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Research Article

# Comparison of Piezosurgery and Conventional Hand-pieces in Open Sinus Lifting Surgery

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**Abstract:** Based on the ultrasonic principle, the piezoelectric transducer produced moderated frequencies in the medical and industrial sciences. Selectable cuttings can be selected by adjusting the frequency only on mineralized tissues, including the highlights of this device. In many of the precise and sensitive surgeries that the site is close to the important anatomical structure, this property is used to facilitate and secure the surgery. Sinus surgeon surgery is performed in cases where there is no sufficient bone for implant support in the posterior maxilla. It is essential to success the implant and the reconstruction of the dental system.

**Purpose:** The aim of this study was to compare the intra-operative and post-operative effects of piezosurgery and conventional rotative instruments in the open-sided sinus lifting procedure.

**Materials and methods**: In this cross-sectional study 23 patients requiring direct sinus lifting were enrolled. The osteotomy and sinus membrane elevation were performed either with piezosurgery tips or rotative diamond and carbide burs and hand-piece membrane elevators. Time elapsed between bony window opening and completion of membrane elevation (duration), incidence of membrane perforation, visibility of the operation site, postoperative pain and swelling were evaluated.

Results: There was no significant difference between piezosurgery and conventional groups regarding incidence of membrane perforation and post-operative pain ($P>0.05$). However, there were significantly more duration, postoperative inflation and poor operation site visibility and access in the piezosurgery group compared with the hand-piece group ($P<0.05$).

**Keywords**:piezosurgery; sinus lift; inflation; pain; rotative instruments

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# Introduction

Piezosurgery is based on ultrasonic principle with modulated frequency and controlled tip vibration range [1]. Selective cutting is possible with different frequencies acting only on hard tissues [2-3]. It is particularly important when working in close proximity to vital anatomical structures such as maxillary sinus membrane [4-5]. Sinus lifting is a commonly performed procedure in implant therapy when there is bone deficiency in the maxillary posterior region [6-7-8]. It allows placement of implants with sufficient length and enables prosthetic rehabilitation of the edentulous maxillary posterior [9-10]. Direct sinus lifting is indicated when the residual alveolar bone height is significantly insufficient [11]. The lower risk for membrane perforation and enhanced patient comfort enables piezosurgery to be the preferred device to conventional techniques [12-13].

This surgery is done in two ways:

1) If less than 9 to 2 mm augmentation is required for implant placement, closed method is used which can be non-invasive surgery at a lower cost.
1) 2- In the open method, there is a possibility of further augmentation for insertion of suitable implants, especially when the remaining alveolar bone height is less than 3 mm [14-15].

In this research, the open method has been investigated and the steps are done by creating the bony window in the anterior wall of the sinus which shows the membrane in the space created by the substances [16-17]. A bone graft is inserted to get enough bone mass [18-19].

# Materials and Methods

43 patients who needed implantation in the posterior maxillary region with severe bone loss in the target area were randomly selected in a cross-sectional study. Individuals with less than 5 mm of residual alveolar bone height had an indication of open-sided sinus surgery. These patients without systemic disease were uncontrolled, with no history or presence of infection and pathology of sinuses, and non-use of cigarettes had been implemented. Panoramic radiography (OPG) for radiographic examinations to evaluate the anatomical structures of sinus maxillary and measurement of the distance between the alveolar crest and the sinus floor was performed. The site of osteotomy, the total widths of a single premolar tooth and a molar tooth were considered to standardize the size of open-bone window. Patients were randomly treated with one of these two methods. All of these patients were operated by a surgeon with the same skill, and the results of the operation were evaluated.

## Surgical Steps

This surgery was performed under local anesthesia and was used to treat Lidocaine with epinephrine (Lidocaine Epinephrine HCL (2%), E-Persocaine). After pushing the Muccoperiosteal flap, osteotomy was performed by a Mectron Piezosurgery device and surgical bridges, or using a surgical hand-piece and a round and diamond burrs. In the common method of surgical hand-pieces, during osteotomy, firstly, the round burrs were used to cut the cutting force [Fig. 1] and in the finalstages, when approaching the membrane, in order to better open the bony window and try to avoid the molding of the membrane from the round diamond burrs that are less powerful were used [Fig. 2].

