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Piezosurgery versus conventional saw in mandibular genioplasty: A comparative study

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Aim: This study aimed to compare piezosurgery and conventional saw osteotomy and evaluate the impact of the two surgical tools on operation time, intraoperative bleeding, postoperative edema & Coagulative bone necrosis in genioplasty.

Materials and Methods: Ten patients undergoing genioplasty were divided into two groups. In Group A (n=5), piezosurgery was used for osteotomy on the right side, and a conventional saw on the left. In Group B (n=5), the osteotomy tools were reversed. All parameters were assessed and compared between the two techniques.

Results: The operation time was longer with piezosurgery compared to the conventional saw. Regarding blood loss and Coagulative bone necrosis the Saw group demonstrated higher than piezosurgery. However, there was no significant difference in the amount of postoperative edema between the two techniques

Conclusion: While piezoelectric surgery offers advantages in bone healing, reduced blood loss, and decreased bone necrosis in mandibular orthognathic procedures, it is associated with longer operative times and does not significantly reduce postoperative edema compared to conventional saw techniques.

Keywords: Genioplasty, Orthognathic, Peizosurgery, piezoelectric osteotomy, surgical saw

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Introduction

Since the eighteenth century, correction of dentaofacial deformities has markedly evolved. Excessive protrusive or retrusive chin can be surgically corrected; the main surgical goals include improvement of the dentofacial harmony to enhance function and appearance.[1:4]

Among various Orthognathic surgeries genioplasty; a technique commonly used to correct maxillofacial deformities which involves cutting the bone to permit chin movement in three dimensions and positioning it in its new chosen position to restore chin harmony and balance with the face. However it does not go without some side effects like intra-operative blood loss, hematoma, pain, swelling, paraesthesia, marginal bone necrosis and impaired bony regeneration which occurs due to excessive heating caused by the use of rotary instruments.[5:8]

Over the past years, the field of Oral and maxillofacial surgery has undergone a lot of evolution in the surgical armamentarium used for bone cutting which offer surgeons the option of performing a minimally invasive surgeries. The success of maxillofacial surgical osteotomy techniques depends on the tools used. Therefore post-outcome determined by the amount and quality of any hard tissue removal. Which play important role in lowering morbidity and lesser discomfort to the patients.[9-10] Hand cutting instruments, micro motor rotary instruments and bone saw generate heat as well as apply a significant pressure during bone cutting and require a copious irrigation.[11] Thus any alteration in temperature cause injuries to cells and bone necrosis.[10] Thereby theoretically lowering temperature reducing damage to healthy tissue and lowering pain.

Also manual or mechanical instruments used in the close proximity to the neurovascular structures do not allow for control of the cutting depth and possibly cause accidentally damage to these delicate structures. With scientific evolution researchers looked towards the most advanced and safest device for bone cutting and use the principle of piezoelectric osteotomy in order to overcome such limitations of manual and traditional mechanical tools.

Vercellotti in 2004 was first one introduce the new and safer procedure for sinus lifts,[9] Then its use was applied in other surgical purposes including : rhinoplasty, neurosurgery, orthopedic surgery, plastic and reconstructive surgery or in maxillofacial surgery as nerve lateralization, tooth extractions, alveolar ridge expansions, harvesting bone graft,[11:14] temporomandibular joint ankylosis, distraction osteogenesis and orthognathic surgery,[14:16]as its precise and selective cut on the bone without damaging the adjacent soft tissues and neurovascular structures.[10:15]
The aim of this study was to perform a split mouth prospective clinical study to compare between piezoelectric surgical device and traditional saw used in Orthognathic surgery.

Material and methods

Study power analysis

Based on a previous study by Abdullah et al., 2022, the mean blood loss for the Piezotome group was 152.9 ±18.5, and for the saw group was 27.3± 72.6 To detect the difference in means between groups with a power of 80% and a level of significance of 5% with an effect size of 1.4, a total sample size of 20 participants was needed i.e. 10 participants in each group. The sample size was calculated by G*Power (version 3.1.9.2; Germany).

The study was conducted on ten patients who suffering from chin asymmetry and had been referred to the department of oral and maxillofacial surgery at Minia University Dental Hospital (MUDH) to undergoing a chin augmentation from December 2021 to

December 2022. Surgical treatment planning based on clinical examination, cast and cephalometric analysis. Any history of previous Orthognathic surgery, maxillofacial trauma or reconstructive facial surgery was considered exclusion criteria.

Informed consent was taken for each patient who agreed to participate in the study, explaining all the treatment details for each patient. The consent was approved according to the standard consent of ethical committee - faculty of dentistry – Minia University decision No. 546 of Committee No.84 at 2021

The patients were randomly divided into two equal groups: group A: The bone was cut on the right side using a piezoelectric device, and the left side was treated with a conventional reciprocating saw. While in group B: The bone was cut on the right side using a conventional reciprocating saw, and the left side was treated with a piezoelectric device and we performed a comparative analysis between intraoperative and postoperative outcomes of both devices in both groups.

