REVIEW ARTICLE

INSIGHTS OF PIEZOSURGERY- AN INNOVATIVE SURGICAL METHOD IN THE FIELD OF PERIODONTOLOGY

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ABSTRACT

Periodontitis is the commonest diseases in the oral cavity. It is defined as inflammation of the Periodontium and alveolar bone with periodontal pocket formation, gingival recession, or both. The various Treatment modalities include non-surgical and surgical methods, but the common drawbacks of these methods are profuse bleeding, pain, and infection which causes discomfort to the patient. To overcome this, in the era of modern dentistry has an innovative surgical technique which was developed and is referred as "Piezosurgery". Piezosurgery is defined as a process that utilizes piezoelectric vibrations in the application of cutting bone tissue. It promotes rapid healing, reduces damages to osteocytes, and permits good survival of bone cells during bone harvesting. It is extremely selective and correct nature makes its path extended to interdisciplinary approaches. This article discusses the new scope of piezoelectric surgery within the field of Periodontology and Oral Implantology.

KEYWORDS: Bone Harvesting, Cavitation, piezosurgery, ultrasonic vibration.

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INTRODUCTION

The term "PIEZO" was derived from the Greek word "piezien", which means "Pressure". Traditional surgical methods for the treatment of periodontitis had quite a lot of drawbacks which includes time-consuming procedure, overheating of adjacent tissue, multiple instrumentations, delayed healing process, and difficulty in maintaining a sterile surgical field. Localized bone necrosis occurs when a temperature of more than 47 degree Celsius was applied to the bone by the rotary instrument which is a major complication of the conventional method. Harder et al observed this rise in temperature was due to insufficient irrigation as low as 20ml/min. To overcome this, Piezosurgery was introduced, in which an internal irrigation system in the piezoelectric device **(Fig 1)** reduces the risk of post-operative complications such as bone necrosis. It is a favourable method for bone harvesting by using low-frequency ultrasonic micro-vibrations. The absence of micro vibration makes the instrument more feasible and permits greater intraoperative management. Piezosurgery also decreases the chance of injuries to vital structures like nerves and blood vessels[1]. Piezosurgery creates a bloodless field throughout the surgical procedure that creates a comfort zone for the patient. Piezoelectric surgery device uses lower micro-vibrations that range from 60-200 micron/second and ultrasonic frequency ranges from 24-36 kHz and the power is approximately 5 W[2]. Nowadays, piezoelectric surgery is considered a boon for modern periodontics, due to its efficacy of handling delicate tissue is straightforward and avails less risk to the patient[3]. Piezosurgery is also utilized in various branches of dentistry like conservative dentistry, implantology, periodontology, and oral and maxillofacial surgery.

Fig 1 : Piezoelectric device

REVIEW OF LITERATURE

In 1880,The Curie brothers 'Jacque and Pierre' discovered that putting pressure on various materials like ceramics or bone, created electricity which is known as the Piezo effect. In 1953, Catuna & 1974 -Shepeleva delineated the cutting of hard tissue with ultrasonic vibrations as piezoelectricity. In 1981- Aro et al delineated Piezosurgery in orthopaedic surgery and Horton et al in oral and maxillofacial surgery. In 1997-Mectron and Tomaso Vercellotti developed piezoelectric bone surgery that uses ultrasonic movements for bone cutting. Mectron created the prototype device for Piezoelectric bone surgery with which the primary extraction was performed. Tomaso Vercellotti named this technique as PIEZO SURGERY in 1999. In 2001, Piezosurgery was introduced for use in dentistry and in 2002, Piezoelectric device was used in the field of dentistry in Germany. Vercelloli in 2003 discovered the ideal frequency for using the Piezoelectric device in various fields of dentistry such as endodontic, orthopaedic, neurologic, periodontal, and oral and maxillofacial surgeries. Mectron in 2004 developed the second generation of piezosurgery device and in 2005, The US Food and Drug Administration extended the use of ultrasonic in dentistry to include bone surgery[4]. Sakkas et al in 2008 suggested that Piezosurgery allows a reduction of intraoperative bleeding, creating better visibility of the surgical field[5]. The third generation of piezosurgery was introduced in 2009 and selective cutting made harvesting of bone possible without encountering necrosis due overheating of the bone, and without damaging nerves and vessels (Seshan et al., 2009, Crosetti et al., 2009)[5]. Piezosurgery (piezoelectric bone surgery) was used for mandibular cyst enucleation that requires sensitive manipulation (Kocyigit et al., 2012)[5]. Recently extraction of impacted lower third molar results in more favourable outcomes when carried out by piezosurgery technique[5]. Piezoelectric surgery resulted in improved quality of life of patients in the first week of post-surgery with lower levels of pain and swelling as well as the number of analgesics taken and better haemorrhage control during surgery[5].

