Assessment of the Change in the Nasal Septum and Nasal Profile After Le Fort I With Cone Beam Computed Tomography

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Objective: This study aimed to determine the relationship between nasal changes and the amount of advancement, impaction, and downward movement of the maxilla after Le Fort I osteotomy.

Methods: The study included 48 patients who underwent Le Fort I surgery and had pre- and postoperative cone-beam computed tomography records. Changes in the nasal septum were evaluated by measuring septal deviation angles and volumes. In addition, nasolabial angle and width of nasal and alar base were examined. Groups were determined according to the movement of point A (the deepest point on the curvature of the maxillary alveolar process), using a threshold of 1.5 mm for vertical movements and 4 mm for sagittal movements. This resulted in the comparison of 6 groups of 8 people each. Results are presented as mean and standard deviation or median and range depending on the data distribution. Significance level was accepted as $P < 0.05$.

Result: There were no significant differences for each group on its own septal deviation volume or angle values pre/postoperatively. Groups 3 and 5, which both had at least 1.5 mm of impaction, showed significant changes in both deviation angle and volume between the preoperative and postoperative measurements. Nasolabial angle did not show significant changes between groups. Alar base width and nasal width increase was significantly highest in Group 1, which has more than 4 mm sagittal movement and less than 1.5 mm vertical movement.

Conclusions: Le Fort I osteotomy may lead to undesirable changes in the spatial positioning of the nasal septum. The results of this study suggest that maxillary advancement does not significantly impact septal deviation, whereas maxillary impaction increases the amount of deviation. In addition, nasal width and alar base width tended to increase, and the nasolabial angle tended to decrease slightly, regardless of the direction of movement of the maxilla after orthognathic surgery.

Clinical Relevance: Surgeons should consider increased nasal septal deviation risks when planning impaction of the maxilla. The soft tissue changes in the nose vary according to different directions and amounts of Le Fort I surgery.

Key Words: Le fort I, septal deviation, orthognathic surgery, nasal profile, CBCT

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Dentofacial deformities lead to many functional and phonetic problems in addition to an unaesthetic appearance. Individuals who cannot effectively perform basic functions such as chewing and speaking may have joint problems, difficulty maintaining oral hygiene, and lack of self-confidence. Patients who are unsatisfied with their jaw positions and relationships for aesthetic and/or functional reasons are treated with orthognathic surgery.[1]

Le Fort I osteotomy is the most popular and beneficial method for correcting midface dentofacial deformities.[1] This procedure allows repositioning of the maxillary segment to correct the midface deformity. However, some expected or unexpected changes to the nasal structure and surrounding soft tissue may occur after maxillary osteotomies. Expected soft tissue alterations include changes in nasal width, alar base width, elevation of the nasal tip, thinning of the upper lip, descent of the oral commissures, and increase in nasolabial angle.[2–6] Especially in cases with maxillary impaction osteotomy, position changes in the maxilla may affect the nasal septum and alter the perinasal architecture.[1]

In general, few studies have been conducted on nasal septal deviation as a result of Le Fort I osteotomy.[7–12] Baeg et al[13] and Moroi et al[7] observed no statistically significant changes in septal deviation after surgery in their studies. In contrast, Kramer et al[14] stated that the nasal septum was among the anatomical structures showing the greatest change in their study on complications after Le Fort I procedures. In addition, although Moroi et al[7] classified cases based on the amount of vertical repositioning in the groups examined in their study, no classification was made according to the amount of advancement. Another study evaluating volumetric changes in the nasal cavity, maxillary sinus, and oropharyngeal airway after Le Fort I osteotomy demonstrated a moderate correlation between the change in airway volume and the extent of surgical maxillary movements.[15]

As a result, whether there is an increase in nasal septum deviation after Le Fort I has been evaluated differently in different studies. In our study, it was deemed important to evaluate the connection between the direction of movement of the maxilla and the deviation of the nasal septum. In the literature, such different groups have not been evaluated in the same study.

The present study examined the effects of maxillary movement on the spatial position of the nasal septum to determine the relationship between septum deviation angle and volume and the amount of maxillary advancement and impaction or downward movement after Le Fort I osteotomy. Nasolabial angle, nasal width, and alar base width changes were also examined to support septal deviation changes.

