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Alveolar repair after the use of piezosurgery in the removal of lower third molars: a prospective clinical, randomised, double-blind, split-mouth study

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Abstract

The objective of this study was to evaluate the use of piezosurgery for osteotomy and odontosection in the repair of the alveoli four months after exodontia. Fifteen young patients who needed third molars extracted were included. During the extractions, one of the teeth was included in the Piezo group, in which ultrasound motor tips were used in both procedures. The other tooth was removed with a conventional rotary instrument. The values of density of the repair regions of the right and left third molars were compared using digital panoramic radiographs. There were no significant differences ($p > 0.05$): piezo group mean (SD) 125.7 (15.4) and control group 126.7 (21.2). The bone density of the alveoli after extraction of the lower third molars with rotary instruments and surgical ultrasound was similar in both groups.

Keywords: Bone Density; exodontia; Osteotomy; Piezosurgery; Third Molar

Introduction

The extraction of third molars is one of the most common procedures done by oral and maxillofacial surgeons.[1] After exodontia, the healing process of the remaining alveolus can be divided into three phases: inflammatory, proliferative, and modelling or remodelling.[2] The inflammatory phase lasts two to three days, and consists of the formation of clots and the migration of inflammatory cells.[2] The proliferative phase is related to fibroplasia and the formation of bone, the latter of which can be identified radiographically two weeks after extraction.[2,3] The last phase, modelling and remodelling, results in qualitative and quantitative changes in the edentulous site that lead to a reduction in the size of the alveolar ridge.[2–4]

The alveolar cavity closes between 10 and 20 weeks after extraction,[5,6] and the complete filling of the cavity with bone is radiographically visible between three and six months.[7] The remodelling process can continue until a year after extraction.[7,8] The healing rate of the dental alveolus is influenced by individual biological differences, alveolar size, and the extent of trauma during the extraction.[2]

Traditionally, rotating instruments have been used for operating on bones. However, they have drawbacks, such as the overheating or fragmentation of bone, formation of a smear layer during osteotomy, and damage to adjacent tissues.[9–11]

Piezosurgery is a selective micrometric technique that uses a defined ultrasound frequency (ranging from 24 to 32 kHz) to cut the bone.[12] The advantages of using it to extract third molars are the lower risks of postoperative pain, trismus, oedema, and neurological complications.[13–16] It has also

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been shown to cause less stress on the bones by evaluation of the expression of heat shock protein 70 (Hsp70).[17]

Results of animal studies suggest that piezosurgery promotes better bony healing after osteotomy than rotating instruments,[9,18,19] and its main disadvantages are the increases in operating time and cost.[13–15,20]

Because of the limited number of studies about the process of bony healing after third molar extraction using piezosurgery,[21] our objective was to evaluate the density of the healing bone. We used panoramic radiographs of patients who had had lower third molars extracted using rotary instruments and piezosurgical ultrasound.

Material and methods

This study was approved by the Research Ethics Committee of the Faculty of Dentistry of Araçatuba – Unesp (CAAE number 48607015.6.0000.5420). All patients signed consent forms to authorise the study and the publication of the results, which was in line with the medical and ethics protocols of the Helsinki Declaration, 2013.[22]

Study design

The study comprised 15 patients between the ages of 18 and 30 years, with impacted or semi-impacted right and left mandibular third molars that required osteotomy and odontectomy. Both teeth in each patient were of a similar level of surgical difficulty (assessed using panoramic radiographs). We decided that the third molars should be buried or partially buried in mandibular bone below the occlusal plane of the second molar, or mesioangular that had a mesially leaned-in relation to the second molar axis according Pell and Gregory's classification (1937).[23]

Patients were excluded from the study if they were smokers, had periodontal disease or non-compensated systemic disease, or were using medications.[24]

To find out whether there was a difference between the piezo and control groups the sample sizes were calculated using the website http:www.lee.dante.br.[25] The data used were extracted from the previous study[14] (SD = 0.23; difference between the means 0.35). For a power of 80% and level of significance 5%, it would be necessary to use five samples/group. To guarantee greater homogeneity, 15 patients with two sites /patient were chosen, giving a split-mouth analysis.

