**International Journal of Clinical Oral and Maxillofacial Surgery**
2015; 1(2): 11-16
Published online July 17, 2015 (http://www.sciencepublishinggroup.com/j/ijcoms)
doi: 10.11648/j.ijcoms.20150102.11



# Effect of Piezosurgical Bone Removal on Postoperative Sequelae of Impacted Mandibular Wisdom Extraction

**Shadia Abdel-Hameed Elsayed[1, *], Eman Seada[2], Nahed Adly[1], Fatma Ahmed Khalifa[2]**

[1]Oral & Maxillofacial Surgery Department, Faculty of Dental Medicine for Girls, Al Azhar University, Egypt
[2]Oral and Maxillofacial Surgery, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt

## Email address:
shadiaelsayed25@gmail.com (Sh. A. Elsayed)

## To cite this article:
Shadia Abdel-Hameed Elsayed, Eman Seada, Nahed Adly, Fatma Ahmed Khalifa. Effect of Piezosurgical Bone Removal on Postoperative Sequelae of Impacted Mandibular Wisdom Extraction. *International Journal of Clinical Oral and Maxillofacial Surgery*. Vol. 1, No. 2, 2015, pp. 11-16. doi: 10.11648/j.ijcoms.20150102.11

**Abstract:** Objectives: This study was conducted to evaluate the effect of piezosurgery device as a recent modality for bone removal of impacted lower eight in comparison to high speed hand piece regarding its effect on postoperative pain, trismus and oedema. Materials and methods: Fifty patients presenting with impacted mandibular third molars were selected from the out-patient clinic of the Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Al Azhar University girls' branch. All patients were followed up clinically at 1, 3, 5, 7, 15 days postoperatively. Histological examination of bone after ostectomy was performed. Results: The caliper measurements of oedema of group I (high speed) at day 1, 3 showed statistically significant higher mean measurements than group II (piezosurgery group). piezosurgery group showed statistically significant higher mean IID compared to high speed group at days 1, 3, 5. High speed group showed statistically significant higher mean VAS score than piezosurgery group at days 1, 3, 5, 7. High speed group showed statistically significant higher mean number of consumed analgesic tablets than piezosurgery group at days 1, 3, 5. Regarding histopathological examination, bone samples of piezosurgery were made up of well organized and well vascularized bone with lamellar architecture surrounding the haversian channels and with a linear and well formed osteotomy lines, while the bone samples from high speed group were badly cut with irregular osteotomy lines and with evidence of bone heat osteonecrosis. Conclusions: The results of this study suggest that piezosurgery should be a suitable modality of osteotomy during surgical removal of impacted lower third molar with less postoperative complications than the conventional method.

**Keywords:** Impacted Wisdom, Clinical Study, Piezosurgery, Histopathological Study

## 1. Introduction

Removal of impacted teeth is one of the most common operations in oral cavity. (1) One of the most critical steps in disimpaction is cutting the bone or osteotomy. Piezosurgery (piezoelectric bone surgery) is a promising, meticulous and soft tissue sparing system for bone cutting, based on ultrasonic microvibrations. It was developed by Italian oral surgeon Tomaso Vercellotti in 1988 to overcome the limits of traditional instrumentation (chisels or motor driven instruments, rotary bur and oscillating saw) in oral bone surgery by modifying and improving conventional ultrasound technology. (2) Piezosurgery unit is approximately three times as powerful as a conventional ultrasonic dental unit. The frequency of oscillations lies between 24-36 kHz with microvibrations of 60-200 µm/s which allowing it to cut highly mineralised cortical bone while soft tissue and nerve tissue remains unharmed. (3, 4, 5).

The philosophy behind the development of piezosurgery is based on two fundamental concepts in bone microsurgery. The first is minimally invasive surgery, which reduce the amount of postoperative pain and swelling as well as discomfort of the patient. The second concept is surgical predictability, ease in controlling the instrument during operation combined with reduce bleeding, precision of the cut and excellent tissue healing make it possible to optimize surgical results even in most complex anatomical cases (6, 7, 8).