METHODS

This retrospective study was approved by the ethics committee of Istanbul Medipol University (E-10840098-772.02-6755) and complied with the Declaration of Helsinki. Patients with maxillary deficiency who presented to the Department of Oral and Maxillofacial Surgery of Istanbul Medipol University between August 23, 2019, and September 2, 2021, and underwent Le Fort I osteotomies were evaluated. Forty-eight patients (29 females, 19 males) were included in the study if they had cone-beam computed tomography (CBCT) scans obtained preoperatively (T0) and at least 6 months postoperatively (T1). Exclusion criteria were as follows:

- age under 18 years
- previous orthognathic surgery
- previous rhinoplasty/septoplasty
- craniofacial deformities such as cleft lip/palate
- type 4 (S-shaped) septum deviation
- history of maxillofacial trauma.

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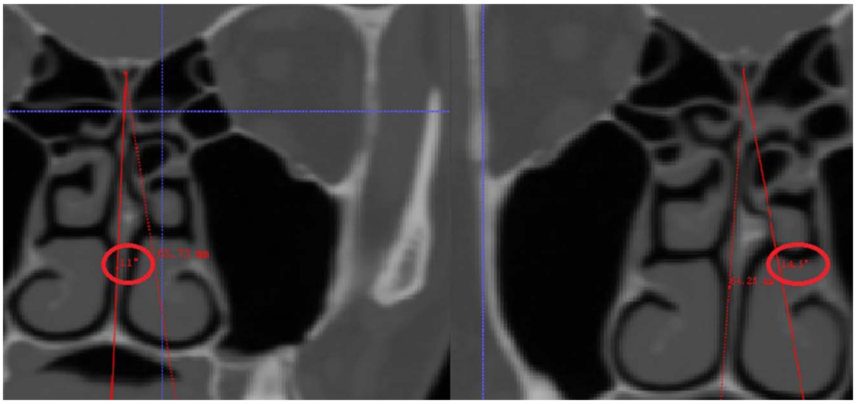

FIGURE 1. Septal deviation angle.

CBCT images were acquired with the Philips Brilliance iCT 256 multislice CT device (Philips Medical Systems, Eindhoven, the Netherlands) with scan settings of 120 kV and 150 mAs. Images were imported into the ITK-SNAP software (version 4.0.1; open source software available at http://www.itksnap.org/pmwiki/pmwiki.php) for septal deviation analysis and 3D Slicer (version 5.3.0) for nasal profile measurements. There was an interval of 6 to 9 months between T0 and T1 CBCT images in all patients.

All patients had undergone similar orthognathic surgical procedures involving the Le Fort I incision at the same hospital. Surgeries were performed under general anesthesia and using nasotracheal intubation. Le Fort I incision was continued from the first maxillary molar to the contralateral side. Maxillary osteotomy was first performed bilaterally with the help of a saw, then a thin osteotome was used to provide the necessary breaks in the lateral and posterior regions. In the final stage of freeing the maxilla, the pterygomaxillary junction was separated with osteotomes, the finger was placed in the mouth, and downfracture was performed by feeling the hamulus and using finger pressure. While determining the new position of the maxilla, the patient was placed in maxillomandibular fixation (MMP) according to the previously prepared surgical splint. The maxilla was fixed in the appropriate position with the help of titanium plates and screws. After proper occlusion was achieved, the incision was sutured, and the surgery was completed.

Septal deviation angle (SDA) and septal deviation volumes (SDVs) were measured in the T0 and T1 CBCT images. SDA was evaluated as the angle between the line from the anterior point of the nasal spine (ANS) to the crista galli and the line from the crista galli to the tip of the deviated nasal septum[16] (Fig. 1).

SDV measurement was based on the space between the ANS and the plane intersecting the crista galli and septal mucosa on the concave side of the deviated nasal septum, and the volume of this space was measured along the anteroposterior length of the septum.[16] During volume measurement, the software was used to delineate the relevant areas in each CT section (Fig. 2), collate the sections to create a 3-dimensional shape, and calculate the volume of the composite shape (Fig. 3).

