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Effect of Piezoelectric Technique on Auditory Function on Postoperative Day One in Septorhinoplasty Surgery

Adem Emre Ilhan, MD, Yusuf Muhammed Durna, MD,† Ahmet Mahmut Tekin, MD,‡ Fahrettin Yilmaz, MD,§ and Yetkin Zeki Yilmaz, MD||*

Aim: To examine the effect of the piezoelectric application used increasingly for osteotomy and correction of nasal dorsum in septorhinoplasty surgeries on early auditory functions.

Methods: Our study was conducted after the decision of 10840098-604.01.01-E.9057 taken from Istanbul Medipol University Clinical Research Local Ethics Committee. This study was designed to be prospective, randomized and controlled. Twenty patients between 18 and 50 years of age that piezoelectric technique was used in the study group and 10 patients in the same age range who underwent nasal surgery (endoscopic sinus surgery, septoplasty, lower concha radiofrequency and nasal valve surgery) for any reason in the control group were included in the study. Audiologic functions of the patients in both the groups were assessed by pure audio audiometry, tympanometry and distortion product otoacoustic emission test before the surgery and 24 hours after the surgery. The data obtained were statistically compared using the SPSS 22.0 program and $P < 0.05$ was considered significant.

Results: Twenty patients (5 males, 15 females) that piezoelectric (ultrasonics) technique was used during septorhinoplasty in the study group and 10 patients (5 males, 5 females) in the control group were included in the study. In the study and the control groups, preoperative and postoperative air/bone path thresholds at the right and left ears did not differ significantly ($P > 0.05$) at 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz. The results of distortion product otoacoustic emission results (signal/noise ratio) obtained postoperatively were not statistically significant ($P > 0.05$) with the results obtained preoperatively.

Conclusion: The results of the study show that the piezoelectric technique used in septorhinoplasty does not cause a negative effect on auditory functions. This study is the first comparative study to investigate the effect of piezoelectric technique used in septorhinoplasty surgery on auditory functions. After further clinical studies performed with well-selected and large patient population, the piezoelectric techniques can be a preferred technique during septorhinoplasty operations.

Key Words: Otoacoustic emission, osteotomy, piezoelectric, pure tone audiometry, rhinoplasty

Septorhinoplasty is a commonly applied cosmetic and functional surgical procedure that is requested and accepted by patients.[1] Septorhinoplasty is a combination of rhinoplasty and septoplasty surgeries. Rhinoplasty is performed for cosmetic or functional reasons to reshape the nose, while septoplasty corrects a deviated septum to restore normal breathing function.[2] Lateral and median osteotomy is one of the important steps in rhinoplasty operations. The osteotomy used to close the open roof occurred after nasal dorsum correction is used in many nasal deformity surgeries. Septorhinoplasty is a complex operation that requires precise preoperative diagnosis to select the appropriate surgical

From the *Rhinocenter, Private Practice, Istanbul; †Luleburgaz State Hospital, ENT Clinic, Kirklareli; ‡Bilecik State Hospital, ENT Clinic, Bilecik; §Department of Otolaryngology, Istanbul Medipol University; and ||Yavuz Selim State Hospital, ENT Clinic, Istanbul, Turkey.
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Address correspondence and reprint requests to Yusuf Muhammed Durna, MD, Luleburgaz State Hospital, ENT Clinic, Kasap Ilyas Mah Org Abdurrahman Nafiz Gurman Cad, Lüleburgaz, Kirklareli 39080, Turkey; E-mail: yusufmdkbb@gmail.com
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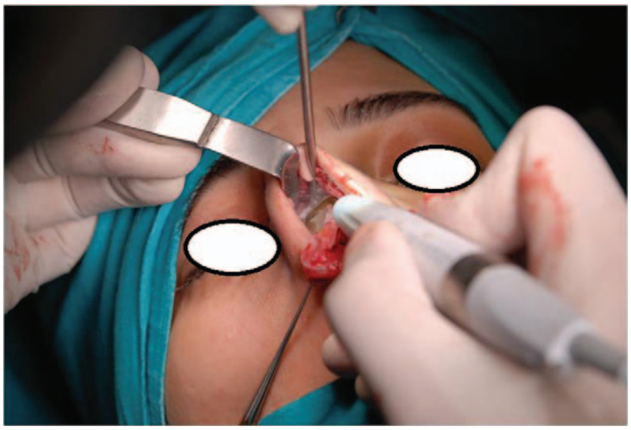