Some experimental studies (9, 10, 11) were performed to evaluate histopathologically the effect of piezosurgery device & conventional bur on bone after osteotomy or drilling. Heinemann et al (9) observed that conventional bur represented irregular cutting surfaces of the damaged spongy trabeculae & disclosure of marrow spaces. Meanwhile, the defect which was created by piezosurgery device showed a funnel shaped opening with smooth cutting surfaces for about 5 mm in depth. There was no destruction of bony tissue along the defect bottom. The trabeculae along the lateral margins & the osteocytes were intact.

Moreover, Maurer et al, (10) reported that the area treated by bur lacked the lamellar texture & lacked normal pigmentation. Also; marginal osteonecrosis from over heating was recorded. They also found that the surface was irregular & covered with bone debris. But with using the piezosurgery device bone osteotomy showed vital osteocytes within harvested bone chips, which exhibited their typical morphology & differentiation. The rough surface was perfectly clean immediately & covered with fibrin. There were no direct or indirect signs of tissue destruction or cell damage on bone.

In addition, the experimental study done by See et al (11) used three output levels of oscillation of piezosurgery unit on the outer cortical bone of calvaria of rats. They proved that, the application of piezosurgery does not cause formation of vascular thrombi in the bone and it seems to improve cellular reactivity thus favoring the healing process of the traumatized tissues. (12, 13).

Therefore, this present study compares between the effect of using piezosurgery and high speed hand piece on surgical removal of impacted lower third molar by evaluating postoperative clinical results and histopathological examination of bone specimens collected at surgery.

# 2. Patients and Methods

Fifty patients 11 males and 39 females presenting with impacted mandibular third molars aged between 19 – 26 years, were selected from the out-patient clinic of the Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Al Azhar University girls' branch. The selected patients were free from any systemic diseases or pericoronitis. A written consent was obtained from each patient after explaining to him the nature of the planned surgical procedure.

Preoperative diagnosis was based on medical, dental history, clinical and radiographic examinations. Digital panorama or periapical x-ray films were done according to the tooth position and the anticipated degree of difficulty.

The patients were classified randomly into two equal groups. The patients of both groups were subjected to surgical removal of impacted lower third molar. Bone removal was performed by high speed handpiece in group I. meanwhile bone removal was done by piezosurgery device in group II. In both groups, bone specimens were examined histopathologically and postoperative clinical follow-up were carried out at 1, 3, 5, 7, 14 days.

Preoperative Clinical Record was done prior to administration of local anaesthesia and considered as the base line value.

- Measuring the maximal interincisal distance (IID): The mesio-incisal angle of the maxillary right central incisor was chosen as a reference point for measurement of IID. The opposing incisal edge of mandibular teeth in the midline when the mouth was opened widely was an opposing reference point. The caliper of the Boley gauge (Mitutoyo Vernier Caliper Mitutoyo MFG Co., LTD / Japan) was placed vertically against these reference points. It was measured during maximal opening of the mandible and within pain free limits.
- Measuring the thickness of cheek on the operating side was measured by means of a caliper done according to Alkhateeb et al. 2008 (14). One arm of the caliper was placed in the lingual embrasure between lower first and second mandibular molar while the other arm was adjusted tangentially to the skin of the cheek parallel to the occlusal plane, the distance between the two tips of the caliper arms was measured using a graduated tape.

## 2.1. Surgical Procedures

All patients received Augmantin 1gm (Amoxicillin 875mg + Clavulanic acid 125 mg medical union pharmaceuticals, Abu Sultan. Ismailia, Egypt.) Orally two hour before surgery. All surgical operations were done under local anaesthesia by the same surgeon. The duration of bone guttering and bone removal of the specimen was recorded in both groups. In Group I, surgical fissure bur was used through all the operation for bone guttering at buccal and distal aspect of impacted tooth and also for removal of a section of bone at the buccal aspect. Meanwhile the piezotome insert was used in Group II in which the bone guttering was performed at the buccal and distal aspect of the impacted tooth using flat osteoscalpel (EX1 insert). A section of bone was taken from the buccal aspect using bone osteotomy tip (OT7 insert) under copious saline solution for irrigation at room temperature to be examined histopathologically. The section of bone was 2-3 mm which was also needed to decrease the resistance during tooth removal. In both groups tooth division was performed when indicated by using surgical fissure bur.

## 2.2. Postoperative Clinical Evaluation

All cases were followed up for 1, 3, 5, 7 and 15 days post operatively to evaluate postoperative pain, edema, and mouth opening. Postoperative cheek thickness and IID was performed as in preoperative clinical record.