Nasolabial angle, nasal width, and alar base width measurements were made from soft tissue results obtained from CBCTs (Fig. 4). In our study, the angle between the line passing through the subnasale-labiale superius and the columella was used as the measurement method.[17] Nasal width was measured based on the widest distance from the right alare to the left alare. The distance from the right alar curvature to the left alar curvature was defined as the alar base width.[3]

The amount of downward, impaction, and advancement was determined according to the movement of the maxilla and the change in point A. Sections with the most prominent ANS were identified from T0 and T1 CBCT images. The ruler function of the program was used to draw 10-mm lines in these sections to provide a point of bearing for the length measurements to be made. Points N (nasion), S (sella), and A were determined. The angles between S, N, and N-Perpendicular were calculated to determine the change in point A in T0 and T1 CBCT images (Fig. 5). In order to ensure a consistent head position for evaluation, the images were superimposed by aligning the angle between the S, N, and N-Perpendicular. In the superimpositions, the amount of maxillary advancement was calculated as the difference in the distance between point A and the N-Perpendicular, and the vertical movement of point A was calculated as the difference in the distance to the parallel line passing through point N (Fig. 6). Patient groups were

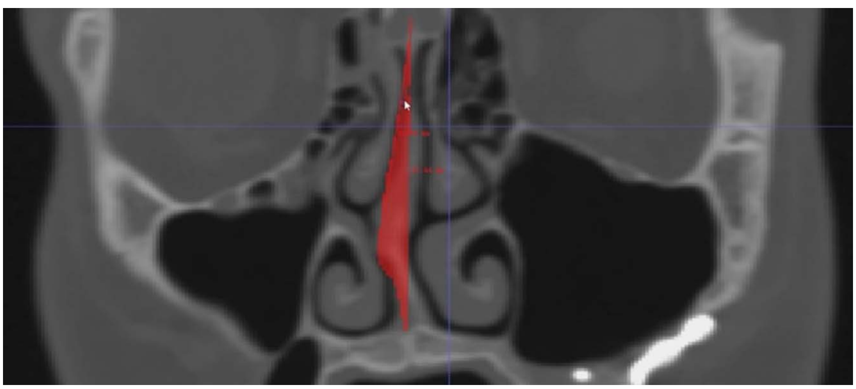

FIGURE 2. Delineated area for a single CBCT section.

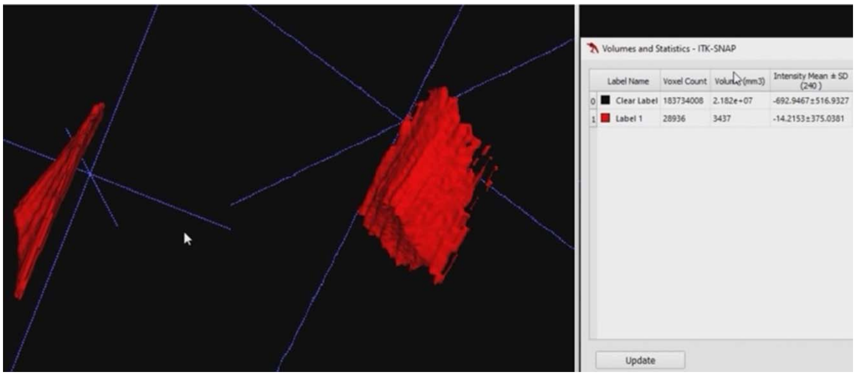

FIGURE 3. Three-dimensional shape of septal deviation volume.

formed based on a threshold of 1.5 mm for impaction/downward movement and 4 mm for maxillary advancement. This resulted in 6 groups of 8 people, as shown in Table 1.

The ratios of the average soft and hard tissue movements were evaluated for the 10 facial regions of all patients. All measurements were repeated at 2-week intervals for 10 randomly chosen patients for the reliability test. Method error was assessed by calculating intraclass correlation coefficients (ICCs) for the first and second measurements. The data were analyzed with IBM SPSS version 23. Compliance with normal distribution was examined with the Shapiro-Wilk test. Normally distributed parameters were compared between the groups using one-way ANOVA with post hoc Tukey HSD test for pairwise comparisons. For nonnormally distributed parameters, comparisons were made using the Kruskal-Wallis test with Dunn's test for post hoc analysis. Repeated measures of normally distributed parameters were compared within groups using paired-samples *t* tests. Results are presented as mean and standard deviation or median and range depending on the data distribution. Significance level was accepted as $P < 0.05$.