According to Miles and leach the genioplasty technique is performed transorally under general anesthesia by the same maxillofacial surgeon.[8-17] Local anesthesia with epinephrine injection was given prior to the incision accomplished 3:4 mm below the mucogingival junction to preserve enough tissue for closure from the mandibular left to the right canine. Then dissection proceeds to expose the mental foramina and the neurovascular bundles bilaterally, which must be identified and preserved (Fig1).

The osteotomy design and angulation vary according to the anatomy and the desired movement for each patient. After the correct positioning of the reference lines the angulation of the osteotomy relative to the lower margin of the mandible should be carefully evaluated taking into account the planned motion vector. At the end of the osteotomy, the segment is carefully mobilized; the distal segment should be movable and remain attached to the lingual musculature. Then, after their separation from the mandibular bone, the lower segment is positioned at the predetermined position in the preoperative.

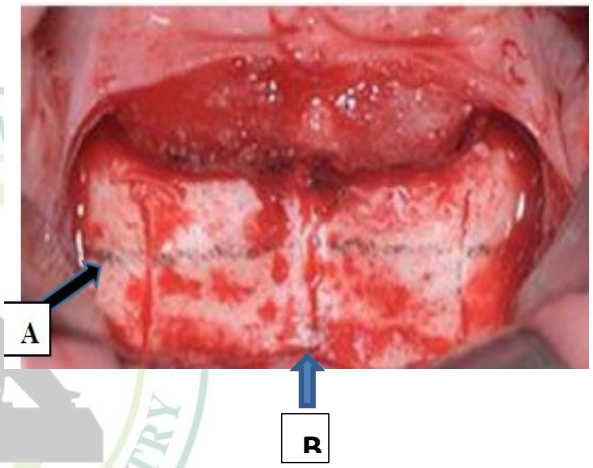

Figure 1: Osteotomy lines, A: Refere to horizontal line , B: Refere to vertical cuts

To avoid postoperative asymmetry and inadequate rotation of the lower segment around the central reference during advancement we marked the chin midline in both segments while the two vertical lines are about 5 to 7 mm anterior to mental foramen.

Parameters assessment

I. Osteotomy time

Osteotomy time is calculated from the beginning to the end of the bone osteotomy by minutes.

II. Intraoperative bleeding

It was calculated by measuring the amount of fluid in suction jar with subtraction of the known irrigant solution plus the calculation of the amount of blood saturation by surgical gauze from the start of each device (saw and piezo) application at the osteotomy which was assessed for each osteotomy separately.

III. Postoperative edema

Facial edema was measured bilaterally one day postoperatively, one week, two weeks, four weeks and twelve weeks in each patient as by photographing the patient at frontal view in order to document the improvement and evolution of their facial appearance during the postoperative period. Imaginary lines were placed on the captured images, as we presumed to draw an imaginary line dividing their faces vertically along its middle point and horizontally at the level of the chin. At this point, we measured the difference in millimeters of the extension of the swelling along the horizontal imaginary line using a caliper (Fig 2).

Figure 2: Postoperative edema tracing

Samples obtained from the cutting edges of the tools used were histologically examined using light microscope. The amount of viable cells and apoptotic cells in specimens were counted by specific computer analysis software (Fig 3-4).

Statistical Analysis:

Recorded data were statistically analyzed using the package for social sciences, SPSS 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative variables were expressed as count (n) and percent (%).The confidence interval was set to 95% and the margin of error accepted was set to 5%. For the statistically assessment of operation time, blood loss, post edema & coagulative bone necrosis independent sample t test was used to compare significant difference between two techniques.

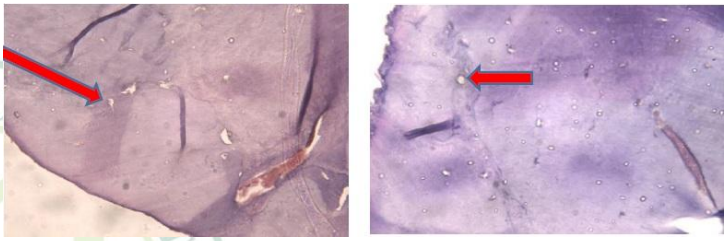

Figure 3: H&E stain showing calcified matrix with empty lacunae at osteotomy margins by saw, red arrow show empty lacunae

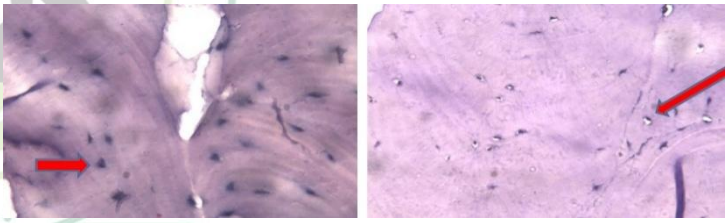

Figure 4: H&E stain showing calcified matrix with osteocytes inside lacunae at osteotomy margins by piezo, red arrow show Osteocyte inside

Results

Ten patients affected by dentofacial deformities underwent surgical Genioplasty correction. All patients were females mean age 22.5 years with the mean age at the time of surgery of 25.5. The osteotomy time was significantly longer in the piezotome group compared to the saw group, with a p-value of <0.0001. The mean (SD) operating time for the conventional saw was 2.38 ± 0.09 minutes, with a 95% confidence interval (CI) ranging from 209.2 to 248.2 seconds. In contrast, the piezoelectric technique had a mean operating time of 4.84 ± 0.14 minutes, with a 95% CI ranging from 251.1 to 277.8 seconds (Fig 5).