## 2.3. Pain Intensity was Recorded Using Two Methods

- Visual analogue scale (VAS) it consists of plan horizontal 10 mm long line, starting from "no pain" at one end represented as (0) point and the "worst pain" at the other end represented as (10) point then the patients were asked to mark each scale according to their pain.
- The number of analgesic tablets that consumed by patients in each follow up period.

### *2.4. Histopathologic Evaluation*

The bone samples were fixed by immersion in 4% buffered formaldehyde (Sörensen buffer) at room temperature for at least 3 days (15). This fixed specimen was suspending in 5% nitric acid and 25% Hydrochloric acid (HCL) for 8 to 10 days and the solution was changed daily until it becomes completely decalcified. Then it was washed in running water for 24 hours to remove the acids. The specimen was embedded in paraffin and cut at 4 microns thickness (16).

### *2.5. Statistical Analysis*

Data were presented as mean and standard deviation (SD) values. For parametric data; Student's t-test was used to compare between the two groups. For non-parametric data; Mann-Whitney U test was used to compare between the two groups. Friedman's test followed by Wilcoxon signed-rank test was used to study the changes by time within each group. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® (IBM Corporation, NY, USA) SPSS® (SPSS, Inc., an IBM Company) Statistics Version 20 for Windows.

## 3. Results

The mean duration for bone removal during guttering and for taking the specimen was 9 minutes for high speed and 11.3 minutes for piezosurgery. No incidence of infection, paraesthesia or altered of nerve sensation, alveolar ostitis was noticed for any patient in either group postoperatively.

### *3.1. Swelling Evaluation*

#### *3.1.1. Changes by Time of Caliper Measurements*

Upon comparison between the two groups, it was shown that, preoperatively, there was no statistically significant difference between the two groups. At day 1 and day 3, high speed group showed statistically significantly higher difference than piezosurgery group. At day 5, day 7 as well as day 15, there was no statistically significant difference between the two groups as shown in Table (1).

***Table 1.*** *Showed the mean, standard deviation (SD) values and results of Student's t-test representing changes by time of caliper measurements in the two groups.*

| P-value | Piezo surgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean | SD | Mean | Period |
| 0.575 | 0.22 | 4.11 | 0.29 | 4.19 | Preoperative |
| 0.027* | 0.26 | 4.71 | 0.31 | 5.06 | Day 1 |
| 0.037* | 0.32 | 4.36 | 0.35 | 4.75 | Day 3 |
| 0.082 | 0.24 | 4.18 | 0.36 | 4.46 | Day 5 |
| 0.128 | 0.23 | 4.10 | 0.29 | 4.31 | Day 7 |
| 0.467 | 0.23 | 4.10 | 0.30 | 4.20 | Day 15 |

**: Significant at $P \leq 0.05$*

#### *3.1.2. Percentage of Changes in Caliper Measurements*

The percentage change was calculated as:

((Measurements (Preoperative) – measurements (Postoperative) ÷ measurements (Preoperative)) x 100

Upon comparison between two groups it was shown that, at day 1, day 3 as well as day 5, high speed group showed statistically significantly higher mean % increase in caliper measurements than piezosurgery group. At day 7 as well as day 15, there was no statistically significant difference between the two groups as shown in table (2).

***Table 2.*** *The mean %, standard deviation (SD) values and results of Mann-Whitney U test for comparison between % changes in caliper measurements of the two groups*

| *P*-value | Piezosurgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean % | SD | Mean % | Period |
| <0.001* | 1.8 | 14.6 | 3.2 | 21 | Preoperative – day 1 |
| 0.005* | 2.6 | 6 | 5.1 | 13.5 | Preoperative – day 3 |
| 0.038* | 1.7 | 1.5 | 4.9 | 6.6 | Preoperative – day 5 |
| 0.065 | 0.9 | -0.3 | 3.6 | 3 | Preoperative – day 7 |
| 0.505 | 0.9 | -0.3 | 1.6 | 0.3 | Preoperative –day 15 |

**: Significant at $P \leq 0.05$*

### *3.2. Trismus Evaluation*

Measurements of maximum interincisal distance (IID)

In comparison between IID in the two groups, preoperatively, there was no statistically significant difference between IID in the two groups. At day 1, day 3 as well as day 5, piezosurgery group showed statistically significantly higher mean IID than high speed group. At day 7 as well as day 15, there was no statistically significant difference between IID in the two groups (Table 3).