FIGURE 1. Bilateral median and internal lateral osteotomies and bone hump resections were performed using peizoelectric technique.

technique, and has a central importance for both nasal function and facial form.[3] Septorhinoplasty includes various new techniques and modifications with the basic aim to improve functional nasal breathing and to restore cosmetic harmony to the face.[3] On the contrary, since hearing and smell are closely related to each other, choosing the techniques that will not harm the sense of hearing and contribute to the hearing function as a result of the surgery performed on the nose should be one of the important points in the nose surgeon. It is a great advantage that the techniques used during septorhinoplasty do not have any side-effects on the hearing sense or other sensory organs, and it also provides comfort to the patient. In recent years, piezoelectric methods have been used to prevent soft tissue damage during osteotomy, to create regular fracture lines, and to give the most appropriate cosmetic shape.[4,5] The vibratory effect that occurs during piezoelectric application can reach the cochlea through the bone and may affect the cochlear functions. However, when the literature data are examined, the effect of the piezoelectric method, which is used increasingly during septorhinoplasty, on the cochlear function has not been investigated. Our purpose is to investigate the effect of piezoelectric (ultrasonic) technique on auditory function on postoperative day 1 in septorhinoplasty surgery in a prospective randomized clinical trial. This study was planned to demonstrate that the use of piezoelectric techniques as an ultrasonic method is safe and has no effect on hearing functions during septorhinoplasty surgeries. As a matter of fact, while the piezoelectric technique we used frequently during septorhinoplasty operations shows no side effects on hearing, we think that surgeons can use the method more reliably and frequently and can easily recommend the patients.

METHODS

Our study was conducted after the decision of 10840098-604.01.01-E.9057 taken from Istanbul Medipol University Clinical Research Local Ethics Committee. Twenty patients (5 males, 15 females) (18–50 years) that piezoelectric technique was used during the septorhinoplasty in the study group and 10 patients (5 males, 5 females) in the control group were included in the study. Study patients were selected among patients who were admitted to the hospital with the reason of deformities of the nose and difficulty in breathing and who were diagnosed with nasal deformity and nasal septum deviation after preliminary evaluation and who had an indication for open technique septorhinoplasty. The control group was selected from patients who did not have any nasal bone problem with no nasal deformity and did not undergo osteotomy during surgery (such as functional endoscopic sinus surgery, conchal surgery, and columella surgery).

Patients who used medicine within the last 2 weeks, which may affect the cochlear system (cochlear toxicity), with known systemic disease, past head trauma and ear surgery history, pathology at the ear examination, or who were not tympanogram type A were excluded from the study. All patients in the study and control groups were subjected to pure audio audiometry, tympanometry and distortion product otoacoustic emission (DPOAE) test 2 hours before preoperatively. Same tests were repeated on postoperative day 1 by using the same methods in the study and control groups. The used devices were interacoustic AC 40 model for pure audio audiometry, interacoustic titan model for tympanometry, and interacoustic model for DPOAE. Pure audiometry was performed with airway thresholds of 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz and bone path thresholds of 500, 1000, 2000, and 4000 Hz. The signal/noise (S/N) ratio was measured at 500, 1000, 2000, 4000, 6000, and 8000 Hz in the otoacoustic emission.

Surgical Technique

Patients in the study group underwent nasal dorsum skin elevation with midcolumellar V incision after local jetcaine infiltration under general anesthesia. The periosteum was incised and elevated and nasal dorsum was revealed. The septum was entered via dorsal approach and the septum-related problems were elevated. Cartilage grafts suitable for the pathologies of the nasal dorsum were used. Bilateral median and internal lateral osteotomies and bone hump resections were performed using piezoelectric technique and the time was recorded (Fig. 1). After the surgery, the procedure was terminated by bandaging and external thermal splint and silicone pad.

