoelectric device is widely used in various procedures. Many studies have, reported this device as safe and easy for harvesting intraoral autogenous bone graft compared to manual and rotary instruments. Piezosurgery device have the following advantages, improved quality of cutting, maneuverability, ease of use, and safety. Patients are seeing amazing results with faster healing time, less swelling and less post operative pain. This article summarizes the various clinical applications of piezosurgery in the field of periodontics and implant dentistry.

**Keywords:** Atraumatic, osteotomy, osteoplasty, piezosurgery, sinus lift and sinus augmentation

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### INTRODUCTION

Piezosurgery is an ultrasound device, introduced by Pohlman in 1950, for treating humans with neuropathic pain and myalgias [1, 2]. This ultrasound device introduced in dentistry in 1952, for preparing dental cavities [1]. These units have been used as periodontal scalers and endodontic instruments and it is a multipurpose unit [1, 3].

It includes periodontal surgery, periapical surgery [4, 5] and removal of impacted tooth, implant surgery, bone regeneration, inferior alveolar nerve lateralization and transpositioning, [5, 6] sinus lift and augmentation, and crown lengthening, distraction osteogenesis [3, 7]. On adding abrasive particles to ultrasonic tips, ultrasound device can be used for removing caries, finishing crown and bridge

preparation [3]. Shock waves in the field of operation minimize bacteria, which acts as a disinfecting medium [3]. It is 3 times more powerful than the conventional ultrasonic tips [3]. It has different ultrasonic tips for each procedures, operates at a frequency of 25-29 KHZ and it can be modulated up to 30KHZ, with advanced oscillation control module that introduces pauses in a high frequency vibrations, which prevents heating of bone and helps in precise cutting of bone. For rigid cortical bone; high frequency (60 to 200µm/sec), micro vibrations of the instrument is needed, perhaps soft tissues are not harmed in this frequency even in direct contact of the instrument due to its soft and pliable nature[3].

The purpose of using this device is precise control in sectioning of bone and atraumatic surgery [1,3] compared to manual and rotary instruments. Piezoelectric device have 3 features which includes, (i) superior precision in cutting mineralised structures, (ii) soft tissues are not damaged, and remain intact in accidental contact with the device, minimal bleeding on physical cavitations phenomenon [1,3]. The effective

way of using piezoelectric device is with high speed with lower pressure; increased pressure results in increased vibration of the inserts [3]. In contrast to conventional drilling procedures; piezosurgery produces micro vibration and little noise, which minimizes patient's psychological stress and fear during osteotomy under local anaesthesia.



**Fig 1: Piezosurgery Device**



**Fig 2: Piezosurgery Tips**

**APPLICATIONS IN PERIODONTICS**

Piezosurgery is applied in various field, its clinical applications are broad; which includes removal of supra and subgingival calculus and stains, scaling and root planing, osteotomy and osteoplasty, sinus lift and sinus augmentation, bone splitting, and cystectomy [8], in all these procedures careful removal of small amount of bone is needed to ensure normal tooth structure [7].

**Osteotomy**

Osteotomy is a surgical procedure where a bone is cut to shorten, lengthen or change its alignment. Other name for osteotomy is corticotomy. Piezoelectric instrument helps

to elevate the periosteum to visualize the impacted or semi-impacted teeth; it can be single or multiple teeth. This is widely used for orthodontic treatment [9]. Precise cutting of bone helps in preventing damage to soft tissues like nerves, mucosa and gingival. It creates positive architecture for pocket elimination. It minimizes bleeding; which helps in improved visibility of surgical site [1, 3].

**Osteoplasty**

Osteoplasty is concerned with bone repair or bone grafting. Piezoelectric device used for grafting an infrabony periodontal defect [2]. Straight or angled piezosurgery tips helps to collect autologous grafts in

monocortical blocks or bone chips. Bone chips are filtered in a filter mesh which is not homogenous in size; bone chips smaller than 200µm is not sufficient for osteoconductivity; Bone chips must be larger than 500µm for osteoconductive bone regeneration & bone chips larger than 1000µm require longer healing times. Bone chips with varied dimensions have different advantages; (i)small sized chips provide early remodelling (ii)larger particles provides slower remodelling and mechanical support; acts as a scaffold for bone formation in the grafting site.