The teeth were removed during two operations for each patient, with an interval of at least 15 days between. The same surgeon operated on both occasions.

For each patient, one tooth was included in the conventional group (control) and the other in the piezo group (osteotomy and odontectomy with surgical ultrasound) (n = 15 in each). The selection was randomised, and both evaluator and patient were unaware of the technique used. The allocation was obtained from sealed envelopes that contained the randomised instruction. During the procedures, a third research worker randomised the instrument for the osteotomy and odontectomy, according to the allocated group. The second operation followed the result of the first randomisation.

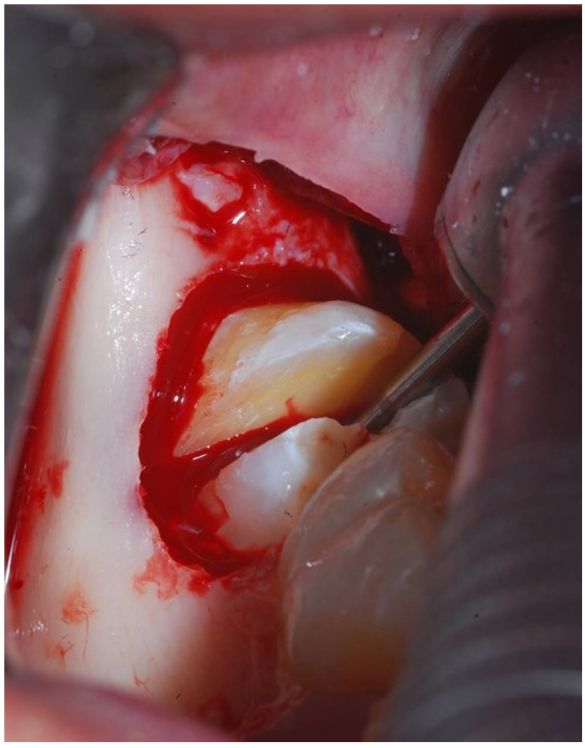


Fig. 1. Control group. Osteotomy and dental section done with the drill in high rotation.

The patients were evaluated four months after operation by a surgeon not concerned with the operation.[19]

Operation

After intraoral and extraoral antisepsis, the patients were anaesthetised using the inferior alveolar, lingual, and buccal nerve-block technique with 2% mepivacaine and 1:100.000 adrenaline (Mepiadre Nova DFL®).

For the control group, the procedure consisted of an Avellanal incision (linear incision in the distal region of the second molar, an intrasulcular incision in the buccal region of the second molar, and an oblique relaxing incision in the mesiobuccal region of the second molar), detachment with a Molt periosteal elevator No. 9 (Quinelato®) (Fig. 1), osteotomy and odontectomy with a surgical burr 702 (KG Sorensen®) at high speed (KaVo Dental) under constant irrigation with saline solution (Fig. 1).

In the Piezo group, the osteotomy and odontectomy were carried out with surgical ultrasound (Piezosonic Driller®, Carapicuíba). The osteotomy was done in a rectangular shape using the ES007R and ES007L tips (Fig. 2) with the objective of partial removal of the buccal bone cortex. The bone block was excised.[9,19] The odontectomy was carried out with the

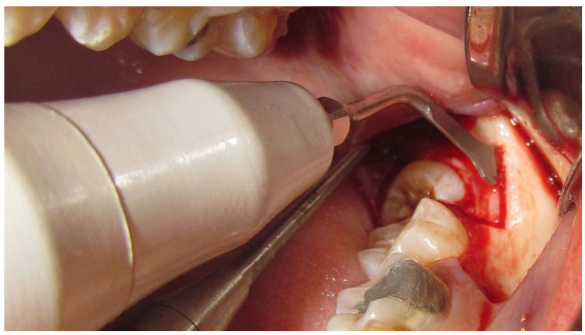


Fig. 2. Piezo group. Use of surgical ultrasound in lower third molar surgery.

