Critical Analysis of Piezoelectric Surgery with Oscillating Saw in Bimaxillary Orthognathic Surgery

Zainab Akbar, Hammad Saleem and Waseem Ahmed

ABSTRACT

Objective: To compare the piezosurgery with conventional saw for osteotomy in orthognathic bimaxillary surgery.
Study Design: Comparative study.
Place and Duration of Study: The Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from January 2012 to July 2015.
Methodology: Twenty-four patients, regardless of gender, were selected for bimaxillary surgery. Each underwent osteotomy with conventional saw and piezorsurgery equipment. Intraoperative and postoperative parameters, like blood loss during operation, time required for surgery, postoperative swelling, nerve function, incision and surgical precisons, were evaluated.
Results: Out of total 96 osteotomies, 48 (50%) maxillary and 48 (50%) mandibular osteotomies were performed. Time required for piezosurgery was more (63 minutes) as compared to saw (p=0.003). Other parameters, like intraoperative blood loss (p=0.091), postoperative swelling (p=0.041), and nerve damage (p=0.009), were far less frequent with piezosurgery than frequent with saw procedures.
Conclusion: Piezosurgery is a favourable alternative technique as compared to saw technique in bimaxillary orthognathic surgeries.

Key Words: Maxillary osteotomy. Piezosurgery. Saw.

INTRODUCTION

Piezosurgery (piezoelectric surgery), based on ultrasonic microvibrations, is a meticulous and soft tissue-sparing method of osteotomy. Vercelloti introduced it to modify the traditional intraoral bone surgery. In piezosurgery, microvibrations of 50 to 200 µm/s at 25 to 30 KHz are used to remove a calcified organ sparing soft tissue, which are endangered only by frequencies above 50 KHz.

Intraorally, piezosurgery is used for sinus lift, mandibular graft harvesting, and bone cuts in bilateral sagittal split osteotomies. Its advantages are minimal risk for soft tissue, improved visualization within the surgical field due to less haemorrhage, precision and geometric cutting, and employing optional frequency. However, the main disadvantages are that dense bone cutting takes up to four times longer than a traditional rotary saw, the need to maintain a stock of tips, early replacement of tips and higher cost than conventional osteotomies using saw. The rationale of this study was that the piezoelectric surgery is much superior than the conventional saw as it is less traumatic, preserves nerve integrity and gives precision bone cuts.

The objective of this study was to compare the conventional saw with piezoelectric surgery in bilateral sagittal split osteotomies.

METHODOLOGY

This comparative study was designed and implemented in the division of Oral and Maxillofacial Surgery at the Armed Forces Institute Of Dentistry, Rawalpindi. Permission was obtained from the ethical committee and all the participants signed an informed consent agreement. Patients were included without any age and gender discrimination, who underwent bimaxillary orthognathic surgery from January 2012 to July 2015. The patients were included if they were with skeletal class I, II or III, facial asymmetry or anterior open bite deformity. Those with history of previous orthognathic surgery, distraction osteogenesis, maxillofacial trauma, reconstructive facial surgery or a diagnosis of maxillofacial congenital anomaly were excluded from the study. The same operating surgeon performed 24 bimaxillary procedures which comprised of lefort-I osteotomy in maxilla and bilateral sagittal split osteotomy in mandible, while the patient was under general anaesthesia with nasal intubation and standard conditions of hypotension.

Lefort-I osteotomy was performed according to the standard method through sulcular incision 5 mm above the attached gingiva. Mucoperiosteal flaps raised. As incision only extended upto 1st maxillary molar, the mucosa was undermined in order to reach the pterygomaxillary fissure (tuberosity) area. Lefort-I osteotomy cut was performed extending from pterygomaxillary fissure...
upto nasal septum bilaterally. Due to variety of saws available in different angulations, the blind procedure was more easy and safe with piezosurgery.

In saw cutting, underlying nasal mucosa was protected by mucoperiosteal elevators, but in piezosurgery no protection was carried out.

For bilateral sagittal split osteotomy, the anterior portion of the vertical ramus was incised midway between the occlusal planes. The incision was carried forward to a point just distal to the first molar. Mucoperiosteal flaps were raised. Bone was cut transversely through the medial cortex of the ramus from just posterior to and above the lingual aspect, to the anterior border of the ramus. The vertical cut was made through the buccal cortex just distal to the second molar. The vertical and horizontal cortical cuts were connected. Bone split was accomplished by bone separating forceps (Smith's bone spreader). Mandibular setback or advancement was performed. Osseous fixation was done. The frequency was set between 25 and 30 KHz and the amplitude ranged from 60 to 210 µm/s. For comprehensive comparison of the two systems, some surgical and clinical parameters were analysed both intraoperatively and postoperatively.

Intraoperatively, haemorrhage was estimated in ml. Normal (0.9%) saline solution was used to reduce the temperature of the bone and cleaning the surgical field. The amount was measured and subtracted from the collected value of the surgical fluid suctioned. An indirect assessment was made by bleeding during the surgery or by clear surgical field during the procedure. Soft tissue damage was visually evaluated. Surgical precision of bone cuts were determined subjectively by surgical ease in bone splitting, in terms of force required during the osteotomy, affectively achieving linear resection with minimum bone consumption. Postoperatively, swelling was observed clinically. Nerve impairment was calculated on 24 (50%) mandibular osteotomies using a clinical neurosensory test that was performed on all the patients postoperatively (third postoperative month).

