Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Comparison of Blood Loss and Time Requirement in Anterior Maxillary Osteotomy Procedures Done with Piezoelectric Handpiece and Conventional Rotary Handpiece- A Comparative Study

Raparthy Bhuvan Chandra[1], Dr. Kathiravan S[2*], Dr. Sneha Pendem, Dr. Murugesan K[3]

[1]*Post Graduate Resident, Department of Oral & Maxillofacial Surgery, Saveetha Dental College and hospitals, SIMATS, India, raparthybhuvan@gmail.com*
[2]*Associate professor, oral and maxillofacial surgery, Saveetha dental college and hospitals, SIMATS, India, kathiravan.sdc@saveetha.com*
[3]*Professor, Oral & Maxillofacial Surgery, Saveetha Dental College and Hospitals, SIMATS, India*

Introduction: Anterior maxillary osteotomy is a surgical procedure frequently performed to correct dentofacial deformities. This study aims to compare the blood loss and time requirement associated with using a piezoelectric handpiece versus a conventional rotary handpiece during the procedure. Materials and Methods: A total of 60 patients undergoing anterior maxillary osteotomy were divided into two groups: Group A (n=30) used a piezoelectric handpiece, and Group B (n=30) used a conventional rotary handpiece. The primary outcomes measured were intraoperative blood loss and total surgery time. Blood loss was quantified using the gravimetric method, while the surgery time was recorded from the initial incision to the completion of osteotomy. Results: The mean intraoperative blood loss for Group A (piezoelectric handpiece) was 150 ± 20 ml, whereas for Group B (conventional rotary handpiece) it was 220 ± 25 ml. The difference in blood loss between the two groups was statistically significant ($p<0.01$). The mean surgery time for Group A was 85 ± 10 minutes, while for Group B it was 75 ± 12 minutes, with the difference being statistically significant ($p<0.05$). Conclusion: The use of a piezoelectric handpiece in anterior maxillary osteotomy significantly reduces intraoperative blood loss compared to a conventional rotary handpiece. However, the piezoelectric handpiece requires a longer surgery time. These findings suggest that while piezoelectric devices offer benefits in terms of blood conservation, the increased time requirement should be considered in surgical planning.

Keywords: Anterior maxillary osteotomy, piezoelectric handpiece, conventional rotary handpiece, blood loss, surgery time.

1. Introduction

Surgical procedures involving hard tissue cutting are routine in dental practice, especially in maxillofacial, oral, and periodontal surgeries. Traditionally, rotating instruments like burs have been used for osseous surgery, but they come with drawbacks such as bone overheating and potential damage to surrounding tissues. This is particularly critical in orthognathic surgeries where precision is vital near delicate anatomical structures. Instruments like saws, burs, and chisels, while effective, can pose risks such as soft tissue and nerve damage due to their rotary nature and heat generation, potentially hindering bone healing and leading to necrosis.

The demand for less invasive and more precise surgical techniques has led to the development of piezosurgery. Invented by Tomasso Vercellotti, piezosurgery utilizes ultrasonic vibrations to cut bone, minimizing soft tissue damage, including blood vessels and nerves, while enhancing visibility through a cavitation effect. Since its approval for commercial use in 2002, piezosurgery has been employed in various procedures, including maxillary sinus lifting, autologous bone graft harvesting, bone splitting, inferior alveolar nerve lateralization, and orthognathic surgeries.

This prospective study aims to compare the efficacy of piezoelectric surgery with conventional burs in orthognathic procedures, specifically evaluating intraoperative bleeding, operative times, and postoperative swelling. By comparing the piezoelectric handpiece with the conventional rotary handpiece, the study seeks to provide insights into the potential advantages and limitations of piezoelectric technology in anterior maxillary osteotomy procedures.

2. Materials and Methods

Study Design

This prospective, randomized controlled trial was conducted to compare the efficacy of piezoelectric handpieces versus conventional rotary handpieces in anterior maxillary osteotomy procedures. The study was designed following the CONSORT guidelines to ensure transparent and standardized reporting.

