

Review Article

Piezoelectric surgery: A novel approach in Periodontics

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Abstract

Piezoelectric surgery is a minimally invasive osseous surgical technique developed in recent years in response to lessen the risk of damage to surrounding soft tissues and important structures such as nerves, vessels and mucosa. Periodontitis is a multi factorial disease of tooth supporting structures. Various treatment modalities are based on removal of etiologic factors and preserving bone architecture. Recently this novel surgical approach has gained popularity in many fields of dentistry. This article reviews its treatment application in periodontics.

Key Words: Piezoelectric surgery, periodontitis, ultrasonic device.

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Introduction

The periodontium is an entity and managing a periodontal environment is a permanent challenge for the periodontist. Different techniques and surgical protocols have been proposed to treat periodontal disease due to bone loss, infection, trauma or placing dental implants. Most of these protocols involve bone surgery techniques¹.

The success of any treatment modality depends on following a precise biological criteria which includes using atraumatic surgical procedures, minimal risk to surrounding tissues, improved visibility, hemostasis and post operative conditions². Most of the instruments used are either manual or motor driven but in bone surgeries they do not help to achieve the above criteria because they are difficult to control in dense bone and generate significant amount of heat in the cutting zone during osteotomies causing overheating, ultimately hampering the healing response³.

These days precision instruments are available for periodontal and implant surgery involving hard tissue. Piezosurgery is one such innovative surgical approach developed with its application in dentistry.

Basics of Piezosurgery

Piezoelectric surgery also known as Piezosurgery was developed in the 1980's. The basics of this technique is based on the principles of "Piezo electricity" which was discovered by Jacques and Pierre Cury in the nineteenth century⁴. Piezo electricity is found in some crystals such as quartz, Rochelle salt and certain types of ceramics. Piezoelectric transducer used is an ultrasonic device which converts an oscillating electric field applied to the crystal into mechanical vibration. These devices are used over an entire frequency range and particular shapes available are chosen for

particular application eg: disc shape produces plane ultrasonic waves.

There is also another concept called inverse Piezoelectricity wherein the crystals when subjected to alternative electric charge expand and contract alternatively producing mid-frequency mechanical oscillation and ultrasonic waves. These ultrasonic waves through a phenomenon of agitation induce disorganization, fragmentation of different bodies. These two concepts form the basis of Piezosurgery which is used in dental field^{5,6}.

Piezo electric device

The Piezoelectric device uses patented, controlled, three dimensional ultrasonic unit with the frequencies of 10, 30, 60 cycles up to 29 KHz. This low frequency allows safe and precise cutting. Power can be adjusted from 2.8 to 16 watts depending on the bone density⁶. It consists of a hand piece and foot switch connected to main power unit. There is a holder for the hand piece with the irrigation fluids which cools the surgical site (Figure 1). The Piezosurgery tips produces vibration ranging from 20µm to 200 µm^{6,7} which allows clean cutting and precise incision. The tips work in linear, back and forth, piston like motion ideal for surgery. They provide advantage of more cycles per second, less heat generation, light weight and adequate water cooling^{7,8}.

Clinical application in dentistry

Piezosurgery is used in different procedures which includes periodontal surgery, periapical surgery⁹, removal of impacted tooth, implant surgery, ridge expansion procedures, bone regeneration techniques⁶, orthognathic surgery¹⁰, sinus lift procedures and

inferior dental nerve lateralization and trans positioning¹¹.

Therapeutic implications:

1. Micrometric cut: Superior precision to limit tissue damage
2. Selective cut: Sectioning of mineralized tissues without damaging the adjacent soft tissues
3. Cavitation effect: This phenomenon results in clear surgical site with the oscillating tip driving the cooling irrigation fluid making it possible for effective cooling and higher visibility⁸.

Clinical application in Periodontology

1. Autogenous bone grafting: Autogenous bone has been harvested by different methods. Bone procured using manual or motor driven instruments may not be suitable for grafting because of the absence of osteocytes and predominance of non-vital bone. The Piezosurgery inserts used for bone harvesting produces a vibration with a width of 60 to 210µm in oscillation controlled module. The use of ultrasonic vibration makes micrometric bone cuts resulting in controlled osteotomies in mobilizing block graft in contrast to rotary burs or reciprocation saws¹². Stubinger et al in his analysis reported increase in levels of bone morphogenic protein (BMP-4) and transforming growth factor (2 proteins) in the bone harvested¹³. The osteotomy makes a narrow cut and increase in temperature is avoided reducing the risk of bone damage and best results can be obtained in terms of bone regeneration⁷.