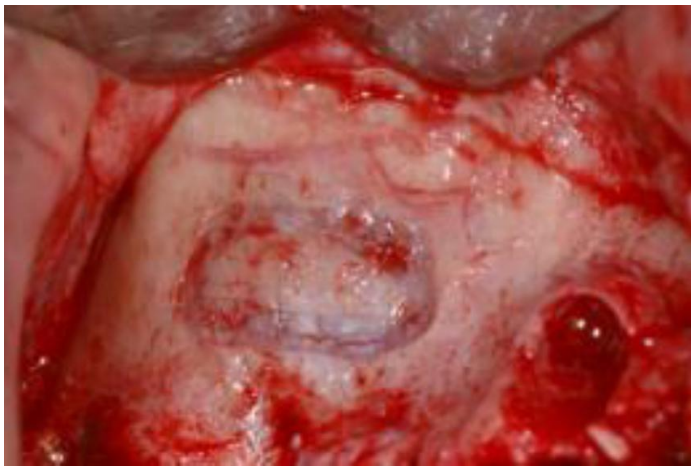

**Fig. 1** Window osteotomy using the round burrs

**Fig. 2** Window osteotomy using the Mectron Piezosurgery device

Separation of the bony window and the sinus membrane from the sinus cavity floor was carried out with special piezoelectric types or hand-piece elevators special for the lift sinus [Fig. 3, 4]. The bony wall was slowly moved into the sinus cavity to form the ceiling of the graft site [Fig. 5, 6].

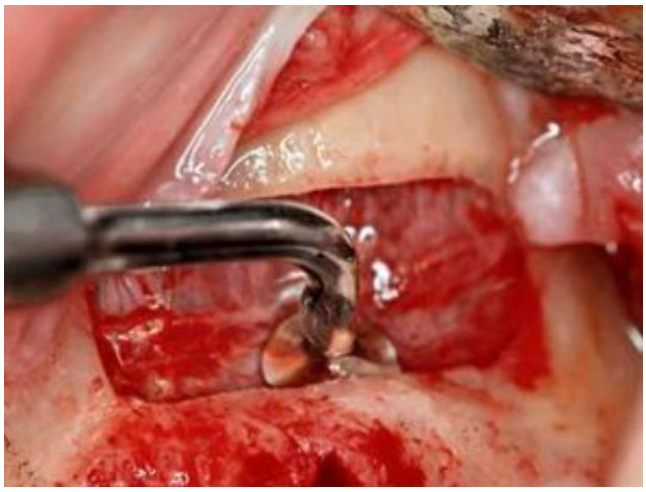

**Fig. 3** Preliminary phase of membrane upgrade by hand-piece elevators

**Fig. 4** Preliminary phase of membrane upgrade by cone compressor

**Fig. 5** The membrane is elevated by Piezosurgery elevators

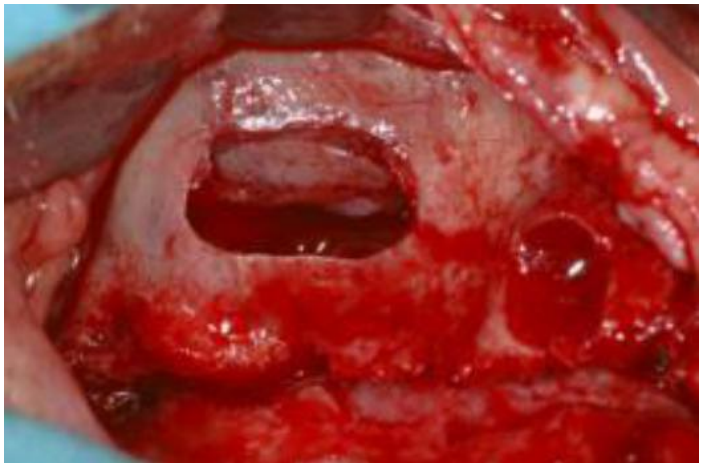

**Fig. 6** The membrane is elevated by hand-piece elevators

In case of membrane perforation, the repairing duration was considered [Fig. 7].