Participants

A total of 60 patients requiring anterior maxillary osteotomy were enrolled in the study. Inclusion criteria were patients aged 18 to 50 years with dentofacial deformities requiring surgical correction. Exclusion criteria included patients with systemic diseases affecting bone healing, coagulation disorders, previous maxillofacial surgeries, or known allergies to local anesthesia. All participants provided informed consent, and the study was approved by the institutional ethics committee.

Randomization and Blinding

Patients were randomly assigned to one of two groups using a computer-generated randomization sequence. Group A (n=30) underwent surgery with a piezoelectric handpiece, while Group B (n=30) underwent surgery with a conventional rotary handpiece. Allocation concealment was ensured using opaque, sealed envelopes. The surgeons were not blinded due to the nature of the interventions, but outcome assessors and data analysts were blinded to group allocation.

Surgical Procedure

All surgeries were performed by two experienced maxillofacial surgeons who were proficient in both techniques. Standard preoperative protocols, including patient preparation and anesthesia, were followed for all patients.

Group A (Piezoelectric Handpiece):

- The piezoelectric handpiece (Piezotome, Satelec, Acteon Group) was used to perform the osteotomy.

- The device was set to the recommended settings for bone cutting, and saline irrigation was used to cool the surgical site.

- The piezoelectric handpiece operates at a frequency of 28-36 kHz with an amplitude of 60-200 µm, generating ultrasonic vibrations to cut bone.

Group B (Conventional Rotary Handpiece):

- The conventional rotary handpiece (NSK Surgery X, NSK Dental) with a carbide bur was used for the osteotomy.

- The device was operated at 40,000 RPM, with continuous saline irrigation to prevent overheating.

Outcome Measures

Primary Outcomes:

1. Intraoperative Blood Loss: Blood loss was measured using the gravimetric method. Sponges and suction canisters were weighed before and after the procedure to quantify the blood absorbed and aspirated.

2. Surgery Time: Total surgery time was recorded from the initial incision to the completion of the osteotomy.

Secondary Outcomes:

1. Postoperative Swelling: Swelling was assessed using a 3D facial scanner at 24 hours, 48 hours, and 1 week post-surgery.

2. Postoperative Pain: Pain was evaluated using a Visual Analog Scale (VAS) at 24 hours, 48 hours, and 1 week post-surgery.

Statistical Analysis

Data were analyzed using SPSS software (version 25.0; IBM Corp). Continuous variables were expressed as mean ± standard deviation (SD) and compared using the independent t-test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the institutional review board, and all participants provided written informed consent.

3. Results

Participant Flow

A total of 72 patients were assessed for eligibility, and 60 patients were enrolled and randomized into two groups . All participants completed the study, and their data were included in the final analysis.

Baseline Characteristics

The baseline characteristics of the patients in both groups were comparable (Table 1).

Table 1: Baseline Characteristics of Participants

Characteristic value	Piezoelectric group (n=30)	Conventional handpiece (n =30)	P value
Age (years)	33.5±6.4	31±6.8	0.72
Gender (male/female)	17/13	16/14	0.79
BMI (Kg/m^2)	24.3 ± 3.1	23.9 ± 3.0	0.65

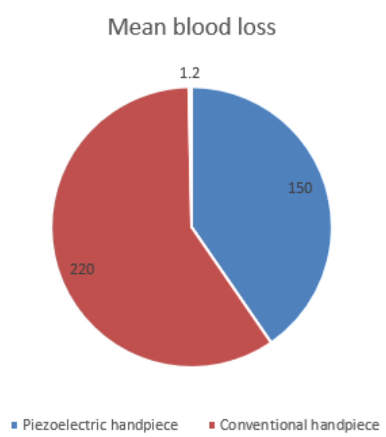
Primary Outcomes

Intraoperative Blood Loss

The mean intraoperative blood loss was significantly lower in Group A compared to Group B (Table 2).