***Table 3.*** *The mean, standard deviation (SD) values and results of Student's t-test representing change by time in IID in the two groups*

| P-value | Piezosurgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean | SD | Mean | Period |
| 0.790 | 0.09 | 4.05 | 0.09 | 4.04 | Preoperative |
| 0.034* | 0.27 | 3.01 | 0.26 | 2.70 | Day 1 |
| 0.015* | 0.31 | 3.40 | 0.29 | 2.99 | Day 3 |
| 0.029* | 0.19 | 3.90 | 0.37 | 3.54 | Day 5 |
| 0.101 | 0.09 | 4.04 | 0.22 | 3.89 | Day 7 |
| 0.790 | 0.09 | 4.05 | 0.09 | 4.04 | Day 15 |

**: Significant at $P \leq 0.05$*

***Table 4.*** *The mean %, standard deviation (SD) values and results of Mann-Whitney U test representing % changes in IID of the two groups.*

| P-value | Piezosurgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean % | SD | Mean % | Period |
| 0.021* | 5.8 | -25.7 | 6 | -33.2 | Preoperative – day 1 |
| 0.028* | 7 | -16.1 | 7.1 | -26 | Preoperative – day 3 |
| 0.028* | 4 | -3.7 | 8.9 | -12.4 | Preoperative – day 5 |
| 0.195 | 0.9 | -0.3 | 4.6 | -3.7 | Preoperative – day 7 |
| 1.000 | 0 | 0 | 0 | 0 | Preoperative –day 15 |

**: Significant at $P \leq 0.05$*

The percentage change was calculated as the previous calculation formula. At day 1, day 3 as well as day 5, High speed group showed statistically significantly higher mean % decrease in IID than piezosurgery group. At day 7 as well as day 15, there was no statistically significant difference between the two groups (Table 4).

### *3.3. Pain Evaluation*

Pain was evaluated by two methods: VAS and second method was number of consumed analgesic tables. Upon comparison between the two groups; at day 1, day 3, day 5 as well as day 7, high speed group showed statistically significantly higher mean VAS score than piezosurgery group. At day 15, there was no statistically significant difference between VAS scores in the two groups (Table 5).

***Table 5.*** *The mean, standard deviation (SD) values and results of Mann-Whitney U test representing changes by time of VAS scores in the two groups*

| *P*-value | Piezosurgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean | SD | Mean | Period |
| 0.001* | 0.7 | 3.6 | 2 | 7 | Day 1 |
| 0.002* | 0.9 | 2.3 | 2.1 | 5.4 | Day 3 |
| 0.007* | 0.8 | 1.1 | 2.1 | 3.9 | Day 5 |
| 0.021* | 0.5 | 0.4 | 1.6 | 2.1 | Day 7 |
| 0.105 | 0 | 0 | 1.2 | 1 | Day 15 |

*: *Significant at P ≤ 0.05*

Upon comparison between the two groups; at day 3, there was no statistically significant difference of % change in VAS. At day 5 as well as day 7, Piezosurgery group showed statistically significantly higher mean % decrease in VAS score than high speed group. At day 15, there was no statistically significant difference between the two groups (Table 6).

***Table 6.*** *The mean %, standard deviation (SD) values and results of Mann-Whitney U test representing % changes in VAS scores of the two groups*

| P-value | Piezosurgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean % | SD | Mean % | Period |
| 0.083 | 17.7 | -39.4 | 10.2 | -25 | Day 1 – day 3 |
| 0.038* | 19.8 | -71 | 18.3 | -47.8 | Day 1 – day 5 |
| 0.038* | 12.2 | -91.3 | 16.3 | -72.6 | Day 1 – day 7 |
| 0.105 | 0 | -100 | 13.6 | -88.5 | Day 1 – day 15 |

