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Research Article

Comparing Piezosurgery and Rotary Techniques in Direct Maxillary Sinus Lifting

Enas Abdulsattar Abdulmageed[1]*, Rana Razzaq Noor[1]

[1]*Al-Wasity Teaching Hospital, Al-Rusafa Health Directorate, Baghdad, Iraq*

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Abstract

Background: Sinus lifting is a common surgery for bone loss in the posterior part of the maxilla. It facilitates inserting prostheses and rehabilitating the edentulous posterior maxilla. If the alveolar bone remains less than 5 mm, direct sinus lifting using the rotatory handpiece is used to perform the lateral window approach. ***Objective***: To compare piezosurgery and rotary techniques in direct sinus lifting. ***Methods***: A cross-sectional study was conducted from October 2022 to August 2023. We enrolled 15 patients, ranging in age from 45 to 66 years, who required bilateral direct sinus lifting. Piezosurgery was performed on one side, while rotary surgery was performed on the other. We assessed the intraoperative time of opening the bony window, as well as the postoperative pain, swelling, and mouth opening at 1 hour, 2 days, 7 days, and 1 month after the procedure. ***Results***: With rotary tools, the time for opening a bony window was significantly shorter. Piezosurgery resulted in significantly less swelling after 2 days, but there was no significant difference between the two groups after 7 days and 1 month. Regarding mouth opening, the piezo group yielded a significantly larger difference after 2 days, but the two groups demonstrated no significant difference after 7 days and 1 month. Regarding pain, the piezo group demonstrated a lower score after 6 hours and 2 days, but the two groups demonstrated no significant difference after 7 days. ***Conclusions***: Postoperatively, piezosurgery for sinus lifting leads to less pain, swelling, and limited mouth opening.

Keywords: Maxillary sinus elevation, Osteotomy, Piezosurgery.

مقارنة جراحة الضغط والتقنيات الدوارة في رفع الجيوب الأنفية الفكية المباشرة

الخلاصة

الخلفية: رفع الجيوب الأنفية هي عملية جراحية شائعة لفقدان العظام في الجزء الخلفي من الفك العلوي. يسهل إدخال الأطراف الاصطناعية وإعادة تأهيل الفك العلوي الخلفي الشديد. إذا ظل العظم السنخي أقل من 5 مم ، يتم استخدام رفع الجيوب الأنفية المباشر باستخدام القبضة الدوارة لأداء نهج النافذة الجانبية. **الهدف**: مقارنة بين جراحة الضغط والتقنيات الدوارة في رفع الجيوب الأنفية المباشر. **الطريقة**: أجريت دراسة مقطعية من أكتوبر 2022 إلى أغسطس 2023. سجلنا 15 مريضا، تتراوح أعمارهم بين 45 و 66 عاما ممن احتاجوا إلى رفع الجيوب الأنفية المباشر الثنائي. تم إجراء جراحة الضغط على جانب واحد، بينما تم إجراء الجراحة الدورانية من جهة أخرى. قمنا بتقييم الوقت أثناء العملية لفتح النافذة العظمية، وكذلك الألم بعد العملية الجراحية والتورم وفتح الفم في 1 ساعة واحدة ويومين و 7 أيام وشهر واحد بعد العملية. **النتائج**: مع الأدوات الدوارة، كان وقت فتح نافذة عظمية أقصر بكثير. أدت جراحة الضغط إلى تورم أقل بكثير بعد يومين، ولكن لم يكن هناك فرق كبير بين المجموعتين بعد 7 أيام أو شهر واحد. فيما يتعلق بفتح الفم، أسفرت مجموعة بيزو عن فرق أكبر بكثير بعد يومين، لكن المجموعتين لم تظهرا فرقا كبيرا بعد 7 أيام أو شهر واحد. فيما يتعلق بالألم، أظهرت مجموعة بيزو درجة أقل بعد 6 ساعات أو يومين، لكن المجموعتين لم تظهر فرقا كبيرا بعد 7 أيام. **الاستنتاجات**: بعد الجراحة، تؤدي جراحة الضغط لرفع الجيوب الأنفية إلى ألم أقل وتورم وفتح محدود للفم.