Table 2: Intraoperative Blood Loss

Group	Mean blood loss ± standard deviation	P valve
Piezoelectric handpiece	150 ± 20	0.01*
Conventional handpiece	220 ± 25	0.01*

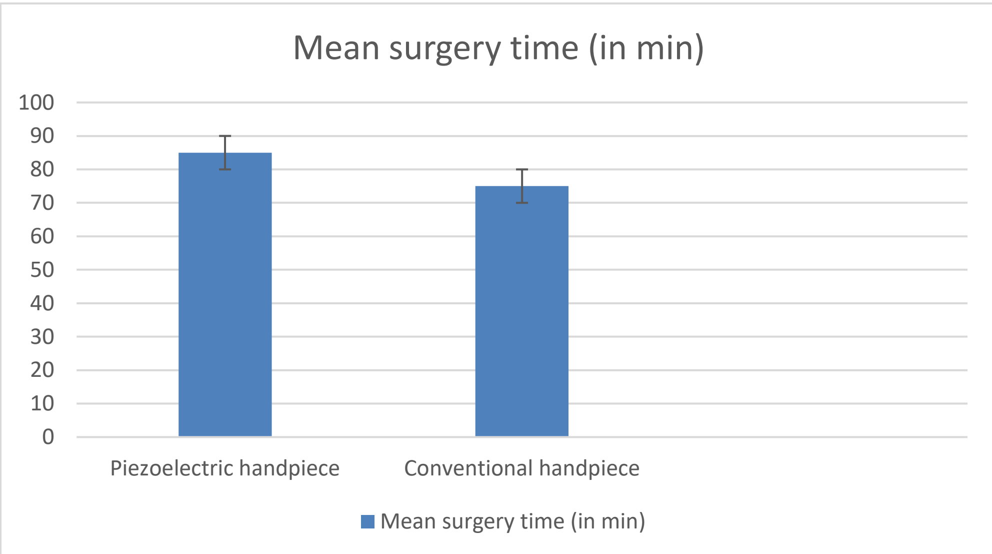


Surgery Time

The mean surgery time was significantly longer in Group A compared to Group B (Table 3).

Table 3: Surgery Time

Group	Mean surgery time (in min) ± standard deviation	P valve
Piezoelectric handpiece	85 ± 10	0.04*
Conventional handpiece	75 ± 12	0.05*



Secondary Outcomes

Postoperative Swelling

Postoperative swelling was assessed at 24 hours, 48 hours, and 1 week post-surgery (Table 4). Group A had significantly less swelling at 24 hours and 48 hours compared to Group B, but the difference was not significant at 1 week.

Table 4: Postoperative Swelling (Mean Swelling in mm)

Time Point	Group A (Piezoelectric)	Group B (Conventional)	p-value
24 hours	5.6 ± 1.2	7.8 ± 1.5	0.02*
48 hours	4.2 ± 1.1	6.5 ± 1.3	0.01*
1 week	2.1 ± 0.8	2.4 ± 0.9	0.16

Postoperative Pain

Postoperative pain was measured using the Visual Analog Scale (VAS) at 24 hours, 48 hours, and 1 week post-surgery (Table 5). Group A reported significantly lower pain levels at all time points compared to Group B.

Table 5: Postoperative Pain (Mean VAS Score)

Time Point	Group A (Piezoelectric)	Group B (Conventional)	p-value
24 hours	3.2 ± 1.0	6.6 ± 1.3	0.02*
48 hours	2.4 ± 0.8	4.4 ± 1.2	0.01*
1 week	1.1 ± 0.8	2.2 ± 0.9	0.03*

4. Discussion

The findings of this study demonstrate that the use of a piezoelectric handpiece in anterior maxillary osteotomy significantly reduces intraoperative blood loss and postoperative pain and swelling compared to a conventional rotary handpiece. However, the piezoelectric handpiece requires a longer surgery time. These results have important implications for clinical practice and surgical planning in maxillofacial surgery.