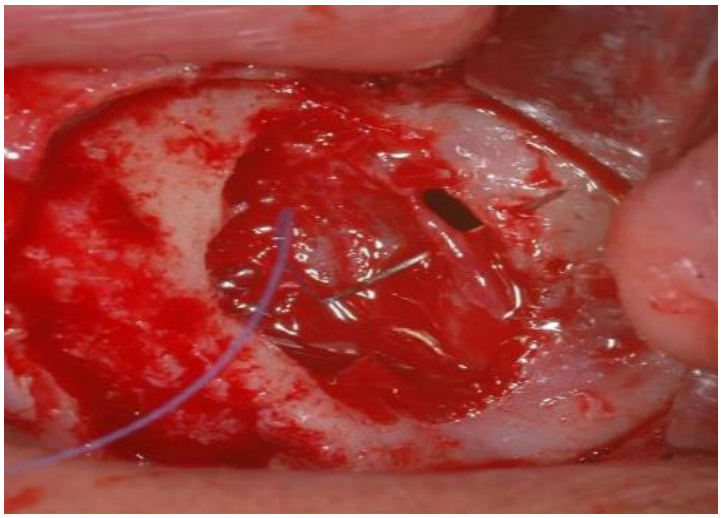

**Fig. 7** Repair of membrane perforation

After obtaining the sufficient space by increasing the sinus membrane, the space was filled with Cerabone material (Natural bovine bone grafting material). The bony window was covered by periosteal elevator except when the perforation occurred that in this case Jason membrane (Porcine pericardium collagen membrane) was used. The flaps were closed with 0.3 silk sutures. All patients received the same version, including Amp Dexamethasone 8 mg, cap Amoxicillin 1500 mg / day, Tab Gelofen 1600 mg / day. Chlorhexidine mouth wash (0.12%) was used in the day after surgery, 2 times a day for two weeks. Sutures were removed 7 days after surgery.

In case of using denture prosthesis, it was not allowed to be used 2 weeks after the operation. Study items were taken in both methods. The duration of the development of the bony window was measured by increasing the sinus membrane, the incidence of perforation, and the repairing duration.

Visibility and access to the surgical site were graded by the surgeon with 4 degrees weak, moderate, good and excellent.

Seven days after the operation, the patient's pain was evaluated by asking him with the following grading:

1) Painless
2) Some pain: If the pain was tolerable and the patient did not have analgesic relief.
3) Quite a bit pain: If the patient had pain and was controlled by analgesic relief use.
4) Severe: If the patient had pain and there was no analgesic effect.

The inflation of each patient by comparing the size of the tragus to the corner of the mouth on the surgical side of the day and 7 days after the operation checked out. The difference between these 2 numbers showed the patient's inflation.

## Statistical Method

The obtained data was abnormal, which was used by various indicators through the Wilcoxon test and Mann-Whitney and Fisher statistical tests to verify or reject the hypotheses. In all sections, if "p" value was lower than 0.05, it indicated the significant of the relationships; otherwise there was not any significant. We analyzed the results through SPSS version 42. To do this, we used the descriptive methods including frequency tables and bar graphs to study the data.