RESULTS

The results of within-group and between-group comparisons of SDA and SDV values are shown in Tables 2 and 3. SDA and SDV values showed no statistically significant difference between the groups at both time periods. Comparison of SDA values between T0 and T1 showed statistically significant increase in Groups 3 and 5 ($P = 0.002$ and $P = 0.022$, respectively). Evaluation of changes in SDV between T0 and T1 within the groups revealed statistically significant increases in Groups 2, 3, and 5 ($P = 0.049$, $P = 0.007$, and $P = 0.026$, respectively), whereas there was no statistically significant difference in Groups 1, 4, and 6.

The comparison of ΔSDA and ΔSDV values between groups is shown in Table 4. In group 3 (impaction ≥1.5 mm and advancement ≥4 mm), the angle and volume of septal deviation have significantly increased compared to other groups. Group 6 (downward movement ≥1.5 mm and advancement <4 mm) showed remarkably lowest ΔSDV values.

The results of the correlation analysis between ΔSDA and ΔSDV for each group and without group discrimination are shown in Table 5. A statistically significant positive relationship was found between ΔSDV and ΔSDA values in Group 2, Group 3, Group 4, and Group 5. Without group discrimination, there is a statistically significant positive correlation between ΔSDA and ΔSDV values ($r = 0.710$; $P < 0.001$).

T0 nasal profile measurements showed no statistically significant differences between the groups. However, at the end of treatment, alar base and nasal width were different significantly ($P < 0.001$ and $P = 0.017$, respectively) (Table 6). The difference between Group 1 (advancement ≥4 mm, impaction/downward movement <1.5 mm) and Group 5 (advancement <4 mm, impaction ≥1.5 mm) was found to be

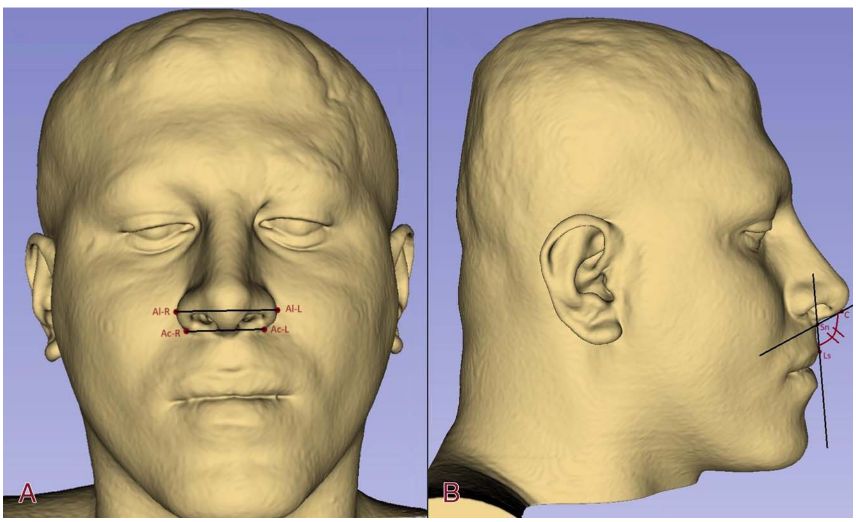

FIGURE 4. Linear and angular measurement. A, Frontal view: nasal width (Al-R – Al-L) and alar base width (Ac-R – Ac-L). B, Lateral view: nasolabial angle (CSnLs). Ac-L, left alar curvature; Ac-R, right alar curvature; Al-L, left alare; Al-R, right alare; C, columella constructed point; Sn, subnasale; Ls, labiale superius.