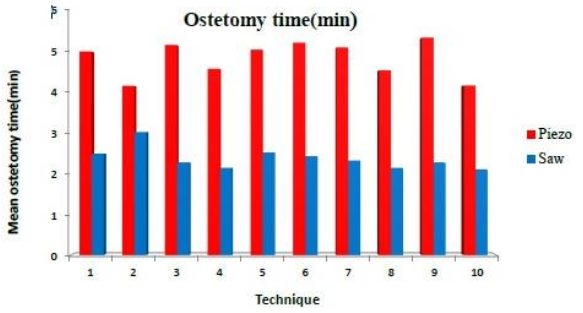

Figure 5: Effect of Piezo vs Saw on osteotomy time (min).

In terms of blood loss, the Saw group demonstrated a statistically significant increase in blood loss by 66.6% compared to the Piezotome group ($p < 0.0001$). The mean (SD) blood loss in the Piezotome group was 38.30 ± 4.50 ml, whereas the Saw group exhibited a mean (SD) blood loss of 114.70 ± 14.35 ml.

Independent sample t test was used to evaluate significant difference between two techniques in each time point regarding postoperative edema, repeated measure anova followed by Bonferoni posthoc analysis to elucidate significant difference between each time point pair in piezo and saw techniques and show no significant differences in edema were observed between the piezoelectric and saw techniques. Furthermore, both techniques exhibited a significant reduction in edema over the entire follow-up period

Coagulative bone necrosis comparison showed a statistically significant higher mean in the saw group compared to the peizotome group with p-value (p P< 0.0001). By comparing both groups the peizotome group had a mean and standard deviation 4.23±0.41, while the saw group had a mean and standard deviation of 66.49±3.39(Fig 6).

Discussion

Genioplasty is most common technique for correction mandibular chin asymmetry. Surgical saw as it has high cutting efficiency and continuous clean cut was the most common and widely used tool for bone osteotomy.[8-18-19]

In our prospective study we compare between piezoelectric device and traditional mechanical saw to obtain a scientific report on the consequent outcome quality in genioplasty surgery, in terms of time, blood loss, post-operative edema and bone necrosis of both tools.

In terms of osteotomy time, our findings reveal that patients undergoing the saw technique experienced a significant reduction in osteotomy time, showing a 50.8% decrease compared to the piezoelectric technique. This outcome agrees with the findings of Spinelli et al., Rana et al., and Rossi et al., although it contrasts with Pagotto et al., who observed no difference in osteotomy time between piezoelectric and saw techniques.[18:22]

Furthermore, our study demonstrates a significant increase in blood loss associated with the saw technique compared to the piezoelectric technique, a result that does not align with findings reported by Pineiro-Aguillar et al.[23-24]

Regarding edema, our findings demonstrate no statistically significant difference between piezoelectric surgery and conventional saw techniques, in contrast to studies by Rossi et al. and Spinelli et al.,[1] which reported a notable reduction in edema associated with piezoelectric surgery.[24] Our results suggest that edema, as a soft tissue-related complication, may not be significantly impacted by the choice of osteotomy tool.

Piezoelectric surgery has been shown to minimize bone trauma relative to conventional surgical saws, primarily due to its cavitation and acoustic effects, which result in less cellular trauma. This reduced mechanical stress on bone cells is associated with decreased marginal bone necrosis and potentially enhanced postoperative healing outcomes, Ma, Li, et al, Stübinger, Stefan et al and Canullo L et al agreed with our results

which improve our result.[25:28] Conversely, Esteves et al.[26] reported no significant histomorphometric differences between piezoelectric and saw osteotomies in a study on rat tibia, indicating that the comparative impact on bone healing may vary depending on the experimental model and anatomical site. This discrepancy underscores the necessity for further investigation to elucidate the specific conditions under which piezoelectric surgery provides distinct advantages over traditional methods.

Conclusion

Piezoelectric surgery is an emerging technique in mandibular orthognathic procedures, demonstrating substantial benefits over conventional surgical saws, including improved bone healing, reduced blood loss, and decreased coagulative bone necrosis. However, it is associated with longer operative times and does not result in a significant reduction in postoperative edema compared to saw techniques.

Ethical Approval

The study was approved by the ethics committee of faculty of dentistry – Minia University decision No. 546 , Committee No.84 at 2021

Competing interest

The authors declare that they have no conflict of interest.

Data availability

The data used or analyzed during this study are available from the authors upon request

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