* ***Corresponding author***: Enas A. Abdulmageed, Al-Wasity Teaching Hospital, Al-Rusafa Health Directorate, Baghdad, Iraq; Email: enassattar80@gmail.com

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INTRODUCTION

Sinus pneumatization increases the paranasal sinus dimensions. The development of maxillary sinuses is complete at birth and continues pneumatization until permanent teeth emerge [1]. Losing a tooth causes the maxillary sinus to pneumatize; hence, its floor unites with the alveolar bone crest in severe cases [2]. Comparing radiographs before and after extraction suggests that posterior tooth extraction causes maxillary sinus pneumatization [3]. Dental implants are important in rehabilitating sinus pneumatization cases [4], but it is common to face insufficient bone volume, which complicates installing implants [5]. This situation can be resolved by maxillary sinus lifting via bone graft placement on its floor and under its membrane (Schneiderian membrane) [6] to increase the height of the maxillary ridge and permit implant placement [7]. The lateral window surgical technique is recommended when the remaining height of alveolar bone is shorter than 5 mm [8–9] and the grafting material fills the area from the remaining maxillary ridge to the elevated Schneiderian membrane [7]. In the lateral window technique, burs

are usually used for osteotomies [6]. Common postoperative complications of this technique include pain, decreased mouth opening, and edema [10]. These complications may arise from the temperature elevation during the jaw bone dissection, which can lead to osteonecrosis and hinder post bone repair [11]. The piezoelectric device was suggested as a new option in the lateral window approach to improve the outcome and reduce the postoperative sequelae [12–13] due to its greater precision, selective bone dissection, soft tissue protection, less bleeding, and faster bone regeneration [14]. This study aimed to compare the conventional burs and piezoelectric modality for maxillary sinus osteotomy in the lateral approach to identify the differences in edema, pain, mouth opening, and operative time. The study's goal was to find out how the piezosurgery device and rotary tools affected the time it took for the bony window to open, the pain and swelling that followed surgery, and the ability to open the mouth after surgery.

METHODS

Study design and setting

A cross-sectional study was conducted from October 2022 to August 2023 at Al-Wasity Teaching Hospital, A-Rusafa Health Directorate, Iraq, Baghdad. We enrolled 15 patients, ranging in age from 45 to 66 years, who required bilateral direct sinus lifting.

Inclusion and exclusion criteria

This study enrolled 15 patients (9 males and 6 females with an age range of 45–66 years) who attended the department of oral and maxillofacial surgery from October 2022 to August 2023. We included patients with good oral hygiene, edentulous posterior maxilla bilaterally with pneumatization of maxillary sinuses, subantral bone height ≤ 4 mm, bone width ≤ 4 mm, no history or clinical evidence of systemic diseases, and no pathology in the maxillary sinus. We excluded patients with respiratory disorders and maxillary sinus pathology, smokers, oral sinus communication history, patients who have unstable mental health, or any systemic condition or medication that may affect bone healing. Preoperative assessment involved history, clinical and radiographic examination.

Ethical considerations

This study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki. The goal of this study was verbally communicated with the sample patients, and analytical approval was obtained before any sample was taken. The researcher clearly explained the purpose and process of the survey to the patients, as well as standard instructions and guidance for completing the questionnaire. The local Ethics Committee of Al-Wasity Teaching Hospital (2432) reviewed and approved the study protocol, subject information, and consent form on August 16, 2022.