Statistical Analysis

Data were presented as mean with standard deviation and median with minimum and maximum. Statistical analyses were performed using the IBM SPSS Statistics for Windows, Version 22.0 program (IBM Corp, Armonk, NY). Paired and unpaired *t* tests were used in the analysis of clinical data. A value of $P < 0.05$ was considered significant.

RESULTS

Pure Tone Audiometry

The average duration of the use of piezoelectric energy in our study was 3.2 minutes (range 3–3.4 minutes). Preoperative and postoperative air/bone gap thresholds at the frequencies of 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz of the right and left ears were not statistically significant in both study and control groups ($P > 0.05$). Postoperative air/bone gap thresholds at the frequencies of 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz of the right and left ears did not show a significant variation in comparison to the preoperative period ($P > 0.05$) (Table 1).

Otoacoustic Emission

Preoperative and postoperative S/N ratios of otoacoustic emission of the right and left ears at the frequencies of 500, 1000, 2000, 4000, 6000, and 8000 Hz were not statistically significant in both the groups ($P > 0.05$). In the study group, postoperative S/N values at the frequencies of 500, 1000, 2000, 4000, 6000, and 8000 Hz did not show a significant variation in comparison to the preoperative period ($P > 0.05$). In the control group, postoperative S/N ratio

TABLE 1. Variations in Air/bone Gap of the Right and Left Ears in Pure Tone Audiometry

