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DENTAL SCIENCE

PIEZOSURGERY: A REVOLUTIONARY TOOL IN PERIODONTICS

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ABSTRACT Periodontitis is one of the chronic inflammatory disease that leads to destruction of tooth- supporting structures. The success of the periodontal treatment depends on the removal of local factors and restoration of the bony architecture. Traditionally manual or motor driven instruments are being used to perform osseous surgery till today which has its own advantages and disadvantages. Recently, the piezoelectric device act as a revolutionary tool was introduced in the field of periodontology and oral implantology. The device proves its efficiency in making extreme precision on micrometric cutting, safety as well as great control on the surgical site. Moreover it selectively cut the bone depending on bone mineralistion, without the damaging the adjacent soft tissue, providing a clear visibility in the operating field. This review article summarises the basic principles of piezosurgery and outlines its application in areas of periodontology and oral implantology.

KEYWORDS : Piezosurgery, ultrasonics, osteoplasty, osteotomy.

INTRODUCTION

Piezosurgery device is an ultrasound device which performs its role in enhancing the surgeon's ability to perform a meticulous bone surgery by reducing the risk of intra-operative and postoperative complications. The word 'piezo' has been derived from the Greek word termed "piezein" which means to press or squeeze. It plays a major role in various fields such as oral & maxillofacial surgery, periodontology & oral implantology and also in cranial & spinal surgical procedures. Piezosurgery performed in various dental surgical procedures like periodontal surgery, removal of impacted teeth, crown lengthening, distraction osteogenesis, in implant surgery for sinus lift procedures, alveolar ridge expansion, in bone regeneration procedures, and inferior dental nerve lateralization and transpositioning[1].

HISTORY

- In 1880, the basic principle of piezoelectric effect was first described by the French physicists Jacques and Pierre Curie in 1880.
- In 1953, Mathew C. Catuna described the piezoelectric effect by using ultrasonic vibrations in cutting hard tissue.[2]
- In 1955, the use of ultrasonics in periodontal procedure was introduced by Zinner[3].
- In 1997, the idea of piezosurgery was first introduced by Tomaso Vercellotti[4].
- In 1998, the first piezosurgical unit was developed by Mectron Medical Technology, Carasco, Italy[5].
- In 2000, Mectron developed first piezosurgery device.
- In 2001 and 2002, first study about sinus lift and first bone block grafting procedures using piezosurgery was performed.
- In 2004, Second generation of piezosurgery device was introduced.
- In 2005, first implant site preparation treatment was done using piezosurgery device.
- In 2009, third generation piezosurgery device was introduced[6].

ULTRASONIC TO SONICS

Ultrasonics is a branch of of acoustics concerned with sound vibrations in frequency ranges above the audible level. It uses the transmission and reflection of acoustic energy[7]. Ultrasound is generated by the transducers, which convert electrical energy into ultrasonic waves. Sonics are referred as the ultrasound waves of very high amplitudes[8].

3 different methods of ultrasonic production:-

1. Mechanical method : up to 100 Khz
2. Magnetostrictive system: 18-25 Khz
3. Piezoelectric system : 25-50 Khz

PIEZO-ELECTRIC EFFECT PRINCIPLE

Two types of piezo-electric effect:-

- Direct effect:- Mechanical energy in the form of tension and compression is converted into electrical energy[9].
- **Inverse effect:-** Electrical energy in the form of electrical signals is converted into (tension and compression) mechanical energy.

PRODUCTION OF PIEZOELECTRIC VIBRATIONS

Most common crystals which produce the piezoelectric signals are Rochelle salt, quartz, ceramics, topaz and other ceramic materials. The piezosurgery device mainly works on the principle of "pressure electrification". Piezoelectric vibrations are produced when those crystals are subjected to mechanical pressure (tension or compression) subsequently when placed under the electrical field .Those crystals undergoes expansion and contraction by inverting the direction of electric charge thereby producing the series of ultrasonic microvibrations. On applying this electric charge on there is an oscillating shape change of the crystal at frequency applied which is the passed onto the working tip. These vibrations are conducted through a piezoelectric transducer higher working efficiency is obtained. Those working tip moves in linear pattern forwards and backwards. The cutting tip works with a reduced vibration amplitude vertically (20-60 µm) and horizontally (20--200 µm)[10]. It allows only two sides of the tip to be active at any time.

It is three times more powerful than the conventional ultrasonic tips[11]. It operates at frequency of 25-29 KHz and it can be modulated upto 10, 30, and 60 cycles/s (Hz) which enables efficient and controlled use. The power of commonly used devices is 5W[12].

PROPERTIES OF PIEZOELECTRIC DEVICE

3 three specific therapeutic features[13]

1. Micrometric cutting- It offers superior precision in cutting and with bone loss at limited vibrations amplitude (max.200µm).
2. Selective cutting- It selectively sections the mineralized structures, without damaging the adjacent tissues.
3. Bleeding free surgical site:- It enhances the bleeding free surgical site for maximum intra-operative visibility and maximum predictability. This is due to the cavitation effect.