Interventions and outcome measurements

Face swelling was measured via four points: the tragus, nasal border, lateral canthus of eye and labial commissure. The measurement timings were preoperatively, 2 days, 7 days and 1 month postoperatively by flexible tape from the center of the tragus to the nasal border, the outer canthus of the eye to the labial commissure of the same side and from the center of the tragus to the labial commissure of the same side. Mouth opening was measured by interincisal distance using a tape measure or roller before surgery and at 2 days, 7 days and 1 month postoperatively. The time of osteotomy by bur and piezo was measured in seconds during surgery. The VAS consists of a 10 cm line, with two end points representing 0 (‘no pain’) and 10 (‘pain as bad as it could possibly be’). We ask the patient to mark their current level of pain on the line. A ruler is used to measure the distance in centimeters from the ‘no pain marker’ (i.e., zero) to the current pain mark. This gives a pain intensity score of 6/10 out of 10. The time of osteotomy by bur and piezo was measured in seconds during surgery. History included name, age, sex, operation date, habits, and chief complaint. The clinical examination evaluated oral hygiene, the presence of any pathological lesions or retained roots, alveolar ridge (width, vertical bone resorption), inter-arch distance, and residual alveolar ridge shape. A cone beam computed tomography scan (CBCT scan) was used in the radiographic examination to assess bone height, width, septa, and sinus pathology. A consent form was signed by patients. The protocol included local anesthesia. The split-mouth technique was used, with raising the maxillary sinus by a bur on one side and a piezoelectric instrument on the opposite side, with the choice being random by flipping a coin and the patients unaware of the randomization. Instruments and materials used were dish for normal saline, dish for betadine iodine, dental syringe, lidocaine carpule and needle, langenbeck retractors, cheek retractor, periosteal elevator, ruler, container, bone substitute, plastic disposable syringe, silk suture 3/0, scissor, needle holder, non-toothed tweezer, scalpel with blade no. 15, sinus lift kit, sucker tip, towel clip, sponge stick, and gauze. Sinus lifting was done with lidocaine hydrochloride at 2% local infiltration into the buccal and palatal mucosa. A non-toothed tweezer made a two-sided flap, a mesial vertical incision, and a horizontal incision. The Haworth periosteal elevator reflected the full thickness of the mucoperiosteal flap, revealing the crestal and buccal alveolar bone. Using the rotary or piezoelectric technique, and with the favorable lapse of time between the two sides being 30 days, an osteotomy was done, measuring a 20x10 mm rectangle on the maxillary sinus lateral wall, about 5 mm superior to the crest of the bone bilaterally. We removed the entire osteotomy-defined rectangular bone, manually detached the Schneiderian membrane on the rotary side with a sinus lifting kit, and used a piezotome non-cutting end tip on the other side. To prepare the grafting material, we used tricalcium phosphate (TCP) (Qualy Bone, Portogal), a porous,

synthetic bio-ceramic that contains 99.9% tricalcium phosphate (Ca_3 $(PO_4)_2$) material as granules for filling bone defects. Stored at room temperature. Each contains 1 g of bone graft, with a granule size of 0.5 to 1 mm. The number of bone substitute units used varies depending on the augmentation requirement. A platelet-rich fibrin (PRF) membrane was obtained by drawing 10 ml of patients' venous blood from a butterfly cannula into one vacuum-filled, plain glass tube. We placed the tube in the centrifuge for a single spin at 3000 rpm (approximately 400 g) for 15 minutes. The tube revealed three layers: a middle fibrin clot (PRF) layer, an upper straw-colored cellular plasma layer, and a lower red layer representing packed red blood cells. The PRF clot is obtained by tweezing and separated from the red thrombus by gentle swabbing with gauze to maintain the junction between them. The PRF clot is put on the PRF Box grid and covered with the compressor and lid. In about a minute, this generates a low-cost autologous fibrin membrane. Graft placement and soft tissue closure involved packing a bone substitute into the subantral area. Before the flap was stitched, a PRF membrane was placed over the bone substitute. An interrupted suture freed the flap from tension. Postoperative care involved drugs and follow-up visits. The patients received Co-Amoxiclav® 625 mg tablets three times a day for five days, Clindamycin capsules 300 mg quadruple daily, Metronidazole tab 500 mg three times a day, Ibuprofen tab 400 mg when necessary, and Otrivin® nasal drop 0.5 mg twice a day for less than a week. They also received instructions to use normal saline for irrigation and mouthwash three times a day, refrain from blowing and sneezing for the first two weeks postoperatively, and had their sutures removed ten days after the surgery. Follow-up visits were scheduled at 6 hours, 2 days, 7 days and 1 month and included assessment of soft tissue healing and pain measurement using a 10-cm visual analog scale (VAS) after 6 hours, two days, and seven days postoperatively.

Statistical analysis

The data was processed by SPSS version 25.0 software. The data description involved frequency, percentage, mean, standard deviation, and graphs. An independent t test was conducted to evaluate the difference in mean between two quantitative variables. In all tests, the significance was determined by a *p*-value of < 0.05.

RESULTS

A sample of 15 patients, 9 males (60%) and 6 females (40%), had an age mean of 52.60±0.57 years, ranging from 45 to 66 years (Table 1).

Table 1: Age mean, minimum, maximum, and sex of patients in the study

Age			Sex	
Mean±SD	Range	n(%)	Male	Female
52.60±6.57	45-66		6(40)	9(60)
		Total	15(100)	

All patients spent only 6 hours in the hospital. When measuring swelling from the center of the tragus to the nasal border, there was a significant difference between piezo and rotary methods after 2 days postoperatively (p=0.03). Similarly, when measuring from the external eye corner to the labial commissure, there was a significant difference between piezo and rotary methods after 2 days postoperatively (p=0.01), and when measuring from the tragus to the labial commissure, there was a significant difference between piezo and rotary methods after 2 days postoperatively (p= 0.001). these results are detailed in Table 2.

