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Piezosurgery: A Boon in Oral and Maxillofacial Surgery – A Review

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Abstract

Piezosurgery is a recent innovative, minimally invasive procedure for hard tissue cutting procedures. It is been more in use recently. It was developed to perform atraumatic osteotomies by use of ultrasonic vibrations as an alternative to the conventional hand and motor driven instruments. Although it is a relatively newer alternative tool for hard tissue procedure but over past few years it has gained immense importance due to its multiple advantages and extensive applications. Applications of piezosurgery in oral and maxillofacial region ranges from dentoalveolar corrections to maxillary sinus procedures to orthognathic surgical procedures. Piezosurgery is also been in use in implantology. Advantages of piezosurgery over conventional instruments makes it a techinique of choice for hard tissue surgeries nowadays. With this the limitations in the hard tissue surgeries can be overcome. Overall piezosurgery allows operator to execute efficient procedure in areas where the risk of damage to soft tissue or adjacent structures like nerves, vessels, sinus etc is more. This review aims to describe the piezosurgery device in terms of its principles of working, effectiveness over conventional instruments, advantages, disadvantages as well as summarizes its applications in the field of oral and maxillofacial surgery.

Keywords: Bone, Maxillofacial surgery, Osteotomies, Piezosurgery, Ultrasonic vibrations.

Introduction

Oral and Maxillofacial Surgery often involves bone surgical procedure. It can be done with different instruments such as manual or motor driven. Since long time manual instruments such as osteotome, chisel and mallet, or gouge for hard tissues procedure has been used in oral and maxillofacial surgery. Nowadays, the most commonly used instrument for bone surgery include motor driven devices that either run on electrical energy or air pressure.[1] Manual bone cutting requires high forces thus may be damaging to adjacent structure. Motor driven leads to generation of heat during cutting and may cause thermal damage to tissue resulting in cell death and lack of regeneration potential in tissue. Drawbacks of using motor driven instruments for bone cutting also includes osteonecrosis due to overheating of bone, lack of fine tactile sensitivity, iatrogenic damage to surrounding tissues, increased risk of injury to soft tissue and other important structures like maxillary sinus, inferior alveolar

nerve etc., also operator may find difficulty in determining the cutting depth.[2] A new alternative to the conventional bone cutting is Piezoelectric bone surgery. It is a novel , promising ultra-sonic microvibration based technology for hard tissue procedures and spares adjacent tissues thus avoids damage to soft tissue.[3]. It is based on ultrasonic high frequency vibrations of metallic tip which cuts the bone selectively.[4] It was first proposed by Jean and Marie Curie in 1880. Process involves the deformation of crystals when exposed to electric current, which leads to oscillating movements along with ultra sound frequency that enables to cut bone structure precisely without causing injury to soft tissue.[5] Errikson stated that necrosis of bone occurs when temperature exceeds 47 degree for one minute.[6]This can be avoided with the use of piezosurgery device. Piezoelectric sound waves uses radiowaves by which the ultra sound tip vibrates and oscillates to cut the bone tissue. This techinique is based on inverse piezoelectric activity. Frequency of about 25-35 kilo hertz is required for cutting mineralized tissues whereas frequency of about 50 kilo hertz is required for incision of soft tissues.[7] Piezosurgery works on this principle. This techinique of bone cutting has now gained a wide application in oral and maxillofacial region.