*: *Significant at P ≤ 0.05*

### *3.4. Number of Consumed analgesic Tablets*

***Table 7.*** *The mean, standard deviation (SD) values and results of Mann-Whitney U test represented changes by time of consumed analgesic tablets in the both groups*

| *P*-value | Piezo surgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean | SD | Mean | Period |
| <0.001* | 0.5 | 2 | 1.1 | 4.4 | Day 1 |
| 0.002* | 0.5 | 1.5 | 0.9 | 3.3 | Day 3 |
| 0.021* | 0.7 | 0.6 | 1 | 1.9 | Day 5 |
| 0.161 | 0.3 | 0.1 | 1 | 0.9 | Day 7 |
| 0.234 | 0 | 0 | 0.9 | 0.6 | Day 15 |

*: *Significant at P ≤ 0.05*

Upon comparison between two groups; at day 1, day 3 as well as day 5, high speed group showed statistically significantly higher mean number of consumed analgesic tablets than piezosurgery group. At day 7 as well as day 15, there was no statistically significant difference between numbers of tablets in the two groups (Table 7).

Through all follow up durations, Percentage of changes in number of consumed tablets showed no statistically significant difference between the two groups as shown in table (8).

***Table 8.*** *The mean %, standard deviation (SD) values and results of Mann-Whitney U test representing % changes in number of tablets of the two groups*

| P-value | Piezosurgery | | High speed | | Group |
|---|---|---|---|---|---|
| | SD | Mean % | SD | Mean % | Period |
| 0.878 | 25.1 | -22.9 | 14.5 | -25.2 | Day 1 – day 3 |
| 0.328 | 36.4 | -70.8 | 14.3 | -59.2 | Day 1 – day 5 |
| 0.328 | 17.7 | -93.8 | 18.9 | -83.3 | Day 1 – day 7 |
| 0.234 | 0 | -100 | 17 | -88.3 | Day 1 – day 15 |

*: *Significant at P ≤ 0.05*

### *3.5.Histopathologic Results*

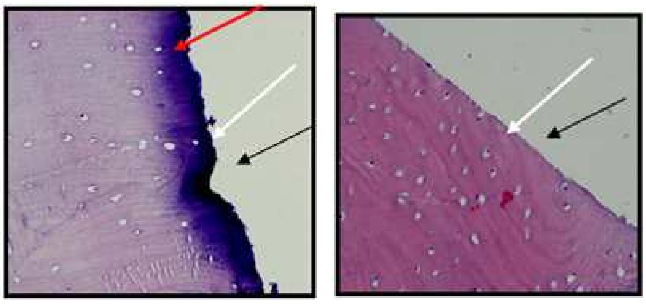
#### *3.5.1.High Speed Group*

The examined sections from the specimens (piece of cortical bone) showing irregular osteotomy lines with evidence of bone osteonecrosis and degenerated osteoblasts under the cutting surface. The lacunae are empty with foci showing dropped out cells about 1mm from the surface and absence of bone lamellar architecture (Fig.1).

***Figure 1.*** *Photograph showing osteotomy cuts in high speed group above and piezosurgery group below.*

***3.5.2. Piezosurgery Group***

Sections examined from the specimens showing smooth cutting surface at osteotomy lines including well organized and vascularised bone with a lamellar architecture surrounding the haversian channels. The lacunae showed viable osteoblasts without significant degeneration (Fig.2 A, B).



A B

***Figure 2.*** *(A): Bone specimen (haematoxylin-eosin staining) harvested with the high speed hand piece showed: irregular cutting surface (black arrow) and degeneration osteoblast 21mm thick under the surface (white arrow). Empty lacunae (red arrow). (B) Bone specimen (haematoxylin-eosin staining) harvested with piezosurgery device showed: smooth cutting surface (black arrow) and no degeneration the lacunae showed viable osteoblast without significant degeneration (white arrow).*

# 4. Discussion

Removal of impacted wisdom is a common surgical procedure in oral cavity. It may be associated with risk of injury of the adjacent tooth or neurovascular structures. Piezosurgery is a new osteotomy surgical tool using the microvibrations of scalpels at ultrasonic frequency to perform safe and effective cut.(4) It seems to be ideal for complex surgical sites where soft and important structure are very close to the osteotomy lines and this is due to its selective cut which work only on mineralized structure.(5)

The time needed for guttering and removal of the bony specimen using piezosurgery was slightly different from the high speed group in the present study. This may be regarded to the cavitation phenomena which provides bloodless surgical site, clear visibility that allow faster working. This is not in accordance with Sivolella et al. 2011(17) who suggested that, piezosurgery osteotomy took longer time than the rotary method.