# Results

As you can see the opening time of the bone window in the piezosurgery group with an average of 6.43 min is more than the hand-piece group with an average of 3.59 min (p=0.0001). There is a significant difference between the two groups (by Wilcoxon and Mann-Whitney tests) (Tab. 1, Fig. 8). The duration of membrane enhancement in the Piezosurgery group was 7.14 min more than the hand-piece group with an average of 4.18 minutes (p=0.0001). There is a significant difference between the two groups (Wilcoxon and Mann Whitney tests) (Tab. 2, Fig. 9). As it is seen, the visibility and access to the surgical site in two cases are weak and in the range of 71.4% in the PIS group and in the hand-piece group is 22.7%, which is significant. Visibility and access to surgical site in both good and high cases were 28.6% in the PIS group and in the hand-piece group 77.3%, which is significant (Fisher's Exact Test = 0.002) (Tab. 3, Fig. 10). The incidence of perforation in the two surgical groups is not significant (Fisher's Exact Test = 0.488) (Tab. 4, Fig. 11). Also the pain score was 0% in two cases of moderate to severe in the piezosurgery group; whereas in hand-piece group (9.1%) the difference was not significant. The pain score was 100% in painless or some pain cases piezosurgery group, while in the hand-piece group it was 90.9% and the difference was not significant (Fisher's exact test = 0.488) (Tab. 5, Fig. 12). And finally, as it can beseen, the inflation in the piezosurgery group with an average of 28.71 mm is higher than the hand-piece group with an average of 23.55 mm (P=0.018) but there is a significant difference between the two groups (Wilcoxon and Mann Whitney tests) (Tab. 6, Fig. 13).

The duration of bone window opening in the piezosurgery group was 77.1 ± 43.6 min more than the hand-piece group with a mean of 14.1 ± 59.3 min and this difference was significant (p=0.0001). The duration of membrane rising in the perioral group was 49.1 ± 14.7 min more than the hand-piece group with a mean 14.1 ± 18.4 min and this difference was significant (p=0.0001). The difference in vision of the surgical site in the two groups is significant in both the piezosurgery and hand-pieces groups, while 2% has had a good visual inspection (p=0.0001). There was no significant

difference between the pain level after one week in both groups (p=0.488). Inflation after one week in the piezosurgery group was 749.0 ±87.2 mm more than the hand-piece group with an average of 16.1 ± 35.2 mm, which is significant (p=0.018).

**Tab. 1** Distribution of bone window opening time in two groups

| **Time to open the bone window** (min) | Surgery type | |
|---|---|---|
| 6.43 | Mean | Piezosurgery |
| 21 | Number | |
| 1.777 | Standard deviation | |
| 3.59 | Mean | Hand-piece |
| 22 | Number | |
| 1.141 | Standard deviation | |
| 4.98 | Mean | Total |
| 43 | Number | |
| 2.053 | Standard deviation | |

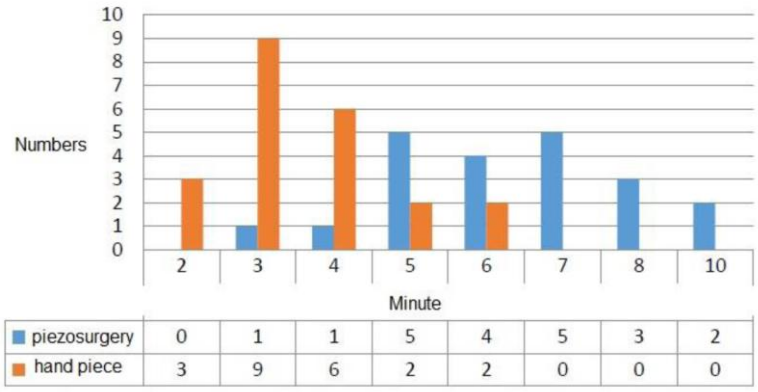


**Fig. 8** Comparison of time to open the bone window in two groups

**Tab. 2** Distribution of membrane rising time in two surgical groups

| **The time to raise the membrane** (min) | Surgery type | |
|---|---|---|
| 7.14 | Mean | Piezosurgery |
| 21 | Number | |
| 1.493 | Standard deviation | |
| 4.18 | Mean | Hand-piece |
| 22 | Number | |
| 1.140 | Standard deviation | |
| 5.63 | Mean | Total |
| 43 | Number | |
| 1.988 | Standard deviation | |