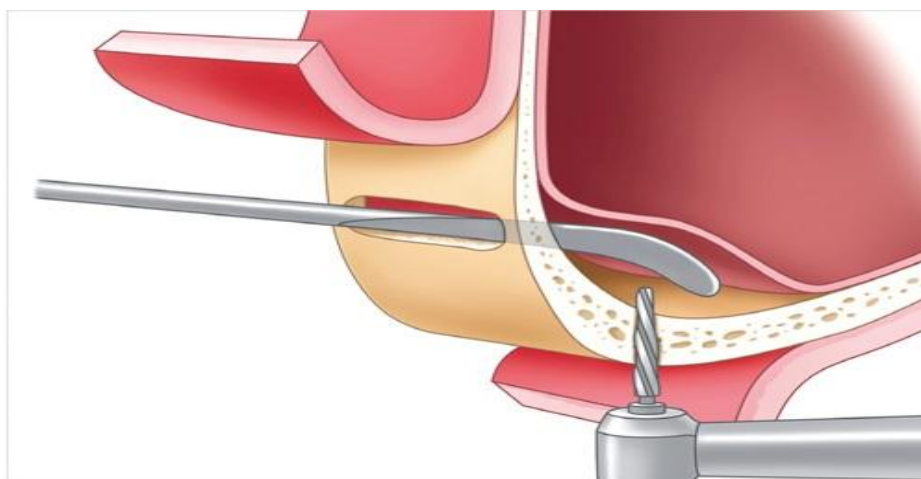
This device doesn't traumatize bone thermally, so post operative wound healing is rapid. & minimize bleeding by the cavitation effect created by the interaction between irrigant and the oscillating tip; results in improved visibility. Bone blocks can be harvested from a concerned site, like chin, iliac crest or oblique line of the mandible; to ensure small surgical site and ease of operation. Shape of the harvested bone can be modified using piezoelectric tips to fit accurately in the recipient site. It is widely used to correct local defects in oral surgery [10, 11].

#### Sinus lift or augmentation

Sinus lift surgery is well accepted surgery for creating sufficient bone volume for

placing endosseous implants [12, 13, 14, and 15]. This technique is introduced by Tatum in 1977 [7], and published in 1980 by Boyne and James [17]. Sinus augmentation is performed in following situations; pneumatized sinus, atrophy of alveolar ridge, and poor bone quality especially in the posterior maxilla.

Sinus lift procedure can be performed using diamond coated tip to penetrate the membrane, blunt inverted cone tip to elevate the sinus lining without damaging the sinus membrane & protect integrity of the membrane by cavitating saline spray [18], eg: peeling a shell from a raw egg (a rigid tissue) without damaging the outer membrane (thin membrane located just inside the shell) [18]. Elevating the sinus membrane is most successful in atrophic maxillary posterior part for creating sufficient bone for placing implants, and it has a greater risk of perforating Schneider membrane, bleeding and sinus infections; can occur while separating the sinus membrane or preparing a window to reach sinus membrane [1,3], perforation of schneiderian membrane resulting in poor graft stabilization, sinus infection, epistaxis and extensive bleeding [13,19-21].



**Fig 3: Sinuses Lift Procedure**

#### Bone splitting procedure

In case of insufficient width of alveolar ridge while performing implant placement; bone splitting is performed, this gives greater results. Osteotomy tips perform atraumatic separation of bone; and the

procedure is completed with manual osteotomes. Ultrasonic tip helps to prevent breakage of bone; which owes for expansion and it tends to be more elastic [9, 22].

**DISCUSSION**

Piezoelectric device is concluded as a best bone regenerating device and it is minimal invasive surgery [1]. It has several advantages in contrast to conventional rotary instrument; it requires less hand pressure (varies from 2kg to 3kg), micrometric cutting that depends on the micro-oscillation of the hand piece, this helps in increased sensitivity and control for clinician which develops better feel and precision for cutting action [23].

This can be used to prepare the bony window in the external wall of the upper maxilla without the risk of perforating the sinus mucosa (perforations can be repaired to complete the grafting procedures; perforations may be simple, difficult or impossible) [18], with limited loss of bone [24]. Cutting is safe because it doesn't traumatize the soft tissue [21, 25], and collateral tissue results in better healing. Due to its cavitations effect on blood; piezoelectric surgery creates bloodless surgical site which improves visibility of surgical site [26, 27].

Unless conventional bone cutting instruments, piezoelectric tip doesn't become hot (due to oxygen molecules are released during cutting and ultrasound vibrations stimulate cell metabolism), which again reduces post operative necrosis [2]. Decreased post operative pain, swelling, bleeding, increased patients comfort [26, 27] (less invasive; which results in reduced collateral tissue damage). Minimal stress and psychological stress on patients (due to reduced noise and microvibrations) [7].

This technique requires special surgical skill to perform [1]. Largest disadvantage of using piezoelectric device is it requires increased operating time for bone preparation, and it immensely lessens the risk of damage to the adjacent tissues (nerves, vessels and sinus membrane), but precautions must be taken because ultrasonic waves have mechanical energy which converts that energy into heat and pass to the adjacent structures, so irrigant is used to avoid overheating and cavitations. Use of bone grafts and barriers helps in new bone formation and prolong the survival rate of implants [28].

**CONCLUSION**

To conclude, piezoelectric device have following advantages;

- Reduced perforations of sinus membrane
- Improved visibility of surgical site
- Reduced intraoperative bleeding
- Reduced trauma to surgical site
- Piezoelectric device have more improvements in upcoming years; this instrument will have lot of clinical application in dental field. E.g. management of pneumatized sinuses, membrane perforation, pocket elimination etc. Result in more successful and complication free surgery.

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