In the present study, statistical analysis of postoperative clinical finding showed that, piezosurgery group represented less sign and symptoms of early postoperative pain and swelling and trismus. These clinical results evaluated through VAS measurements of pain which was significantly higher in high speed group than the piezosurgery group on the early postoperative days. Also, the number of analgesic tablets consumed was significantly higher in high speed group than the piezosurgery group. These findings could be attributed to the absence of intraoperative soft tissue trauma due to piezosurgery selective cutting property. As well as it is less traumatic to bone due to the absence of the typical macrovibration of the bur which increase the surface area of bone removal, this may cause an undesirable intraoperative pressure which result in increasing temperature that may produce more trauma and this results was in agreement with Rullo et al. 2013(18) and Goyal et al. 2011(19).

In addition, the evaluation of postoperative swelling of piezosurgery group was significantly lower than the high speed group on postoperative days 1,3 and there was no significant difference between the two groups on postoperative days 5,7,15. This was resembles to results of Goyal et al. 2011(19). According to the correlation between swelling and trismus, the IID measurments in the present study were significant higher in piezosurgery group on days 1, 3, 5 in comparison to the high speed group. Indeed, all these results may be due to the absence of the two main contributing factors in the formation of postoperative swelling which are trauma and infection. Furthermore, Piezosurgery is not only less traumatic to tissues but it has a disinfecting action by providing shock waves as a result of cavitation phenomena in the coolant irrigating fluid which assist in reducing the levels of bacteria (12,20).

In the present study, histopathological evaluation of piezosurgery samples of bone represented well organized and well vascularized bone with lamellar and architecture surrounding the haversian channels and with a linear and well formed osteotomy lines. This goes in agreement with the finding of Robiony et al. 2004 (6) who made experimental studies on piezosurgical bone osteotomy which shows vital osteocytes within harvested bone chips, exhibited their typical morphology and differentiation. In addition, Goyal et al. 2011 (19)who suggested that the piezosurgery delivers a micrometric cut involving minimal surface area that may be one of the factor that contribute to good result obtained. Meanwhile, the histopathological evaluation of bone sample in rotary group was badly cut with irregular osteotomy lines and with evidence of marginal osteonecrosis. This finding is in accordance with that of Heinemann et al (9), Maurer et al (21) and these histological differences observed between the two groups explained their influences on vitality of bone structures and confirm the clinical finding of our study. Moreover, piezosurgery cause less damage at the structural and cellular level when compared with the rotary bur. This finding was emphasized by Berengo et al. 2006 (22) and Maurer et al. 2007(10) who proposed that, piezosurgery does not produce direct or indirect signs of tissue destruction or cell damage of bone.

Moreover, the favorable clinical and histological findings obtained from the present study in piezosurgery group may be due to that piezosurgery preserve bone structures which may improve cellular reactivity and induce an earlier increase in neoosteogenesis. This result could be explained by the cavitation effect that allows a cooling effect which avoid significant hyperthermia and coagulation damage in the surrounded area and does not cause formation of vascular thrombi in the bone as emphasized by See et al. (11), Vercelloti et al. 2005(23) and Blus et al. 2006(24).

## References


[1] Renton T, Smeeton N, Mc Gurk M: Factors predictive of difficulty of mandibular third molar surgery. Br Dent J. 2001; 190: 607.

[2] Pavlikova G, Folta'n R, Horka M, Hanzelka T, Brunska H, S'edy J: Piezosurgery in oral and maxillofacial surgery. Int J Oral Maxillofac Surg. 2011; 40: 451.

[3] Stubinger S, Kuttenberger J, Filippi, Sader R, Zeihofer HF: Intraoral piezosurgery: Preliminary results of a new technique. J oral Maxillofac Surg. 2005;63 (9): 1283.

[4] Vercellotti T, De paoli S, Nevins M : The piezoelectric bony window osteotomy and sinus membrane elevation: introduction of a new technique for simplification of the sinus augmentation procedure. Int J Periodontics Restorative Dent. 2001; 21:561.

[5] Cristalli PM, Monaca LG, Sgaramella N, Vozza J: Ultrasonic bone surgery in the treatment of impacted lower third molar associated to complex exodontoma: A case report. Ann Stomatol (Roma). 2012; 3:64.