2. Periodontally accelerated orthodontics : In this treatment modality small vertical bone incisions were made between the teeth which allowed more expedient orthodontic movement. The corticotomy performed by piezosurgical saw reduced the treatment time by 60 to 70 % with accepted degrees of pain and discomfort. Surgical control for piezosurgery was reported to be easier than conventional surgical burs for selective alveolar corticotomies¹⁰. Another alternative technique to corticotomies was proposed by Sebaoun et al¹⁴ in which piezocision, minimally invasive flapless procedure combining micro incision, piezoelectric incision and selective tunneling showed better results compared to the earlier techniques used.

3. Scaling and root planing : The piezosurgery device with a vibrating tip used for removal of debris, calculus and stains uses cavitation effect and microstreaming, which disrupts the bacterial cell wall and subgingival environment¹⁵. The inserts used are placed vertically parallel to the long axis of the tooth and is moved continuously providing better calculus removal and patient comfort.

4. Curettage: Piezosurgery device can be used for debriding the epithelial lining of the pocket wall resulting in microcauterization. With thin tapered tips and altered power setting piezosurgery device can be used for efficient removal of root calculus and residual soft tissue compared to manual instruments⁷.

5. Sinus grafting in implant surgery : The piezoelectric device used for sinus elevation procedure comprises of handpiece fitted with the insert and irrigation fluid which removes debris from the cutting area. The microvibrations produced ranges from 60-200mm/sec with the modulating frequency 25-30 khz. Piezoelectric osteotomies cuts mineralized tissue without damage to the scheinderman membrane allowing easy separation and is raised with piezoelectric elevators without perforation and the space between the bone and membrane filled by new graft. There is no risk of injury to the adjacent structures and effect of cavitation cleans the working area improving the visibility^{17,18}. This technique offers favourable repair and better comfort compared to rotational bur.

6. Ridge split procedure for implant placement : Classic ridge split procedures involves razor sharp bone chisels and rotator or oscillating saws. This is time consuming and requires technical skill. Rotating saws used damage soft tissues such as tongue, cheek and the vertical incisions require more effort and care but with Piezoelectric surgery, the split crest procedure used is technically less sensitive and horizontal and vertical incision is made without damaging the adjacent structures¹⁶.

Other procedures such as Osteoplasty, Ostectomy and crown lengthening requires careful removal of bone without damaging the adjacent structures and by using piezosurgery device, positive architecture is created for better flap closure and bone support⁷.

Advantages of Piezosurgery:

1. The device enables hard tissue incision with superior precision for safe cutting action with minimum bone loss¹.
2. The piezosurgery hand piece operates with ultrasonic frequency which is safe providing greater control of surgical device and enhanced operator sensitivity¹².
3. There is minimal bleeding of bone tissue and this provides good visibility of the operating site. The reason is due to the cavitation effect creating bubbles leading to implosion which generate shock waves causing micro-coagulation¹⁵.
4. Selective cutting and specificity to the surgical site reduces the risk of damage to the soft tissue including arteries, nerves and risk of perforation to the sinus membrane is eliminated¹⁸.
5. Less risk of post-operative necrosis accelerates bone regeneration^{3,19} unlike conventional burs.
6. Decrease in post-operative pain since the cutting action is less invasive producing less collateral damage which results in better healing⁷.
7. Less noise is produced in comparison with the conventional motor driven devices so fear and psychological stress is reduced¹⁴.

Limitations

1. Operating time is increased for osteotomies compared to traditional methods^{16,20}.

2. The ultrasonic waves generates mechanical energy and in case of increased working pressure which impedes the vibration of device that convert vibrational energy in to heat so damage is incurred to the tissues^{16,21}.
3. The technique is highly sensitive.

Conclusion

Piezosurgery is truly an innovative osseous surgical technique in field of dentistry compared to the traditional hard and soft tissue methods that uses manual or rotary instruments. The handling characteristics of the technique offer advantages such as minimal risk of injury to the soft tissues, bloodless surgical field, comfort and precision to the surgeon, minimum postoperative pain, faster healing and the limitation being increased operating time and technique sensitivity.

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