Discussion

Using ultrasonic vibrations formed by the piezoelectric effect, the cutting of hard tissue was first described by Catuna in 1953.[8] Piezoelectric devices operates on the same principles as of piezoelectric dental scalers, but dental scalers are not efficient in cutting of hard tissues. The unusual feature of piezoelectric device is selective cutting. It cuts mineralized tissue but no the soft tissues such as vessels, mucosa and nerves. Piezosurgery have been more in use recently due to its property of minimal invasive surgery. This has been created with the aim to perform precise osteotomies with minimal damage to soft tissues, to avoid necrosis of bone and adjacent tissues and to provide proper control on instrument while in use. First model was developed by Vercellotti et al [9] These instrument consist of handheld handpiece, foot control and a base unit. The settings can be adjusted on base unit and the handpiece can be controlled by foot control. Depending on the use or type of procedure there are different varieties of insert shapes that can be screwed to the handpiece before use. The cutting efficiency of piezosurgery depends on the design of inserts , the degree of mineralization of bone the speed and pressure applied on handpiece while in use- a) design of insert: different inserts require different level of power [W] for efficient cutting, b) degree of mineralization: low mineralized tissue requires low frequency for cutting whereas highly mineralized tissue needs high frequency for cutting, c) the speed of piezosurgery instrument show be high as slow speed will lead to increase in temperature, d) pressure applied on handpiece: piezosurgery requires minimal pressure, according to Claire[10] excessive pressure while using piezosurgery device leads to reduced oscillation and ultimately reduces the cutting efficiency. In a case presented by Yaman et al [11], showed the advantage of piezosurgery in the protection of vital structure when the surgery is to be done in close approximation to the vital structure.

Clinical Application of Piezosurgery in Oral and Maxillofacial Surgery

- Dental procedures such as dental extractions, disimpaction, root resection procedure, alveolar distraction procedure, root planning etc.[12] Piezosurgery provides the advantage of meticulous preparation of small bone or tooth required in these procedure (use of piezosurgery prevents damage to nerve, canal, maxillary sinus etc.).+Preparation of bony window in sinus procedure, sinus floor lifting procedure, sinus grafting

procedure. Perforation of sinus membrane is mostly encountered in sinus grafting procedures which can be avoided with the use of piezosurgery.

- In enucleation of cyst: piezosurgery instruments helps in cautious handling of cystic lining and prevents tearing of epithelial walls [13].
- Resection of tumors.
- In lefort 1 , mandible saggital osteotomies, osteotomies in maxillary sinus etc. The use of piezosurgery has gained popularity in orthognathic surgery. According to the survey conducted by Landes et al[14] in 90 patients in which piezosurgery was performed, amount of blood decreased in case of Le fort 1 osteotomies when compared to conventional method.
- Lateralization of inferior alveolar nerve
- Mental nerve repositioning
- In implantology: implant socket preparation, recontouring of alveolar crest, alveolar ridge splitting. Piezosurgery has extensive application in this field. Piezosurgical site preparation provides selective enlargement of one socket wall and also provides with similar primary stability of implant as compared to conventional site preparation. Bone cutting efficiency is good because of enhanced vibrations, specially in soft type 4 bone.[15]
- Other uses include: craniofacial surgery, head and neck surgery, neurosurgery, reconstructive surgery,ophthalmology.

A study by Preti et al (2007), compared the osseous integration in perforated implant sites using piezo electric system instead of conventional instruments, showed increased osteoblast regeneration as compared to conventional and visible remodeling of bone within 2 months.

Advantages of Piezosurgery

- There is no thermal damage to tissues, there is no necrosis of bone.
- Adjacent soft tissue damage can be avoided using piezosurgery.
- Safe and precise hard tissue cutting.
- Enhanced patient comfort due to microvibrations.
- Faster healing of bone
- Less force required for cutting.
- Better surgical control.
- Excellent visibility of surgical site due to minimal bleeding.

Disadvantages of Piezosurgery

- Increased duration of surgery
- As compared to conventional method piezosurgery cost more.
- It is contraindicated in patients with pacemaker.
- There is a need for regular sharpening of inserts.

Conclusion

Piezosurgery is more significant and efficient system for bone cutting procedures as compared to the conventional methods. It is an innovative device in the field of oral and maxillofacial surgery providing multiple advantages over traditional mechanical or electrical instruments. Use of piezosurgery in oral surgical procedure assures the surgeon about minimal invasive selective bone cutting, safety, precision, preservation of surrounding structures during surgery, comfort to operator in terms of accessibility as well as comfort to patient along with faster healing of bone. This clinical as well as biological advantages of piezosurgery leads to improve bone healing, improve post operative results, thus making it effective tool in the field of oral and maxillofacial surgery.

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