	Right Ear					Left Ear				
	Patients		Controls			Patients		Controls		
	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)	*P*-value	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)	*P*-value
Air conduction										
250 Hz										
Preop	13.5 ± 7.7	15.0 (−5.0 to 25.0)	12.5 ± 7.5	10.0 (5.0–30.0)	0.481	12.2 ± 7.5	15.0 (−5.0 to 25.0)	13.0 ± 8.2	12.5 (0.0–30.0)	0.123
Postop	12.5 ± 6.1	12.5 (0.0–25.0)	10.4 ± 5.5	7.5 (0.0–30.0)	0.138	13.3 ± 7.0	12.5 (−5.0 to 25.0)	10.0 ± 6.7	10.0 (0.0–20.0)	0.190
500 Hz										
Preop	10.5 ± 6.9	10.0 (−5.0 to 25.0)	9.5 ± 9.0	7.5 (0.0–30.0)	0.433	9.3 ± 6.5	10.0 (−5.0 to 25.0)	11.0 ± 7.4	10.0 (5.0–30.0)	0.173
Postop	10.3 ± 5.1	10.0 (−5.0 to 25.0)	7.5 ± 5.9	5.0 (5.0–30.0)	0.184	10.5 ± 6.3	10.0 (−5.0 to 25.0)	7.0 ± 4.8	7.5 (0.0–15.0)	0.089
1000 Hz										
Preop	8.8 ± 6.5	7.5 (0.0–25.0)	8.5 ± 6.3	5.0 (0.0–20.0)	0.795	6.0 ± 6.2	5.0 (0.0–20.0)	7.0 ± 7.9	5.0 (0.0–25.0)	0.194
Postop	7.5 ± 6.4	5.0 (−5.0 to 25.0)	7.0 ± 5.9	5.0 (0.0–25.0)	0.825	5.2 ± 5.2	5.0 (0.0–20.0)	4.5 ± 6.4	5.0 (−5.0 to 15.0)	0.166
2000 Hz										
Preop	6.3 ± 6.0	5.0 (0.0–20.0)	7.0 ± 4.2	10.0 (0.0–10.0)	0.376	5.0 ± 6.9	5.0 (−5.0 to 25.0)	6.5 ± 7.5	10.0 (−5.0 to 15.0)	0.101
Postop	5.3 ± 6.0	5.0 (0.0–25.0)	6.0 ± 3.9	5.0 (0.0–15.0)	0.473	4.0 ± 6.2	5.0 (−5.0 to 20.0)	4.0 ± 7.4	5.0 (−5.0 to 15.0)	0.210
4000 Hz										
Preop	6.8 ± 8.6	5.0 (−10.0 to 30.0)	5.5 ± 8.0	5.0 (−10.0 to 15.0)	0.911	5.0 ± 6.8	5.0 (−10.0 to 20.0)	13.5 ± 10.0	15.0 (0.0–30.0)	0.020
Postop	5.2 ± 7.6	5.0 (−5.0 to 30.0)	5.5 ± 6.4	7.5 (−5.0 to 10.0)	0.500	4.5 ± 6.2	5.08 (−5.0 to 20.0)	10.0 ± 8.5	7.5 (0.0–25.0)	0.060
6000 Hz										
Preop	10.8 ± 9.4	10.0 (−5.0 to 35.0)	10.5 ± 9.3	10.0 (0.0–25.0)	0.924	9.0 ± 7.8	7.5 (−5.0 to 30.0)	12.5 ± 6.8	12.5 (0.0–20.0)	0.129
Postop	11.0 ± 7.8	10.0 (−5.0 to 30.0)	12.0 ± 7.9	12.5 (0.0–20.0)	0.610	10.2 ± 8.4	10.0 (−5.0 to 25.0)	13.0 ± 7.1	12.5 (5.0–25.0)	0.137
8000 Hz										
Preop	8.8 ± 8.7	10.0 (−5.0 to 35.0)	6.5 ± 7.1	5.0 (−5.0 to 20.0)	0.463	8.5 ± 8.1	10.0 (−5.0 to 30.0)	8.0 ± 6.7	7.5 (0.0–15.0)	0.110
Postop	8.2 ± 6.6	10.0 (−5.0 to 30.0)	6.0 ± 5.7	5.0 (0.0–20.0)	0.412	6.0 ± 7.0	5.0 (−5.0 to 25.0)	6.5 ± 9.4	5.0 (−10.0 to 25.0)	0.187
Bone conduction										
500 Hz										
Preop	7.8 ± 6.0	10.0 (0.0–20.0)	5.5 ± 9.8	2.5 (−10.0 to 25.0)	0.311	6.0 ± 6.6	5.0 (−5.0 to 25.0)	6.0 ± 9.9	5.0 (−5.0 to 30.0)	0.159
Postop	6.5 ± 5.7	7.5 (−5.0 to 15.0)	3.5 ± 7.5	5.0 (−10.0 to 10.0)	0.305	6.3 ± 7.2	5.0 (−10.0 to 20.0)	4.2 ± 5.3	2.5 (−5.0 to 10.0)	0.051
1000 Hz										
Preop	3.5 ± 7.1	5.0 (−10.0 to 20.0)	2.0 ± 5.9	0.0 (−10.0 to 10.0)	0.421	3.2 ± 5.3	0.0 (−5.0 to 20.0)	3.0 ± 7.1	0.0 (−5.0 to 15.0)	0.108
Postop	2.5 ± 7.3	0.0 (−5.0 to 25.0)	2.0 ± 6.3	2.5 (−10.0 to 10.0)	0.782	2.2 ± 5.5	0.0 (−10.0 to 20.0)	2.1 ± 6.6	0.0 (−5.0 to 15.0)	0.260
2000 Hz										
Preop	3.3 ± 6.6	0.0 (−5.0 to 25.0)	4.5 ± 6.4	5.0 (−10.0 to 10.0)	0.238	2.0 ± 6.9	0.0 (−5.0 to 25.0)	2.8 ± 6.4	10.0 (−5.0 to 10.0)	0.104
Postop	1.3 ± 6.1	0.0 (−5.0 to 15.0)	2.0 ± 5.9	0.0 (−10.0 to 10.0)	0.357	1.2 ± 7.2	0.0 (−10.0 to 15.0)	1.3 ± 7.4	0.0 (−5.0 to 10.0)	0.323
4000 Hz										
Preop	2.0 ± 7.8	0.0 (−10.0 to 30.0)	1.0 ± 7.7	0.0 (−10.0 to 10.0)	0.908	2.1 ± 5.5	0.0 (−5.0 to 10.0)	2.4 ± 9.5	7.5 (−5.0 to 25.0)	0.292
Postop	1.2 ± 6.8	0.0 (−5.0 to 25.0)	1.3 ± 6.7	0.0 (−10.0 to 10.0)	0.326	1.8 ± 5.8	0.0 (−10.0 to 15.0)	2.2 ± 5.7	5.0 (0.0–15.0)	0.111