Table 2: Mean edema as measured from the tragus center to the nasal border, the external corner of the eye to the labial commissure, and the tragus to the labial commissure

	Group	Center of tragus to nasal border	*p*	External eye corner to labial commissure	*p*	Tragus to labial commissure	*p*
Preoperative	Piezo	147.2±9.6	0.56	80.5±1.8	0.83	112.3±5.5	0.63
	Rotary	145.6±10		80.7±1.7		111.3±5.8	
2 days	Piezo	149.7±9.8	0.03	84.0±3.6	0.01	115.4±5.5	0.001
	Rotary	156.0±7.9		88.3±5		125.0±6.3	
7 days	Piezo	148.2±10.6	0.81	81.8±4.1	0.33	113.1 ± 5.7	0.79
	Rotary	149.0±7.8		83.1±2.9		113.7±5.4	
One month	Piezo	147.5±9.9	0.62	80.7±1.8	0.52	112.5±5.4	0.58
	Rotary	145.7±10		81.1±2		111.3±5.7	

Values were expressed as mean±SD.

Regarding mouth opening, after two days, the piezo group had a larger mouth opening (43.86±4.05) than the rotary group (41.40±3.85; p= 0.001). After seven days and one month, the two groups showed no significant difference (Table 3). There was a significant difference between the pain scores of the rotary group (5.40±1.12) at 6 hours and 2 days after surgery and the piezo group (3.13±1.12 and 1.40±0.91), with p values less than 0.0001. The two groups didn't differ significantly after seven days. These results are detailed in Table 4.

Table 3: Mean of opening the mouth between the groups

Time		Mouth opening	*p*-value
Preoperative	Piezo	46.80±3.21	-
	Rotary	46.80±3.21	
2 days	Piezo	43.86±4.05	0.001
	Rotary	41.40±3.85	
7 days	Piezo	46.20±3.40	0.75
	Rotary	45.80±3.64	
One month	Piezo	46.80±3.21	-
	Rotary	46.80± 3.21	

Values were expressed as mean±SD.

Table 4: Mean of VAS pain score

Pain record	Group	Value	*p*-value
Preoperative	Piezo	-	-
	Rotary	-	
6 hr after operation	Piezo	3.13±1.12	<0.0001
	Rotary	5.40±1.12	
2 days after operation	Piezo	1.40±0.91	<0.0001
	Rotary	3.26±1.09	
7 days after operation	Piezo	-	0.23
	Rotary	0.20±0.07	

Values were expressed as mean±SD.

The average number of analgesics varied significantly between the two groups (7.37±0.49 in the rotary group and 4.62±0.39 in the piezo group), with p= 0.001. This result is detailed in Table 5.

Table 5: The average number of analgesics consumed by each group

Group	Number of analgesic consumption
Piezo group	4.62±0.39
Rotary group	7.37±0.49

Regarding the bony window opening mean time, the piezo group yielded a significantly higher mean (238.93±44.99 sec.) compared to the rotary group (175.46±23.32; p<0.0001). This result is detailed in Table 6.

Table 6: Mean of bony window opening time

	Group	Mean±SD	*p*-value
Bony window opening time (Sec)	Piezo	238.93±44.99	<0.0001
	Rotary	175.46±23.32	