CAVITATION PHENOMENON

It is the most crucial phenomenon that plays a key role in bone surgery. The specific effects of piezosurgery are cavitation, heat, formation of bubbles, ultra massage, electrical and acceleration[14]. It is a micro-boiling phenomenon. It is the formation and implosion of cavities within a liquid. These bubbles are formed as a consequence of the forces that act 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. Cavitation describes the formation of vapourisation, bubble generation and subsequent implosion (growth and collapse of bubbles) into minute fractions of its original size that will occur in flowing liquid as a result of the decrease and increase in pressure that is caused by the ultrasonic vibrations. This effect will bring about haemostasis, which results in a bloodless surgery. Walmsly et al.[15] stated that cell walls of bacteria are fragmented with antibacterial efficiency by the cavitation effect.

PARTS OF PEIZOSURGERY DEVICE

Peizoelectric device mainly composed of three main components namely handheld device(handpiece), foot pedal and a base unit. The base unit which supplies the power and has the holder for hand piece and irrigant fluids. There are different inserts with different shape and size. There are different inserts corresponds to different applications in performing the bone surgery. They are classified based on its morphology and function. There are different types of inserts like Titanium nitrate coating, diamond coating, sharp insert tips, smooth insert tips, blunt insert tips. Generally the tip colours are gold and steel. These inserts are screwed into the handpiece using a dynamic wrench with a pre-defined force to obtain the energy transmission. The handpiece is controlled by a foot pedal with settings that can be adjusted on the base unit. This base unit which consists of a control panel which operated based on two programs:-

- Bone program:- It is possible to adapt the power to any four levels depending upon the bone quality
- Root program:- It further consists of two modes namely, Perio and/or Endo

The cutting characteristic of piezoelectric device depends on degree of bone mineralization (density), the design of the insert, the pressure applied on the handpiece during use and the speed of the handpiece movements. The power (W), frequency (Hz) and the irrigation fluid level should be set in accordance with the intended procedure[14].

APPLICATIONS OF PIEZOSURGERY IN PERIODONTICS

- Scaling and root planing
- Curettage
- Resective and regenerative surgery
- Harvesting bone blocks and bone grafting
- Osteolplasty and osteotomy
- Crown lengthening procedure
- Implant site preparation
- Sinus lift procedure
- Ridge split technique
- Tooth extraction
- Retrograde root canal preparation

Scaling, root planing & curettage

It is efficiently used for removing supra and subgingival calculus deposits and stains from the teeth. This procedure is based on the cavitation effect and microstreaming. It is used for debriding the epithelial lining of the pocket wall resulting in microcauterisation. It is done by using tapered tips and also by altering the power setting intended for this procedure[8].

Resective and regenerative surgery[1,16,17]

It has its role in various dento-alveolar procedures involving periodontal surgeries. It includes:-

- Root amputation
- Separating the tooth roots
- Hemisection
- Apical resection and endodontic treatments.

Harvesting Bone blocks and bone grafting

The piezosurgery device is used for collecting autologous grafts in the form of bone chips. The adequate amount of graft material is obtained by gently scrubbing the bone surface. Some authors has stated that the use of piezosurgery favours with regards to the number of living cells, such as osteocytes[18]while others have reported that piezosurgery owes lower percentage of living cells when compared with conventional techniques[19,20]. Most commonly autogenous graft for implantology procedure is taken from the mandibular ramus area and it is mainly made up of cortical bone which is very thick. A saw- shaped insert is used to give a precise cutting in the bone along with the cavitation effect. A dual angled insert is used for deeper areas, especially for lower horizontal bone cutting during ramus bone graft harvesting.

Crown lengthening

The main aim is to maintain the biologic width while repositioning the periodontal bone and soft tissues to a more apical position ensuring the proper prosthetic restoration of the crown.The osteotomy in a direct contact mode with root surface is done using piezosurgery because of its precise cutting.

Implant site preparation and peri-implantitis

Implant site preparation is performed using specifically designed piezosugery inserts. It ensures selective enlargement and preparation of socket wall which is termed as differential ultrasonic socket preparation. It provides primary stability and short term survival rate of an implant when compared with conventional site preparation technique. Stelzle et al.,[21] stated there is a probability of increasing the negative thermal effect on the bone that depends on the load applied to the hand piece. The piezosurgery has its main advantage in management of peri-implantitis by removing of calculus from titanium osteosynthetic surface quickly. Debris and infected bone can be removed from the implant surfaces without damaging the implant.[22]

ADVANTAGES

- It allows precise and selective cutting.
- It enhances faster bone regeneration and healing process.
- Proper control of surgical device by adapting the frequency of the vibrations of piezoelectric ceramics producing an efficacious and efficient cutting action on the bone of different qualities.
- It shows minimal operative invasion.
- Reduction in traumatic stress.
- Providing an aseptic environment through a sterile coolant system making it free from contamination[23].