Postop, postoperative; preop, preoperative; SD, standard deviation.

values at the frequencies of 500, 1000, 2000, 4000, 6000, and 8000 Hz did not show a significant variation in comparison to the preoperative period ($P > 0.05$) (Table 2).

DISCUSSION

Our study was the first comparative study to investigate the effect of piezoelectric technique on auditory function in septorhinoplasty surgery. Considering the analysis of pure tone audiometry and otoacoustic emission data, the use of piezoelectric technique during septorhinoplasty does not have a significant and negative contribution to the hearing function of the right and left ears. Lateral osteotomy is one of the important steps in rhinoplasty operations.[1] In lateral osteotomy used to close the open roof occurred after nasal dorsum correction, piezoelectric methods have been used to prevent soft tissue damage during osteotomy, to create regular fracture lines, and to give the most appropriate cosmetic shape.[4,5] The use of piezoelectric application has increased during rhinoplasty with the reason that postoperative edema and ecchymosis are minimized.[5] Apart from that, the use of piezoelectric energy has been reported in otologic surgeons such as otosclerosis surgeon, intact canal wall tympanoplasty.[6] The effect of vibrations in the piezoelectric application on the inner ear was investigated in the literature in stapes surgery and experimental cochleostomy studies. Its use was reported to be safe according to postoperative 6 months results after stapes surgery and glomus jugulare surgery.[7] It has been shown histologically in the cochleostomy model performed with intact endosteum in rats that it caused considerable damage to the cortical organ in the early period (week 1) compared to the diamond