ES009 tip. The other steps of the extraction were similar to those in the control group (Fig. 2).

The teeth were removed with the aid of dental extractors and the wound sutured with 4/0 interrupted silk (Ethicon®).

All patients were prescribed amoxicillin 500 mg orally every eight hours for five days, non-steroidal anti-inflammatory nimesulide 100 mg every 12 hours for three days, sodium dipyrone 500 mg every six hours, and 0.12 % chlorhexidine digluconate mouthwash twice daily for seven days.

The suture was removed seven days postoperatively, and at four months postoperatively each patient had a digital panoramic radiograph.

Obtaining and analysing images

All digital panoramic radiographs were obtained by the same radiology technician. A panoramic PaX-i™ device (Vatech Technology Ltd) was used at standardised image settings and exposure times, and all images were stored in JPEG format.

The images were analysed using the Image Tool 3.0 software (UTHSCSA). The area of repair of the alveolar bone of the right and left third molar were individually selected using a square, 1 cm^2 in size, selection template (Fig. 3). In the sequence, the images were analysed by considering the grey levels (pixel values). The pixel intensity, expressed as PI, is a measure of density, ranging from zero (black) to 255 (white). For each measure, the histogram tool was selected to provide the mean density of each region (Figs. 4 and 5).

Based on density data obtained on histogram, the control and piezo groups were compared by statistical analysis.[26,27]

Bone density values of the repair region of left and right third molars were compared.

Statistical analysis

Data were tabulated and compared statistically using the SigmaPlot™ 14.0 statistical software (SigmaPlot Exact Graphs and Data Analysis). Shapiro-Wilk normality test showed the homogeneity of data ($p > 0.05$). A paired *t* test was used to compare the significance of the differences between groups. For all tests, probabilities of less than 0.05 were considered significant.

Table 1
Bone density of control and piezo groups.

Mean (SD) bone density (pixel)		
Participant	Piezo	Control
1	99 (19.4)	125 (20.8)
2	108 (13.1)	143 (9.6)
3	139 (25.5)	161 (17.6)
4	124 (12.1)	84 (13.8)
5	143 (14.8)	149 (18.1)
6	113 (11.8)	111 (12.1)
7	136 (23.5)	115 (15.4)
8	143 (28.5)	113 (26.6)
9	124 (17.2)	131 (10.1)
10	151 (19.7)	123 (13.1)
11	119 (22.7)	150 (29.6)
12	139 (29.2)	98 (21.7)
13	112 (15.7)	129 (16.5)
14	112 (28.8)	147 (30.3)
15	123 (11.2)	130 (21.5)

Results

The mean bone densities obtained are shown in Table 1 (density values that were obtained in selected alveolar areas on panoramic radiographs).

There was no significant difference between the groups ($p = 0.883$). Ultrasound of the extraction sites of third molars showed a mean (SD) bone density of 125.7 (15.4) PI and the surgical sites in which the teeth were removed by the conventional technique a mean of 126.7 (21.2).

There were no complications postoperatively, and the surgical sites healed without complications such as infection, haemorrhage or dehiscence of the sutures. Trismus and oedema were no more than would be expected.

Discussion

Currently, there is much concern regarding the process of alveolar repair because the quantity and quality of bone are paramount.