INDICATIONS

- Supra and subgingival scaling and root planing
- Smoothening of the root surface
- Bone grafting
- Sinus lift preparation
- Implant site preparation
- Retrograde root canal preparation
- Apicoectomy
- Orthodontic surgeries.

CONTRAINDICATIONS

- Increased operating time
- Expense
- Learning curve
- Pacemakers and defibrillators[6].

Parts of the Device: (Fig 2)

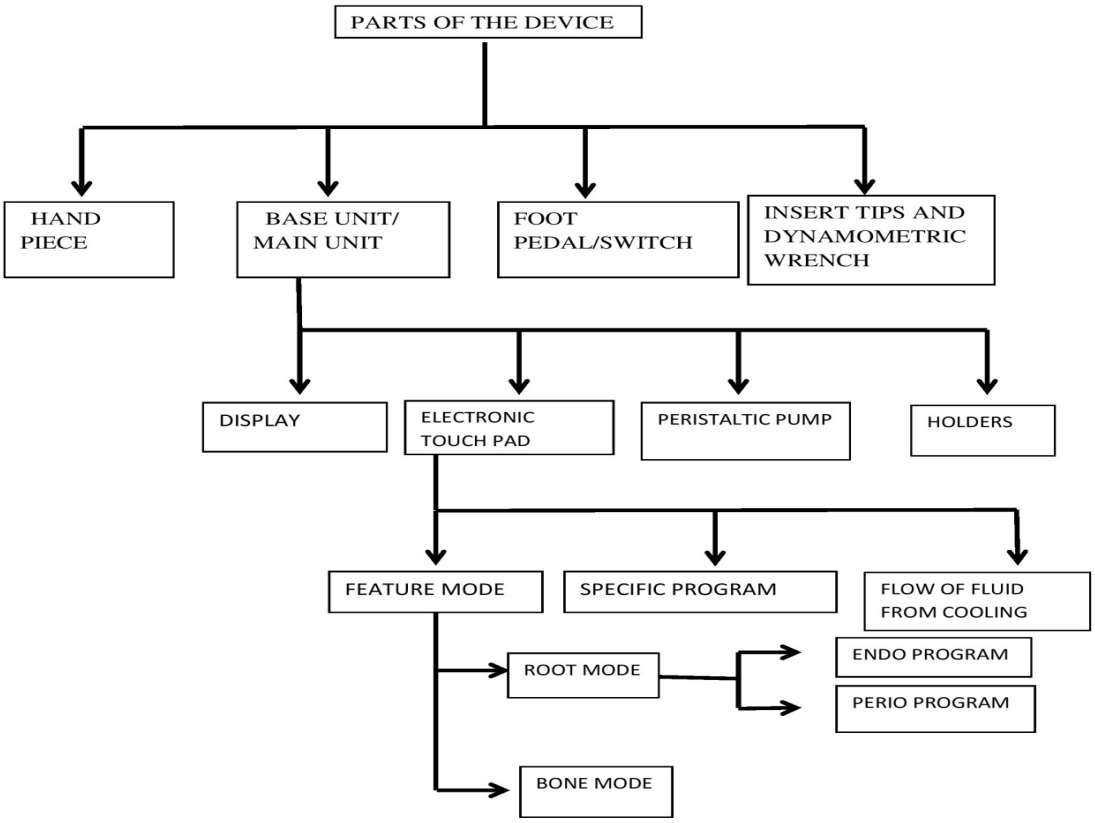

Fig 2: parts of piezoelectric device

BASE UNIT OR MAIN UNIT

The main unit consists of a Display, Electronic touchpad, Peristaltic pump, Holders.

THE ELECTRONIC TOUCHPAD CONSISTS OF THREE KEYS

Feature mode, Specific program, Flow of fluid from the cooling system
The irrigation fluid flows at the rate of 0-60 m/min through the peristaltic pump.

FEATURE MODE

It has two feature modes Root mode, Bone mode

ROOT MODE HAS TWO PROGRAMS

Endo program

This type of vibration is used in washing out the apical area of the root canal in endodontic surgery.