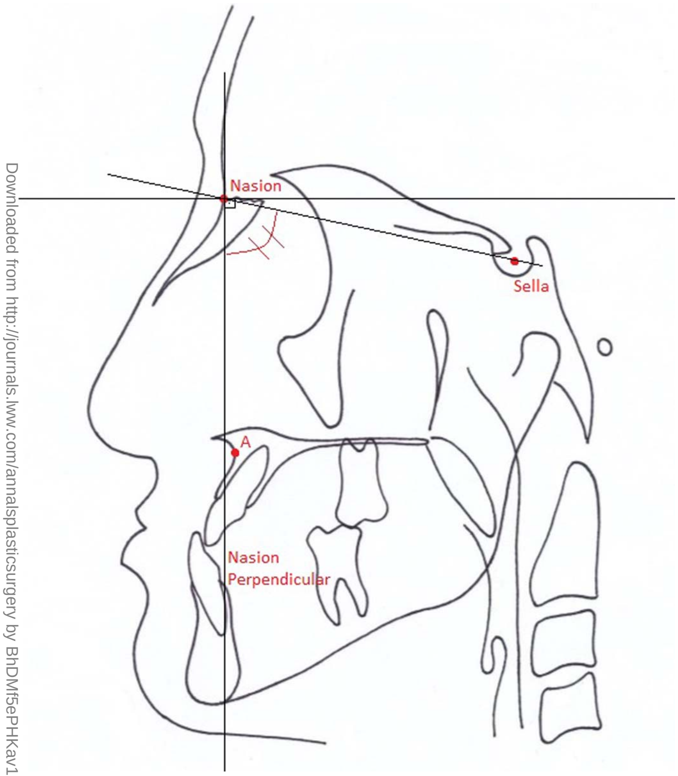

FIGURE 5. S, N, and N-Perpendicular were calculated to determine the change in point A.

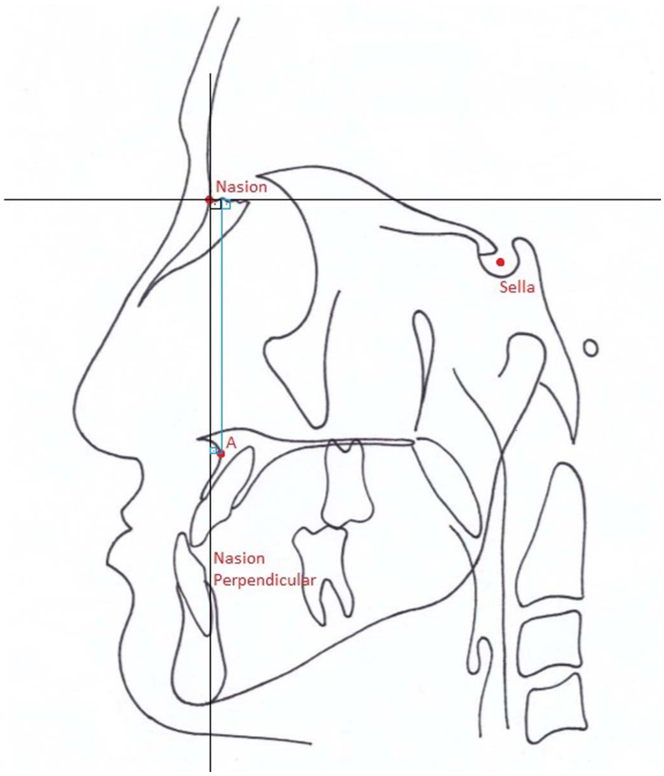

FIGURE 6. Movements of point A were calculated as the differences in the distance to the parallel and vertical lines passing through point N.

statistically significant. The differences in nasal profile measurements are shown in Table 7. Alar base width and nasal width measurements in Group 1 and Group 2 (advancement <4 mm, impaction/downward movement <1.5 mm) increased for all patients. Additionally, nasal width of Group 5 for all patients increased. The increase of nasal width was found to be statistically highest in Group 1. Nasolabial angle and alar base width differences between groups were not found to be statistically significant.

In the evaluation of method error between the first and second measurements of soft tissue, SDA, and SDV, we obtained ICCs between 0.954 and 0.983, indicating that these measurements can be repeated with high reliability.

DISCUSSION

With advances in surgical technique, orthognathic surgery is now considered lower risk than ever before in most cases and has become increasingly common in recent years. However, there are still rare complications that should not be ignored. Therefore, it is important to understand and study these complications to ensure a correct diagnosis and take all possible precautions.[18,19]

Changes in the nasal septum as a result of orthognathic surgery have been discussed in various studies. This change has generally been determined by measuring the differences in nasal septum angle. Fewer studies have measured the nasal septum volume for this purpose. In our study, we examined both the septum deviation angle and volume to evaluate their relationship with the amount of maxillary advancement and impaction or downward movement after Le Fort I osteotomy.

Our results revealed a positive correlation between ΔSDA and ΔSDV values. These findings are consistent with those reported in a study by Orhan et al[16] comparing maxillary sinus volume with SDA and SDV values. Eliason et al[8] evaluated the axial displacement of the septum before and after Le Fort I osteotomy in both degrees and millimeters using computed tomography scans. In the comparison of preoperative and postoperative images, they observed varying amounts of nasal septum deviation in all 30 patients in their study. They reported that Le Fort I osteotomy may cause permanent nasal septal perforations, changes in the nasal septum, and increased nasal dyspnea.