DISADVANTAGES

- Increased operation time required for bone preparation.
- Over heat is produced and damages the tissues when work pressure is increased. In order to avoid this adequate precautions are taken to prevent the damage.
- It is not recommended in patients with pacemakers.
- More practice time is required for the clinicians to gain experience.

CONCLUSION

The piezosurgery device plays an excellent revolutionary role in periodontics and other fields of dentistry. The device by its efficient cutting, efficacious surgical comfort makes the surgical procedure to be precise. It also helps the dental surgeon to practice in a comfort zone in handling the major surgical procedure. It provides a revolutionary 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. Penarrocha Diago M, Ortega Sanchez B, Garcia Mira B. Evaluation of healing criteria for success after periapical surgery. Med Oral Patol Oral Cir Buccal. 2008; 13:E143-7.
2. Catuna MC. Sonic energy: A possible dental application, Preliminary report of an ultrasonic cutting method. Ann Dent. 1953 Dec;112:256-60.
3. Zinner DD. Recent ultrasonic dental studies, including periodontia, without the use of an abrasive. J Dent Res.1955;34:748-9.
4. Vercellotti T, Paoli SD, Nevins M, The piezoelectric bony window osteotomy and sinus membrane elevation: Introduction of a new technique for simplification of the sinus augumentation procedures. Int J Perio Rest Dent. 2001; 21:561-67.
5. Bains VK, Mohan R, Bains R. Application of ultrasound in periodontics: Part II. J Indian Soc Periodontol 2008;12:55-61.
6. Agarwal E, Masamatti S, Kumar A. Escalating role of piezosurge in dental therapeutics. J Clin Diagn Res 2014; 8:8- 11.
7. Vive K Bains, Ranjana Mohan, Rhythm Bains. Application of ultrasound in perioodntics: PART I. J Indian Soc Perioodntol.2008 May-Aug;12(2): 29-33.
8. Hema S, Kranti K, Sameer Z. Piezosurgery in periodontolgy and oral implantology. J Indian Soc Periodontol 2009; 13 (3): 155-156..
9. Yaman Z, Suer BT.Piezoelectric surgery in oral and maxillofacial surgery. Annals of Oral and Maxillofacial Surgery 2013; 1(5):1-9.
10. Stubinger S, Landes C, Seitz O, Zeilhofer HF, Sader R. Ultrasonic bone cutting in oral surgery: A review of 60 cases. Ultraschall Med. 2008; 29: 66 - 71.
11. Laurence J. Walsh, Piezosurgery: an increasing role in dental hard tissue surgery, Australian dental practice.2007.
12. Schlee M. Piezosurgery : A precise and safe new oral surgical technique. Aust Dent Pract. 2009; 144-148.
13. Nalbandian S. Piezosurgery techniques in implant dentistry. Australian Dental Practice 2011: 116-26.
14. Vercellotti T. Technological characterisitcs and clinical indications of piezoelectric bone surgery. Minerva Stomatol 2004; 53:207-14.
15. Walmsley AD, Laird WR, Williams AR. Dental plaque removal by cavitational activity during ultrasonic scaling. J Clin Periodontol. 1988 Oct;15(9):539-43.Piezosurgery in oral and maxillofacial surgery.
16. Pavlikova G, Foltan R, Horka M, Hanzelka T, Borunska H, Sedg. 2011 J. Int J Oral Maxillofac Surg 2011 May ; 40(5) : 451-7.
17. Vercellotti T. Essentials in piezosurgery. Clinical advantages in dentistry. 1st ed. Milan Quintessenza Edizioni; 2009.p65-107.
18. Lee HJ, Ahn MR, Sohn DS. Piezoelectric distraction osteogenesis in the atrophic maxillary anterior area: a case report. Implant Dent. 2007;16(3) : 227-234.
19. Miron RJ, Gruber R, Hedbom E, Saulacic N, Zhang Y, Sculean A, et al. Impact of bone harvesting techniques on cell viability and the release of growth factors of autografts. Clin Implant Dent Relat Res.2012; Feb.
20. Swyeta Jain Gupta, Vivek Gautam, Amit Gupta. Piezosurgery: a revolutionary approach in periodontal surgery. Int J Dent Health Sci 2015;2(5):1205-1221.
21. Stelzle F, Frenkel C, Riemann M, Knipfer C, Stockmann P, Nkenke E. The effect of load on heat production, thermal effects and expenditure of time during implant site preparation – an experimental ex vivo comparison between piezosurgery and conventional drilling. Clin Oral Implants Res, 2012.
22. Robiont, M., F.Polini, et al. "Ultrasonic bone cutting for surgically assisted rapid maxillary expansion (SARME) under local anaesthesis." Int J Oral Maxillofac Surg 2007;36(3):267-9.
23. Kwan JY. Enhanced periodontal debridement with the use of micro ultrasonics, periodontal endoscopy. J calif Dent Assoc.2005; 33(3):241-248.