Perio program

The program is characterized by an intermediate level of power, The ultrasonic wave is transmitted through the transducer in a continuous sinusoidal manner .this vibration is used in periodontics for the root planing.

BONE MODE

It is characterized by extremely high ultrasonic power. It has two selections:

Quality 1:cutting of cortical bone or high-density spongy bone
Quality 3: cutting low-density spongy bone

SPECIAL PROGRAM

It is characterized by a standard power level slightly lower than bone mode. This special program is designed to form specific

types of inserts.

INSERT TIPS: (FIG 3)

Classifications of inserts tips:

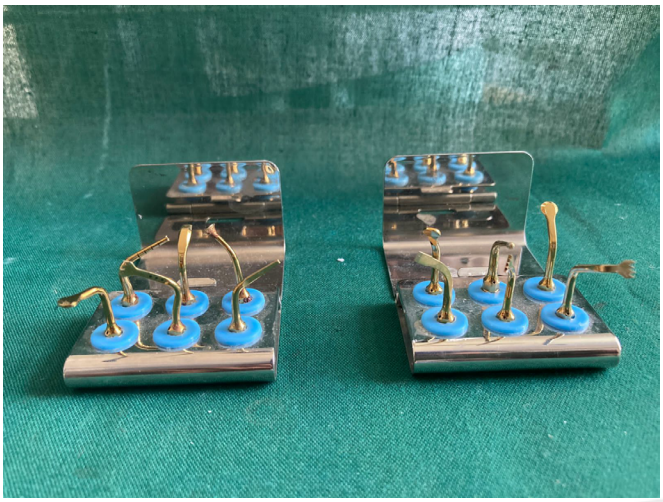

Fig 3 : Insert tips

BASED ON THE COLOR OF THE TIPS

- Gold- used to treat bone, golden color is obtained by plating titanium nitride to improve surface hardness.
- Steel – used to treat soft tissue

MORPHOLOGICAL FUNCTIONAL CLASSIFICATION

- Sharp insert tips – for osteotomy and osteoplasty where fine and well-defined cutting of bone is required.
- Smoothing insert tips – for precise and controlled cutting effect during osteotomy.
- Blunt insert tips – In periodontics, these insert tips are used for root planing.

CLINICAL CLASSIFICATION

- The clinical classification includes the inserts according to basic surgical technique
- Osteotomy - OT1-OT2-OT3-OT4-OT5-OT6-OT7-OT7S4-OT7S3-OT8R/L
- Osteoplasty-OP1-OP2-OP3-OP4-OP5-OP6-OP7-
- Implant site preparation –IM1-IM2A-IM2P OT4- IM3A-IM3P-
- Sinus lift –OP3-OT1-EL1-EL2-EL3-
- The inserts for basic osteotomy, osteoplasty, and extraction techniques are used in combination with each other for different surgical protocols

MECHANISM OF ACTION

When driving an electric current from a generator, piezoelectric ultrasonic frequency created over the piezoceramic rings results in deformation. In dentistry, ultrasonic frequency ranges from 24-36 kHz with the capability of cutting minimal tissues. so movement from the deformation of piezoceramic rings sets up a vibration in the transducer that creates ultrasonic output. These waves are transmitted to hand piece tips and inserts have resulted in longitudinal movements leading to cutting of bony tissues. Transducers in the piezoelectric element convert an electrical signal into mechanical vibration and mechanical vibrations into electrical signals. When an electric field is applied through the material like Quartz (SiO2) and Barium titanate (BaTiO3) will produce an electric field once the material changes dimensions as a result of mechanical force. This can be referred to as electrostriction [7].

When the water spray contacts the inserts "CAVITATION' occurs. Cavitation is that the micro boiling development occurs once solid and liquid interface to rupture of molecular cohesion in liquid and look of a zone of depression, crates and forms bubbles about to implode. In osteotomy procedure, this phenomenon maintains smart visibility within the field of operation by coolant as an aerosol and provides haemostasis. Cavitation shows antibacterial properties by fragmenting bacterial walls. For optimum use and most potency, the operators choose the accurate power based on site by applying minor pressure in the tips and manage the irrigation process by preventing overheating of tissue and decreases the possibility of injury to the soft tissues [8,9].