The data was fed into and evaluated on SPSS Version 22.0. Mean values and their standard deviations were calculated for quantitative variables. Frequencies and percentages were determined for qualitative variables. Chi-square test was employed for comparing the nerve impairment (three months) in both the groups. The decision criteria suggest that the data is significant and thus the hypothesis is proved. P-value ≤ 0.05 was taken as the level of significance. Independent sample t-test was applied to compare the duration (mins) in both the groups.

RESULTS

Total of 96 osteotomies, 48 (50%) maxillary and 48 (50%) mandibular osteotomies performed. Four osteotomies on 1 patient. Twelve (50%) patients were treated with traditional saw and 12 (50%) with advanced piezoelectric surgical unit. In total 24 (50%) maxillary and 24 (50%) mandibular osteotomies were performed with each system. Out of the 24 patients, 12 (50%) patients were of male gender and 12 (50%) females. In this study, the mean ± standard deviation of age (years) at the time of surgery was 21.96 ±1.42. Traditional saw had an average blood loss of 315 ml. For the peizoelectric procedure, the average 212 ml. The minimum and maximum values for saw surgical procedure was an average duration of 100 minutes as compared with piezoosteotomy's values of 163 minutes. The maxillary procedure (Lefort-I osteotomy) had a minimum blood loss of 70 ml and maximum of 200 ml; the mandibular procedure had minimum 90 ml and maximum 300 ml blood loss.

The piezosurgery procedure showed a better surgical precision compared to saw; and a further analysis showed that maxillary osteotomy presented better surgical precision as compared to the mandible. The postoperative parameters, like swelling and nerve impairment, were assessed. In case of conventional saw, postoperative swelling and hematoma were present in 75% of the patients initially, which was assessed subjectively on 3rd postoperative day in all the patients. While in case of piezoosteotomy, swelling was observed in 33% of the patients. Neurosensory deficit was evaluated one month postoperative. Nerve impairment was assessed on 48 osteotomies performed, using the saw. About 58.3% of the subjects had neurosensory deficit three months postoperatively, while 41.7% subjects had no nerve impairment (Figure 1). While in case of piezosurgery, 8.3% of the patients were positive for neurosensory deficit; and in 91.7% subjects, nerve was intact, having a p-value of 0.009.

![Figure 1: Comparison of nerve impairment (6 months) in both the groups.](image-url)
DISCUSSION

French physicists Jean and Marie Curie were the pioneers to mention the direct piezoelectric effect to occur where crystals emit electrical current when subjected to mechanical pressure; the indirect piezoelectric effect being the reciprocal change in shape on exposure to electrical current which was found later.2,13

Applications of piezoelectric surgery in dentistry and practice include dento-alveolar procedures, dental implantology, maxillary sinus bone grafting surgery, maxillofacial osteotomy, harvesting of autogenous bone grafts, alveolar decortications and corticotomy, orthognathic surgery, alveolar distraction, resection of cyst and tumour-like lesions, orthodontic microsurgery, and TMJ ankylosis and jaw resection.

This device has several main advantages in oral and maxillofacial surgery such as minimal damage to soft tissue, good visibility within the operative field, and precise cutting.4,8-15 In case of oscillating saw, it has some serious drawbacks which can negatively affect patient's outcome. As the saw is cutting, a significant amount of heat is generated, which is transferred to the surrounding bone cells. It has been shown that if the bone cells sustain a temperature of 44-47 degree Celsius for longer than one minute then they can be damaged. In a typical surgery, temperature can reach up to 200 degrees Celsius, routinely damaging a large amount of cells in the immediate vicinity. Some drawbacks of piezoelectric surgery are restricted use on patients with pace-makers, expensive equipment, and longer duration of the surgical procedure. Piezoelectric surgery in oral and maxillofacial discipline requires more practice time and skill.3

In this study, comparison of conventional saw and piezoelectric surgery device was performed through analysis of certain intra- and post-operative parameters. Intra-operative time of piezoelectric surgery was more than saw, which is in accordance with the other studies. Previous studies had shown it to be up to 3 or 4 times longer than conventional technique because of heat dissipation to occur when excising the dense cortical bone.16,17 Surgeons are usually trained with the conventional surgical technique, and the change to a piezoelectric system can be gradually incorporated. Previous literature showed less mean blood loss of 25% compared to the traditional osteotomy, which supports this study. Likewise, swelling and hematoma post-operatively was significantly less in piezoelectric surgery procedures. Surgical accuracy is improved by better visibility in the surgical site.18

Regarding neurosensory testing, incidence of nerve injury was less in piezoelectric surgery than in traditional procedures, supporting previous literature.4 Recovery, following nerve injury, was higher in piezoelectric surgery. Same results were reported by Coll who found a greater frequency of sensation recovery of the lower lip after piezoelectric osteotomy.9 Ultrasound osteotomy has been described as protective to the inferior alveolar nerve.19,20 This might be due to the intact soft tissue including the vasa nervosa surrounding the perineurium of the infra-orbital and the alveolar nerves, avoiding damage due to excessive heat production. This is in accordance with many other reports of ultrasound osteotomy.21,22

CONCLUSION

Piezosurgery is an innovative and novel technique that can be used as a favorable alternative to traditional saw. In case of orthognathic surgical procedures, values of intra- and post-operative parameters, like blood loss, surgical precision of bone cuts, swelling and nerve impairment, were markedly less in case of piezosurgery in comparison to saw. Some efforts and expertise are required to overcome its demerits, like increased operating time.

REFERENCES

11. González-García A, Diniz-Freitas M, Somoza-Martín M,
Comparison of piezo vs. saw in bimax surgery


****