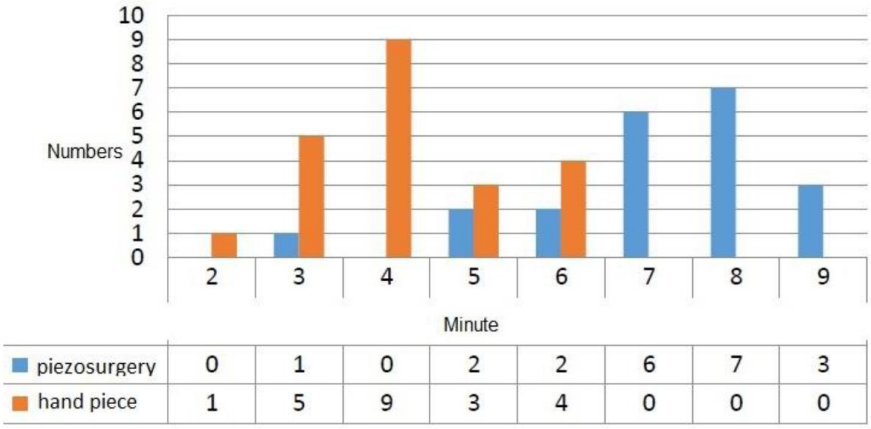


**Fig. 9** Comparison of time to raise the membrane in two groups

**Tab. 3** Distribution of how to see and access the surgical site in the two groups

| Total | Surgery site view and access | | | | | | |
|---|---|---|---|---|---|---|---|
| | Very Good | Good | Moderate | Weak | | | |
| 21 | 0 | 6 | 14 | 1 | Number | Piezosurgery | Surgery type |
| 100.0% | 0% | 28.6% | 66.6% | 4.8% | % in group | | |
| 22 | 6 | 11 | 3 | 2 | Number | Hand-piece | |
| 100.0% | 27.3% | 50.0% | 13.6% | 9.1% | % in group | | |
| 43 | 6 | 17 | 17 | 3 | Number | Total | |
| 100.0% | 14.0% | 39.5% | 39.5% | 7.0% | % in group | | |

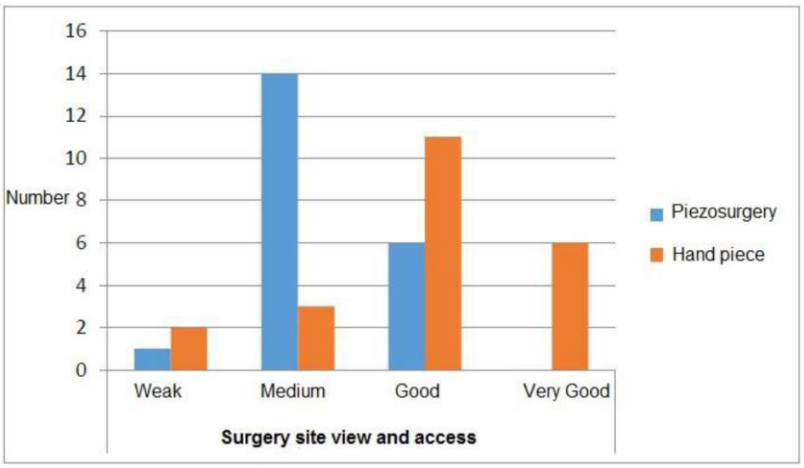


**Fig. 10** Comparison of surgery site view and access in two groups

**Tab. 4** Distribution of perforation in the two groups

| Total | Perforations | | | | |
|---|---|---|---|---|---|
| | + | - | | | |
| **21** | **0** | **21** | Number | Piezosurgery | Surgery type |
| **100.0%** | **0%** | **100%** | % in group | | |
| **22** | **3** | **19** | Number | Hand-piece | |
| **100.0%** | **13.7%** | **86.3%** | % in group | | |
| **43** | **3** | **40** | Number | Total | |
| **100.0%** | **6.9%** | **93.0%** | % in group | | |