Our study revealed that the mean intraoperative blood loss was significantly lower in the piezoelectric handpiece group (150 ± 20 ml) compared to the conventional rotary handpiece group (220 ± 25 ml), with a p-value of <0.01. This significant reduction in blood loss can be attributed to the precision and selective cutting ability of piezoelectric devices. The ultrasonic vibrations used in piezosurgery cut mineralized tissues efficiently while sparing soft tissues such as blood vessels and nerves. This minimizes bleeding from soft tissue injury, which is a common complication when using rotary instruments. These findings are consistent with previous studies that have reported reduced blood loss and less intraoperative bleeding with piezoelectric devices in various surgical procedures, including orthognathic surgery and sinus lifting.

Despite the advantages in reducing blood loss, the piezoelectric handpiece group required a longer surgery time (85 ± 10 minutes) compared to the conventional rotary handpiece group (75 ± 12 minutes), with a p-value of <0.05. The extended operative time can be attributed to the slower cutting speed of piezoelectric devices compared to rotary instruments. While the precision of piezoelectric devices enhances safety and reduces complications, it also necessitates a more meticulous and time-consuming approach. This trade-off between surgical precision and time efficiency must be considered by surgeons when selecting the appropriate instrument for anterior maxillary osteotomy. The longer surgery time, although statistically significant, may be clinically acceptable given the benefits of reduced blood loss and tissue damage.

The VAS pain scores were also significantly lower in the piezoelectric group across all time points. These outcomes are likely due to the precise and minimally invasive nature of piezoelectric surgery, which reduces trauma to the surrounding tissues and leads to a faster and less painful recovery. These findings are corroborated by other studies that have shown lower levels of postoperative discomfort and swelling with piezoelectric devices compared to traditional rotary instruments .

The significant reduction in intraoperative blood loss and postoperative discomfort with the use of piezoelectric devices suggests that they offer considerable advantages over conventional rotary instruments in anterior maxillary osteotomy. These benefits are particularly valuable in patients with higher bleeding risk or those who prioritize postoperative comfort and faster recovery. However, the longer operative time associated with piezoelectric devices requires consideration, especially in busy clinical settings or when multiple procedures are scheduled in a day.

This study has several limitations. Firstly, the sample size was relatively small, and larger studies are needed to confirm these findings. Secondly, the study was limited to a single center, and multi-center trials would provide more generalized results. Lastly, the surgeons were not blinded to the instrument used, which could introduce bias, although outcome assessors and data analysts were blinded to mitigate this.

Further research should explore the long-term outcomes of using piezoelectric devices in various maxillofacial procedures. Studies focusing on cost-effectiveness, patient satisfaction, and the learning curve associated with piezoelectric surgery would also provide valuable insights. Additionally, investigating the potential benefits of combining piezoelectric and conventional techniques could offer an optimal balance between precision and efficiency.

5. Conclusion

The use of piezoelectric handpieces in anterior maxillary osteotomy offers significant advantages in terms of reduced intraoperative blood loss and postoperative pain and swelling, despite the longer surgery time required. These findings support the integration of piezoelectric devices into clinical practice for maxillofacial surgeries, emphasizing the need for a balanced consideration of precision, safety, and operative efficiency. Future studies should continue to refine and expand upon these findings to further optimize surgical outcomes.