Alveolar repair is completed by the formation and maturation of bony trabecula within the alveolus.[1,3] The chronology of this formation can be influenced by several factors inherent in the patient and the surgical technique used.[3,5] It has been suggested that the less traumatic the surgical technique, the better the quality of alveolar bone.[4,7] We chose the sites of the lower third molars for this study because these teeth are often selected for excision for different reasons and therefore enabled the use of a control and study group in the same patient under similar conditions, which is rare with erupted teeth. The choice of four months of observation was justified by the fact that alveolar repair is already complete and the

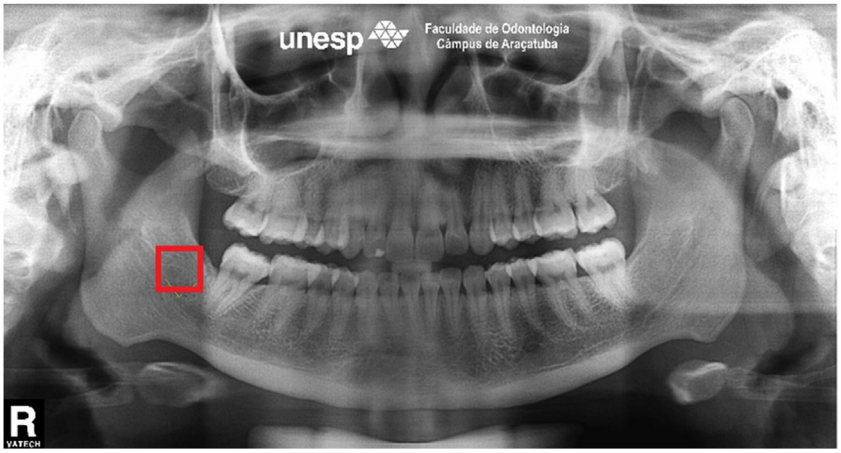


Fig. 3. Selected area (in red) on a panoramic radiograph corresponding to the alveolar repair area on the right side.

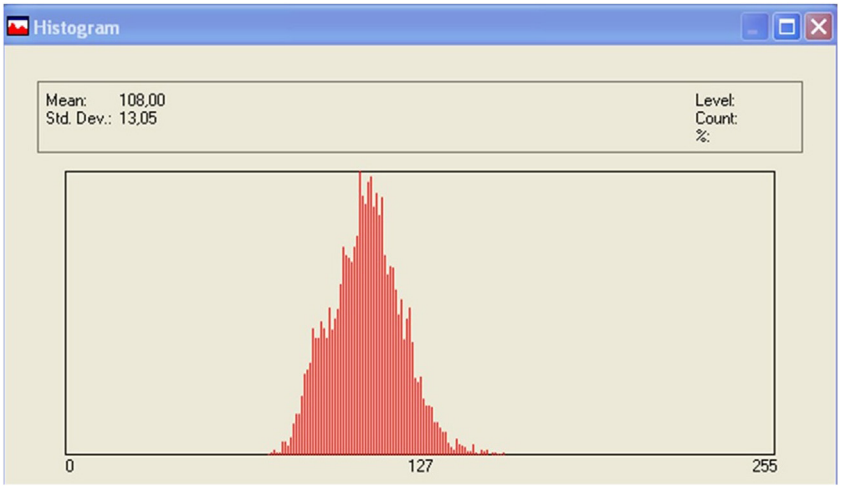
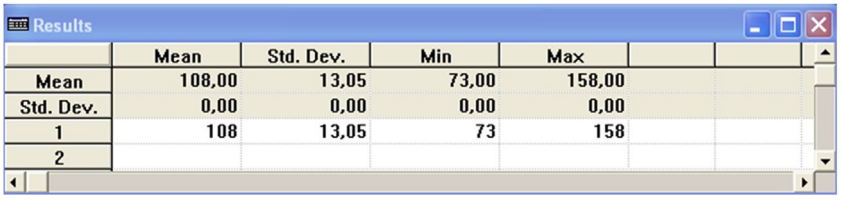


Fig. 4. Histogram generated from the selected area.