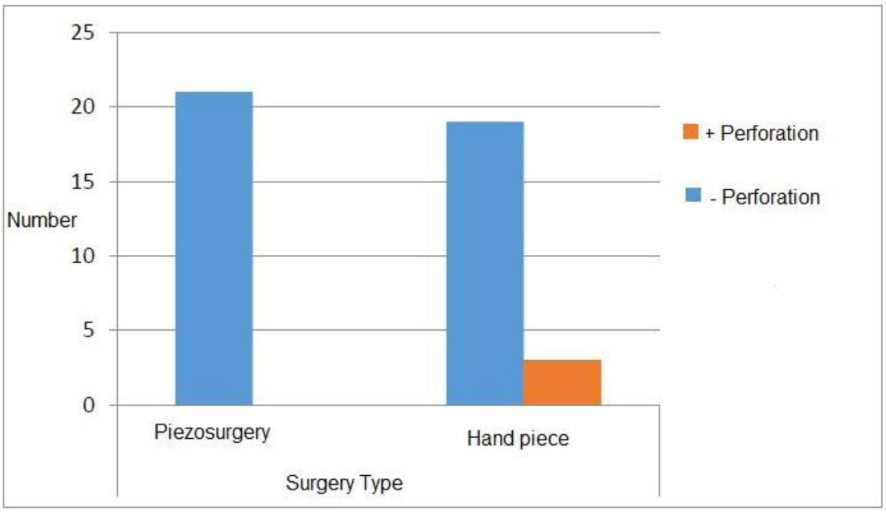


**Fig. 11** Comparison of perforation in the two groups

**Tab. 5** Distribution of pain in the two groups

| Total | Pain | | | | | |
|---|---|---|---|---|---|---|
| | Moderate | Little | No pain | | | |
| **21** | 0 | 16 | 5 | Number | Piezosurgery | Surgery type |
| **100.0%** | 0% | 76.2% | 23.8% | % in group | | |
| **48.8%** | 0% | 80.0% | 23.8% | % in total | | |
| **22** | 2 | 4 | 16 | Number | Hand-piece | |
| **100.0%** | 9.1% | 18.2% | 72.7% | % in group | | |
| **51.2%** | 100% | 20.0% | 76.2% | % in total | | |
| **43** | 2 | 20 | 21 | Number | Total | |
| **100.0%** | 4.7% | 46.5% | 48.8% | % in group | | |
| **100%** | 100% | 100% | 100% | % in total | | |

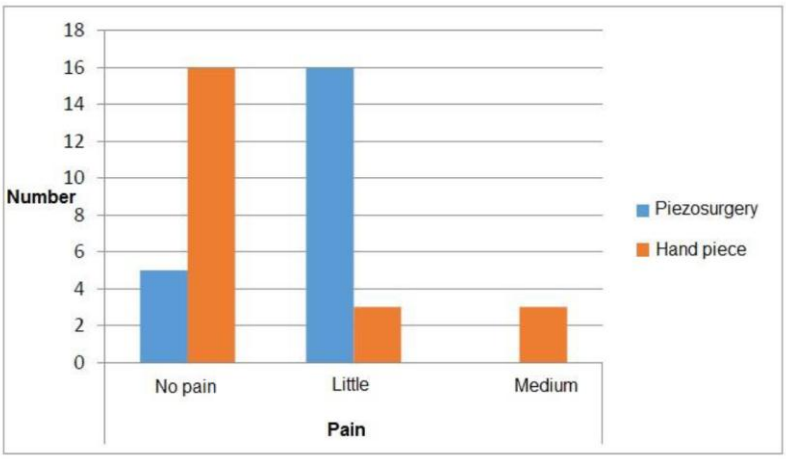


**Fig. 12** Comparison of pain in the two groups

**Tab. 6** Distribution of inflation in the two groups

| **Inflation** (mm) | Surgery type | |
|---|---|---|
| 2.87 | Mean | Piezosurgery |
| 21 | Number | |
| 0.749 | Standard deviation | |
| 2.35 | Mean | Hand-piece |
| 22 | Number | |
| 1.163 | Standard deviation | |
| 2.6 | Mean | Total |
| 43 | Number | |
| 1.006 | Standard deviation | |