TABLE 2. Otoacoustic Emission Values of Right and Left Ears

(Signal/Noise % Level)	Right Ear					Left Ear				
	Patients		Controls		*P*-value	Patients		Controls		*P*-value
	Mean ± SD	Median (range)	Mean ± SD	Median (range)		Mean ± SD	Median (range)	Mean ± SD	Median (range)	
500 Hz										
Preop	4.4 ± 6.1	6.4 (−12.0 to 14.0)	6.2 ± 6.2	7.1 (−6.5 to 13.6)	0.463	5.8 ± 4.2	7.7 (−3.6 to 11.5)	6.6 ± 3.8	7.0 (0.4–11.0)	0.492
Postop	5.2 ± 5.8	6.0 (−11.8 to 17.1)	7.1 ± 5.8	8.5 (−6.5 to 12.3)	0.138	4.1 ± 8.5	6.0 (−6.2 to 13.2)	5.0 ± 4.9	6.8 (−7.4 to 9.1)	0.901
1000hz										
Preop	13.5 ± 4.9	13.2 (−0.4 to 23.7)	15.4 ± 5.6	15.2 (8.8–24.2)	0.453	14.0 ± 5.6	13.2 (4.4–22.7)	14.1 ± 5.4	10.7 (8.6–23.2)	0.888
Postop	13.5 ± 5.7	12.9 (−1.3 to 26.3)	17.0 ± 5.3	17.7 (9.2–25.7)	0.089	13.8 ± 4.5	14.4 (2.7–20.4)	15.1 ± 5.4	15.0 (8.2–23.1)	0.696
2000hz										
Preop	17.4 ± 5.4	18.4 (7.9–27.7)	18.6 ± 5.2	18.7 (10.8–28.1)	0.532	8.5 ± 4.9	17.1 (8.1–28.9)	17.4 ± 4.1	17.7 (11.5–23.5)	0.662
Postop	17.3 ± 5.1	18.1 (8.7–25.2)	20.3 ± 5.2	21.7 (10.8–28.1)	0.108	17.1 ± 6.6	17.0 (0.0–26.8)	18.1 ± 4.8	18.3 (11.2–24.5)	0.851
4000hz										
Preop	16.6 ± 6.1	18.4 (−1.0 to 27.4)	17.9 ± 4.7	17.1 (10.5–26.4)	0.803	18.1 ± 4.8	19.0 (6.0–26.0)	16.2 ± 5.0	16.1 (8.9–24.3)	0.274
Postop	17.2 ± 4.7	17.7 (8.5–26.1)	16.9 ± 5.1	16.8 (7.9–25.8)	0.864	17.6 ± 5.5	18.2 (4.3–26.7)	15.1 ± 6.0	15.8 (2.5–24.3)	0.142
6000hz										
Preop	11.6 ± 6.9	11.9 (−0.4 to 25.4)	11.4 ± 8.4	12.9 (−6.9 to 23.5)	0.901	12.3 ± 4.9	12.1 (−3.8 to 22.9)	10.1 ± 7.5	11.4 (−7.0 to 18.1)	0.502
Postop	11.3 ± 6.5	11.8 (−4.2 to 21.7)	10.5 ± 8.6	11.0 (−6.9 to 23.5)	0.791	13.4 ± 6.3	13.0 (0.7–26.6)	10.5 ± 3.9	11.3 (2.2–14.3)	0.151
8000hz										
Preop	5.2 ± 6.7	5.3 (−9.6 to 20.0)	3.4 ± 6.9	4.7 (−5.7 to 11.9)	0.595	5.6 ± 6.7	8.7 (−7.1 to 20.5)	3.6 ± 17.3	4.6 (−6.4 to 15.1)	0.189
Postop	6.0 ± 7.1	6.8 (−12.3 to 22.4)	4.2 ± 6.5	5.6 (−5.6 to 11.9)	0.651	6.2 ± 5.6	7.4 (−1.0 to 18.6)	4.3 ± 17.3	7.5 (−4.9 to 15.1)	0.357

Postop, postoperative; preop, preoperative; SD, standard deviation.

surgery.[8] However, the effect on auditory functions in this study has not been evaluated. With regard to its use in stapes surgeries, evaluation of auditory function at 6 months postoperatively may have resulted in the skipping of the vibrator injury that may have occurred in the early period. The differences in the results of the two studies may be related to the method and frequency used and may be related to the investigation of the cochlear damage at different times. In addition, investigating the cochlear damage during the use of the piezoelectric method in otologic surgeons does not answer the question of direct cochlear damage or damage due to vibration effect. For this reason, we think that evaluation of early auditory function after rhinoplasty may give more objective results.

In literature, the effect of osteotomy used during septorhinoplasty operation on cochlear functions has not been investigated. In our study, the effect on auditory function was investigated with pure audio audiometry and otoacoustic emission. The frequency range from 250 to 8000 Hz was studied considering that different topographical areas of the cochlea could be affected. Both the study group and the control group did not show a statistically significant difference between preoperative and postoperative average pure tone threshold values. No significant difference was observed between the thresholds of the right and left ear pure sound averages in the study and control groups. In the presence of these findings, it was concluded that the piezoelectric method used during the septorhinoplasty operation did not have an adverse effect on the cochlear functions. Similarly, there was no significant difference between preoperative and postoperative periods in the OAE examination used to measure cochlear follicular cell damage in the study and control groups.

In conclusion, our results show that the piezoelectric technique used in septorhinoplasty operations does not cause any negative effect on early auditory functions.

CONCLUSION

The use of piezoelectric technique during a septorhinoplasty operation may be beneficial in terms of preserving hearing function. After further clinical studies performed with well-selected and large patient population, the piezoelectric techniques can be a preferred technique during septorhinoplasty operations.

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