[6] Robiony M, Polini F, Costa F, Vercellotti T, Politi N: Piezoelectric bone cutting in multipiece maxillary osteotomies. J Oral Maxillofac Surg. 2004; 62:759.

[7] Sivolella S, Berengo M, Scarin M, Mella F, Martinelli F: Autogenous particulate bone collected with a piezo-electric surgical device and bone trap: a microbiological and histomorphometric study. Achieves of oral Biology. 2006; 51: 883.

[8] Vercellotti T: Technological characteristic and clinical indication of piezoelectric bone surgery. Minerava Stonatol. 2004; 53(5): 207.

[9] Heinemann F, Hasan I, Keil C K, Gotz W, Gedrange T, Spassov A, Schweppe J and Gredes T: Experimental and histological investigations of the bone using two different oscillating osteotomy techniques compared with conventional rotary osteotomy. Annals of Anatomy. 2012;194: 165.

[10] Maurer P, Kriwalsky MS, Block versa R, Brandt J, Heissc: Light micrscopic examination of rabbit skulls following conventional and piezsurgery osteotomy. Bio Med Tech. 2007;52: 351.

[11] See CV, Gellrich NC, Rucker M, Kokemuller H, Kober H and Stover E: Investigation of perfusion in osseous vessels in close vicinity to piezoelectric bone cutting. Brit J Maxillofac Sur. 2012; 50: 251.

[12] Vercellotti T: Essentials in Piezosurgery clinical advantages in dentistry. London, Paris and Warsaw by Quintessenza Edizioni; 2009.

[13] Wallace SS, Froum SJ: Effect of maxillary sinus augmentation on the survival of endosseous dental implants, a systemic review. Ann periodontal. 2003; 8: 328.

[14] AlKhateeb TH, Nusair Y: Effect of the proteolitic enzyme serrapeptase on swelling, pain and trismus after surgical extraction of mandibular third molars. Int J Oral Maxillofac Surg. 2008; 37: 264.

[15] Gedrange T, Mai R, Mack F, Zietek M, Borsos G, Spassov A, Gredes T: Evaluation of sharp and size changes of bone and remodeled bone substitute after different fixation methods. J Physiol Pharmacol 2008;59:87.

[16] Frentzen M, Gotz W, Lvanenko M, Atilar S, Werner M, Fiering P: Osteotomy with 80 microns Co2 laser pulses - histological results. Lasers Med Sci. 2003; 18: 119.

[17] Sivolella S, Berengo M, Bessan E, Di Fiore A, Stellini E. Osteotomy of lower third molar germectomy: randomized prospective crossover clinical study comparing piezosurgery and conventional rotary osteotomy. J Oral Maxillofac Surg. 2011; 69 (6):e15.

[18] Rullo R, Addabbo F, Papaccio G, DAquino R, Festa MV: Piezoelectric device vs. conventional rotative instruments in impacted third molar surgery: Relationships between surgical difficulty and post operative pain with histological evaluations. J Craino Maxillofac Surg. 2013; 41: 33e.

[19] Goyal M, Marya K, Jhamb A, Chawala S, Sonoo RP, Singh V, Aggarwal A: Comparative evaluation of surgical outcome after removal of impacted mandibular third molars using a piezotome or a conventional hand piece: a prospective study. Br J Oral Maxillofac Surg. 2011;10: 1016.

[20] Walsh LJ: Piezosurgery: an increasing role in dental hard tissue surgery. Austral Dent Pract. 2007; 9: 52.

[21] Maurer P, Kriwalsky MS, Block versa R, Brandt J, Heissc: Light micrscopic examination of rabbit skulls following conventional and piezsurgery osteotomy. Bio Med Tech. 2007;52: 351.

[22] Berengo M, Bacci C, Sartori M, Perini A, Della Barbera M, Valente M: Histomorphometric evaluation of bone grafts harvested by different methods. Minerva Stomatol. 2006;55: 189.

[23] Vercelloti T, Kim DM, Wada K, Fiorellini JP: Osseous response following respective therapy with piezosurgery. Int J Periodontics Restorative Dent. 2005;25(6): 543.

[24] Blus C, Moncler SS: Split crest and immediate implant placement with ultrasonic bone surgery: A 3 years life table analysis with 230 treated sites. Clin Oral Implants Res. 2006;17(6): 700.