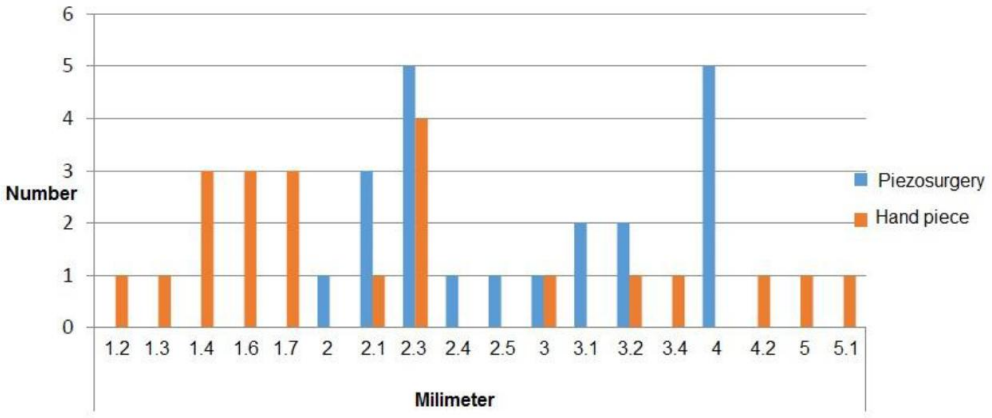


**Fig. 13** Comparison of pain in the two groups

# Discussion

Increasing of the membrane and subsequent bone grafting to restore the posterior region of maxilla for implant placement is widely accepted [20-21]. There are various ways to carry out this plan but the use of ultrasonic waves in the piezosurgery device due to the selective cutting on the mineralized texture and no damage to the soft texture in high risk surgeries it can be justified [22-23-24] Membrane perforation is one of the most commonly encountered surgical complications, and its repair, depending on the size of the perforation, can guarantee the success of the surgery [25-26]. An integrated membrane is essential for bonding stability and prevention of sinus infections [27]. One of the advantages of a piezosurgery device is the lack of damage to the soft texture in the case ofaccidental collision or its slipping [28]. This device due to vibrations and less noise, compared with surgical hand-pieces, can further control the surgeon during surgery [29-7]. Less pressure is required on the surgical site of the surgeon during piezoelectric cutting, which makes it more precise cutting [30-2].

Significant increase in surgical duration in the piezosurgery method is confirmed in many articles. In our study, as in the study of Vercellotti [10], there is a significant difference in the duration of the two operations; while in the study of Barone [13], Rickert [18], and DelliBasic [19] despite of the longer duration of surgery in the Piezosurgery method, the result was that the difference was not significant. The result of our study on the incidence of membrane perforation, such as Barone [6], Rickert and DelilBasic is due to the fact that, despite of the decrease in the incidence of perforation, the difference between the two groups is not significant but Vercelloti [30, 10], Wallace [28], Geminiani [20] and Seoane [21] claimed a significant reduction in perforation in the piezosurgery method. DelliBasic's reason in his article did not see any significant difference between the visual and access examinations of the surgical site in two ways but in our research, visual and access to the surgical site was better in the conventional method of surgical hand-pieces. It can be interpreted that the eruption and splashing of droplets from the tip of the piezosurgery types during surgery can make the visual surgical site weaker; while the usual surgical hand-pieces are washed out by a surgeon when it is essential, by normal syringe saline, in order to achieve a better mastery of the site of surgery. Pain and inflation are one of the most common post-surgical complications in bone surgery. The reason of DelilBasic, Goyal [22] and Arakji [23] have been a significant reduction in pain and inflation in the piezosurgery group; however, in our study, despite of a lesser evaluation of pain in the piezosurgery group, there was no significant difference between the two methods. But in post-surgical inflation, this study showed that a significant increase ininflammation of the piezosurgery group compared with the conventional surgical hand-pieces.

In the interpretation of this result, it can be said that the duration of surgery and the removal of the flap and the rise of the perosteal from the bone and, as a result, the longer the manipulation and more inflammatory response of the body, can make an important contribution to the increase of inflation.

# Conclusion

According to the results of this study, considering the longer duration of surgery, the features of sight and access to the site of surgery and complications after surgery are recommended to use a piezosurgery device in cases where anatomical structures an important site is the surgical site, in order to do a less risky surgery and more certainty for the surgeon, and the advantage of disadvantages should be prioritized.

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