	Mean	Std. Dev.	Min	Max
Mean	108,00	13,05	73,00	158,00
Std. Dev.	0,00	0,00	0,00	0,00
1	108	13,05	73	158
2				

Fig. 5. Screen-shot of table with the mean (SD) of the selected area.

trabecular bone is mature. In the event of a delay in repair, the mineral bone density of these sites would be different between the groups. Ideally, this tissue would be analysed using a biopsy and histological analysis, but this would not be ethical.

We followed a technique already published,[26,27] in which postoperative radiographs, with periods ranging from three to six months, were used to evaluate the healing of surgical sites after the extraction of mandibular third molars. The study by Schropp et al[7] evaluated the alveolar healing of maxillary and mandibular molars and premolars using intraoral radiographs for 12 months after extraction. They noted that the formation of bone in the surgical site and loss of height of the alveolar bone crest occurred simultaneously during the first three months. The amount of bone lost was also almost unchanged from three to 12 months. We think, therefore, that the four-month postoperative period is ideal for observing alveolar repair (Tables 2 and 3).

Our study is a prospective, double-blind and split-mouth study, which reflects results that are reliable as the control and the test regimens were used in the same patients. This reduces the chances of individual differences in healing. In addition, in the current review of publications, we found only one study that evaluated the healing of the dental alveolus after the

Table 2
Bone density of control and piezo groups.

Mean bone density (pixel)		
Participant	Piezo	Control
1	99	125
2	108	143
3	139	161
4	124	84
5	143	149
6	113	111
7	136	115
8	143	113
9	124	131
10	151	123
11	119	150
12	139	98
13	112	129
14	112	147
15	123	130

Table 3
Mean and standard deviation bone density of Control and Piezo groups.

Group name	No.	Mean	SD
Piezo	15	125.67	15.40
Control	15	126.67	21.17

extraction of third molars with piezosurgery. Unfortunately, one of the limitations of this study is the use of panoramic radiographs for the evaluations, because the image presents some degree of magnification. However, because the objective of the study was to compare sites in the same patient, using the same equipment and protocol for acquisition of images, so this limitation does not affect the reliability of the results found.

Another limitation was that the postoperative evaluation was done only after four months, and it might have been interesting if a radiograph had been taken during the first week postoperatively. These data could be useful in evaluating if piezosurgery favours alveolar repair for this procedure at an earlier time. The present study, however, fulfilled our objective of evaluating whether or not there was a difference in bone density on the radiographs of the alveolus after extraction of lower third molars using two different techniques.

The use of conventional high-speed devices for ostectomy and odontosection generates great heat in the bony tissue, and delays alveolar repair. Conversely, piezosurgery[25] is an alternative which causes less thermal damage to the tissue. However, its use increases the operating time of ostectomy and odontosection and costs more for equipment and maintenance.

The postoperative short-term effects of third molar extractions done with piezosurgery compared with conventional rotating instruments include less oedema, pain, and trismus.[12–16]

However, prospective studies of these patients and evaluation of the quality of newly-formed bone tissue need to be investigated.

Panoramic radiographs showed that there were no significant differences in bone density. Anesi et al,[9] Reside et al,[19] and Rullo et al[20] found early bone repair after osteotomy was quicker when a piezoelectric device was used than with a conventional rotary instrument. Protein expression was also more advantageous to the bony tissue after extraction with the piezo technique.[17]

However, Horton et al[18] in a three to 90 days' histological analysis in dogs showed bony damage after the use of surgical ultrasound, chisel and hammer, and rotating instruments. The use of piezosurgery resulted in bony damage that was similar to that of the chisel and hammer. The chisel and hammer would be the best option for completing osteotomies in exodontia, but it causes greater discomfort for the patient. Piezosurgery is an important alternative that is associated with less tissue damage, and is more comfortable for the patient than rotating instruments and a chisel.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

This study was approved by the Research Ethics Committee of the Faculty of Dentistry of Araçatuba - Unesp (CAAE number 48607015.6.0000.5420). Patients' permission was obtained.

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