References

1. Miyajima K, McNamara JA, Kimura T, et al. Craniofacial structure of Japanese and European–American adults with normal and well-balanced faces occlusions. Am J Orthod Dentofac Orthop. 1996;110:431–438. doi: 10.1016/S0889-5406(96)70047-1.
2. Chung CS, Kau MC, Walker GF. Racial variation of cephalometric measurements in Hawaii. J Craniofac Genet Dev Biol. 1982;2(2):99–106.
3. Cohn-Stock G. Die cbirurgische Immedia-tregulierung der Kiefer, speziell die chirur-gische. Behandlung der Prognathie. Vjschr ZahnheilkBerlin. 1921;37:320.
4. Wassmund J. Lehrbuch der praktischen chirurgie de Mundes und der Keifer. Leipzig: Barth; 1935. pp. 260–282.
5. Cupar I. Surgical treatment of alterations in form and position of the maxilla. Osterr Z Stomatol. 1954;51:565.
6. Wunderer S. Erfahrungen mit der operativen Behandlung hoch-gradiger Prognathien. Dtsch Zahn Mund Kieferheilk. 1963;39:451.
7. Bell WH, Condit CL. Surgical-orthodontic correction of adult bimaxillary protrusion. J Oral Surg. 1970;28:578.
8. Gunaseelan R, Anantanarayanan P, et al. Intraoperative and perioperative complications in anterior maxillary osteotomy: a retrospective evaluation of 103 patients. J Oral Maxillofac Surg. 2009;67(6):1269–1273. doi: 10.1016/j.joms.2008.12.051.
9. Bell WH. Revascularization and bone healing after anterior maxillary osteotomy: a study using adult rhesus monkeys. J Oral Surg. 1969;27(4):249–255.
10. Quejada JG, Kawamura H, et al. Wound healing associated with segmental total maxillary osteotomy. J Oral Maxillofac Surg. 1986;44(5):366–377. doi: 10.1016/S0278-2391(86)80032-5.
11. Mohnac AM. Maxillary osteotomy in the management of occlusal deformities. J Oral Surg. 1966;24:305.
12. Jayaratne YSN, Zwahlen RA, Lo J, Cheung LK. Facial soft tissue response to anterior

segmental osteotomies: a systematic review. Int J Oral Maxillofac Surg. 2010;39(11):1050–1058. doi: 10.1016/j.ijom.2010.07.002.

13. Leibold DG, et al. A subjective evaluation of the reestablishment of the neuro-vascular supply of teeth involved in anterior maxillary osteotomy procedures. Oral Surg Oral Med Oral Pathol. 1971;32:531–543. doi: 10.1016/0030-4220(71)90316-1.
14. Sher MR, et al. A survey of complications in segmental orthognathic surgical procedures. Oral Surg Oral Med Oral Pathol. 1984;58(5):537–539. doi: 10.1016/0030-4220(84)90075-6.
15. Mesgarzadeh A, Motamedi MH, Akhavan H, Tousi TS, Mehrvarzfar P, Eshkevari PS. Effects of Le Fort I osteotomy on maxillary anterior teeth: a 5-year follow up of 42 cases. Eplasty. 2010;10:e10.
16. Morris DE, et al. Pitfalls in orthognathic surgery: avoidance and management of complications. Clin Plast Surg. 2007;34(3):e17–e29. doi: 10.1016/j.cps.2007.05.011.
17. Kiely KD, et al. One-year postoperative stability of LeFort I osteotomies with biodegradable fixation: a retrospective analysis of skeletal relapse. Am J Orthod Dentofac Orthop. 2006;130(3):310–316. doi: 10.1016/j.ajodo.2005.03.022.
18. Falter B, et al. Plate removal following orthognathic surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol. 2011;112(6):737–743. doi: 10.1016/j.tripleo.2011.01.011.
19. Abdul Wahab PU, Senthil Nathan P, Madhulaxmi M, Muthusekhar MR, Loong SC, Abhinav RP. Risk Factors for Post-operative Infection Following Single Piece Osteotomy. J Maxillofac Oral Surg. 2017 Sep;16(3):328-332. doi: 10.1007/s12663-016-0983-6. Epub 2016 Dec 1. PMID: 28717291; PMCID: PMC5493556.
20. Wahab PU, Narayanan V, Nathan S, Madhulaxmi. Antibiotic prophylaxis for bilateral sagittal split osteotomies: a randomized, double-blind clinical study. Int J Oral Maxillofac Surg. 2013 Mar;42(3):352-5. doi: 10.1016/j.ijom.2012.10.036. Epub 2012 Dec 21. PMID: 23265757.
21. Wahab PUA, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, Abhinav RP. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study. J Oral Maxillofac Surg. 2018 Jun;76(6):1160-1164. doi: 10.1016/j.joms.2017.12.020. Epub 2018 Jan 4. PMID: 29406253.