DISCUSSION

In severe cases, maxillary sinus pneumatization resulting from tooth loss can fuse the alveolar bone crest with the sinus floor [2]. Several studies have documented the possibility of maxillary sinus pneumatization following the extraction of a posterior tooth [1]. Before implants were put in the back of the maxilla, procedures like sinus pneumatization, trauma, and maxillary sinus augmentation—also called sinus floor elevation procedures—became popular in people who had lost a lot of bone due to atrophied alveolar bone. The direct lateral window technique is used when less than 5 mm of the alveolar bone remains in the posterior part of the edentulous maxilla [15] by creating a window in the maxillary sinus lateral wall accessing the underlying Schneiderian membrane. After elevating the membrane, the bone graft is put in the newly created area between the elevated membrane and the remaining alveolar bone. This study included more males, which is an expected finding, as men are less caring for their oral health and less likely to seek preventative dental care compared to females [16]. Females are also more knowledgeable about oral health, have more appropriate oral health behaviors, and have more positive views regarding dental visits [17]. By a ratio of about 2:1, men sustain dental trauma more frequently than women do [18]. The use of tobacco also has a significant impact on dental health. Tooth loss, cavities, and oral cancer are all made more likely by using tobacco products. According to Abuse (2020) [19], men have a higher percentage of using tobacco products than women. In this study, the patients' age range was 45 to 66 years, with a mean of 52.60±6.57 years. This finding is similar to that identified by other studies, which mention that the normal age for tooth loss is thought to be beyond 40 years; this impacts sinus pneumatization and crestal bone loss following tooth extraction. The alveolar ridge undergoes three-dimensional resorption, which diminishes its dimensions. Moreover, the osteoclastic activity in the periosteum of the maxillary sinus (MS) may increase [20]. In the preoperative period, both approaches demonstrated postoperative swelling. These results are similar to others that have shown that swelling happens when tissues are damaged during surgery and cause an inflammatory response. They show that prostaglandin E2, bradykinin, and other pain and swelling mediators are being made [21]. After two days, the piezo group experienced significantly less swelling. This finding is similar to what Arakji *et al*. found in 2016 [22]. They found big differences between the sides of piezoelectric and rotary instruments, with swelling being higher on the side of the rotary instrument. The results were also similar. The possible reason might be the selective osteotomy caused by the piezosurgery. Proper usage of piezosurgery decreases damage to blood vessels and nerves during and after the operation, and there is less hematoma, which might reduce facial swelling. Unlike conventional rotary techniques, piezosurgery is not associated with heat production, thus minimizing structural and cellular damage [23]. After 7 days and 1 month, the mean swelling in the piezo group wasn't significantly different from that in the rotary group. These findings are consistent with those from some other studies [24], which reported no significant changes between the piezoelectric and rotary modalities in 7 months and 1 month postoperatively. Regarding mouth opening, due to an inflammatory response to tissue damage during surgery, which reflects the creation of prostaglandin E2, bradykinin, and other pain and edema mediators, a decrease in mouth opening was seen in both groups [21]. After two days, the piezo group had a significantly larger mouth opening. This finding is consistent with that by Arakji and others in 2016 [22], who discovered significant variations between the piezo and rotary instrument sides, with trismus being higher on the rotary instrument sides. Additionally, Sortino *et al*. [25] showed superior jaw opening postoperative results using piezoelectric sides as compared to rotary sides. Piezosurgery is a precise micrometric cut that results in a very limited bloody region; this may be one of the reasons for the successful outcomes. The two groups showed no significant difference after 7 days. Compared to rotary sides, Sortino *et al*. [25] found that piezoelectric sides produced better postoperative mouth opening results. The two groups showed no significant difference after one month. This is in line with Chang *et al*. [26], who reported no discernible change between the piezosurgery and rotary groups regarding the mouth opening. Regarding pain, both methods produced more discomfort following surgery than they did

before. The creation of prostaglandin E2, bradykinin, and other pain and swelling mediators is reflected in these results, which are consistent with those from other research since pain is a result of an inflammatory response in tissues damaged during surgical procedures [21]. After 6 hours and 2 days, the piezo group showed significantly lower mean VAS scores than those in the rotary group. One potential factor that led to the positive findings is the piezotome's ability to deliver a micrometric cutting with the least amount of surface area. Seven days later, the two groups demonstrated no appreciable difference in the reported pain. This finding is consistent with that in some other studies (2018) [27], which documented no discernible difference between the two groups on day 7 regarding pain. The average number of analgesics consumed up until day 7 was significantly lower in the piezo group. This outcome is in line with that reported in other studies [28,29]. Regarding the bony window opening time, both groups had approximately similar dimensions of the bone windows, and the osteotomy was done by the same surgeon. Rotative instruments had a significantly shorter opening time for the bony window. This finding agrees with that in some other studies [30,31]. Regarding complications, no perforation of the sinus membrane, no chronic sinusitis after 3 months, no hemorrhage and no overfilling were observed in both groups.

Limitations of the study

The study has several limitations, including a small sample size, a short follow-up period without a long-term assessment of bone density after maxillary sinus lifting, and the significantly higher cost of piezosurgery compared to traditional rotational surgery.

Conclusions

The piezoelectric technique is more effective and safe for bone excision than the rotary technique because it causes no noise or macrovibrations, and it is safer for dissection. Compared to rotary, the piezoelectric technique causes less postoperative pain, trismus, and edema. Additionally, the piezo technique makes postoperative time more comfortable for patients.

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Conflict of interests

No conflict of interests was declared by the authors.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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