APPLICATION OF PIEZOELECTRIC DEVICE IN THE FIELD OF DENTISTRY

PERIODONTOLOGY

- Supragingival and subgingival scaling and root planing.
- Periodontal pocket lavage
- Crown lengthening
- Soft tissue debridement
- Resective surgeries
- Regenerative surgeries- to obtain autogenous graft for the treatment of periodontal intrabony defects.
- Implantology:
- For harvesting bone grafts
- Recipient site preparation for implant placement
- Osteotomy procedures
- Distraction osteogenesis
- Ridge expansion procedures
- Maxillary sinus elevation procedure [10].

SINUS FLOOR ELEVATION

The sinus floor elevation is commonly used to augment and enhance the insufficient maxillary posterior ridge for optimal implant placement. The piezoelectric device plays a vital key in sinus floor elevation. Piezosurgery decreases the chance of perforation and separation of schneiderian membrane, is much easier during lateral wall osteotomy [11].

RIDGE EXPANSION PROCEDURE

The ridge splitting technique is indicated when there is an

adequate height of bone and inadequate ridge thickness for the placement of implant placement. While using conventional techniques, it may take prolonged time for second-stage surgery for implant placement and also high risk of soft tissue injuries, but in case of Piezosurgery, gives us better visibility and control which prevents the damage to adjacent structures and risk of bone thermonecrosis [12,13].

BONE GRAFT HARVESTING

Piezosurgery is commonly used to harvest bone grafts (bone chips/bone blocks) from the mandibular ramus region. This device uses ultrasonic micro-vibration to create an osteotome with this micro-vibration, cutting off the selective bone is quite possible. In addition, surgical access to the deep oral cavities can be done more precisely using piezosurgery and also lowers the chance of damage to adjacent vital soft tissues structures such as nerves and vessels during bone graft harvesting [14].

IMPLANT SITE PREPARATION

Implant site healing and ultimate Osseo integration of implant are negatively influenced by the high temperature for rotary instrument created during the site preparation, but with the use of piezosurgery, although the trabecular bone and osteocytes were still intact and found implant stability is higher with piezosurgery [11].

DISTRACTION OSTEOGENESIS

Distraction osteogenesis is indicated when there is a need for a significant amount of bone augmentation or lengthening or when the soft tissue around the bone doesn't allow for osseous augmentation. Distraction osteogenesis with a piezoelectric device ensures the preservation of original bone structures which favours the healing process due to its high healing potential [2,15].

DISCUSSION

In the past decades, osteotomy and osteoplasty were the surgical treatment modalities for the treatment of periodontitis. Shortcomings of these procedures were, post-operative pain, infection, bleeding, etc. so in the era of modern dentistry, a promising technique has come into light which is referred to as "PIEZOSURGERY" also known as "PIEZOELECTRIC SURGERY". The piezoelectric effect is produced when there is electric tension on ceramic material such as Quartz that results in ultrasonic vibration. These vibrations are carried to vibrating tips and as a result cavitation is produced [16].

In 2018, Daniel Isaac et al, suggested that there is slight evidence that implant stability can be improved when osteotomy is performed with a piezoelectric device.

Vamsi lavu et al, in 2019, gave a case report which highlights the application of contemporary technology of piezosurgery for crown lengthening. the insert tips used in piezosurgery not only reduce the bone but also preserve the tooth's root surface integrity. Thus it is a viable option to improve the aesthetic appearance of the patient [16].

Cynthia et al in 2021 whose study showed that the majority of dental professionals had good awareness, knowledge, and attitude about piezosurgery and they understand the advantage of using piezo over other methods [17].

Recently, In 2022, Saurabh S Simre et al concluded about piezo guided corticotomy was effective in providing rapid Orthodontic Tooth Movement with a profound reduction in total treatment time and may be proposed as a suitable adjuvant to conventional corticotomy having comparable postoperative complications [18].

LIMITATIONS

The following are the common disadvantages of a piezoelectric device, dense bone cutting can take four times longer than with rotary, expensive, technique sensitive, frequent tip breakage, and tips get worn out more rapidly.

CONCLUSION

The piezoelectric technique offers advantages such as the minimal risk of injury to soft tissue, bloodless surgical field, comfort and precision to the surgeon, minimal post-operative pain, and fast healing. Even though it is precise it has quite a small limitation like increased operating time and technique sensitivity. With this scientific evidence, it is wise to conclude that Piezosurgery is truly an innovative osseous surgical technique in the field of dentistry when compared to traditional hard and soft tissue surgical method that uses manual and rotary instruments.

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Nil

CONFLICTS OF INTEREST

There are no conflicts of interest.

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