The changes in the nasal structure induced by maxillary osteotomies also led to discussions about performing rhinoplasty concurrently with maxillary osteotomy surgery. In a 2017 study, it was concluded that, although some authors argued for concurrent rhinoplasty and maxillary osteotomy, performing the procedures sequentially was more appropriate in most cases.[20] Yong et al[21] conducted a literature review to investigate whether the nasal airway was adversely affected by maxillary impaction. They reviewed the PubMed, Embase, and Cochrane Library databases and determined that, although the volume

TABLE 1. Patient Groups

Groups	Amount of Advancement	Amount of Impaction/Downward Movement
Group 1	Advancement ≥4 mm	Impaction/downward movement <1.5 mm
Group 2	Advancement <4 mm	Impaction/downward movement <1.5 mm
Group 3	Advancement ≥4 mm	Impaction ≥1.5 mm
Group 4	Advancement ≥4 mm	Downward movement ≥1.5 mm
Group 5	Advancement <4 mm	Impaction ≥1.5 mm
Group 6	Advancement <4 mm	Downward movement ≥1.5 mm

TABLE 2. Comparison of SDA Values

	T0 – SDA		T1 – SDA		
	Mean ± SD	**Median (Min–Max)**	**Mean ± SD**	**Median (Min–Max)**	***P****
Group 1	9.18 ± 5.38	9.2 (2–18.4)	9.41 ± 5.24	9.2 (2–18.3)	0.255
Group 2	11.08 ± 4.94	10.75 (4–17.2)	11.38 ± 4.91	11.25 (4.5–18.7)	3.305
Group 3	10.84 ± 5.75	11.35 (2.6–19.3)	12.75 ± 5.29	12.8 (5–20.1)	**0.002**
Group 4	11.94 ± 4.97	13.6 (1.8–17.5)	12.53 ± 4.43	13.8 (3–16.5)	0.098
Group 5	11.43 ± 2.34	11.2 (8.4–16)	12.56 ± 2.37	12.8 (9.8–16.3)	**0.022**
Group 6	9.73 ± 5.58	8.95 (3.4–19.9)	9.95 ± 5.88	9 (3.3–21)	0.247
*P***	0.875		0.610		

Bold values indicate statistical significance as $P < 0.05$.

*One-way ANOVA.

**Paired two-sample *t* test.

Min–max, minimum–maximum; SD, standard deviation; SDA, septal deviation angle.

of the nasal cavity decreased after maxillary impaction, there was no increase or decrease in nasal air flow and resistance. Thus, they concluded that impaction of the maxilla did not adversely affect the nasal airway. Similarly, Kim et al[22] evaluated pre- and postoperative nasal airway function in patients who underwent orthognathic surgery with maxillary impaction and concluded that nasal airway function actually improved after the procedure. Pourdanesh et al[23] conducted a similar study and stated that improvements in nasal airflow should be expected after Le Fort I osteotomy, especially if the amount of impaction is less than 5.5 mm. However, there are also studies concluding that the risk of deviation is higher after Le Fort I osteotomy in cases with impaction. Although Shin et al[1] described it as a rare complication, they reported that maxillary impaction in particular may affect the septum and perinasal architecture. Asan et al[10] determined in their study that 37% of patients may have septum deviation after Le Fort I surgery. In their study examining complications after orthognathic surgery, Chow et al[24] reported that 7.2% of patients who developed postoperative complications had deviated nasal septum.

In our study, no significant relationship was found between the amount of maxillary advancement and the risk of septum deviation. Although there are many studies in the literature, the amount of vertical movement of point A has not been considered much in these studies. There are conflicting results in these studies whether maxillary advancement causes septum deviation or whether a relationship cannot be established.[7–12,25] We think that the separation of maxillary impaction from advancements in our groups increases the reliability of the results compared to studies in the literature.

Maxillary downward movement is considered a less stable orthognathic surgery procedure.[26] However, no study has been found in the literature indicating that the downward movement causes any deviation in the nasal septum. In our study, no unexpected results were detected in this respect.

There were studies that concluded that the risk of deviation was higher after Le Fort I osteotomy, especially in cases where impaction movements were performed.[1,11,27,28] This deviation after surgery may depend on the extent of maxillary movement and in which direction it occurs.[9,28] In our study, attention was drawn to the risk of septum deviation in maxillary impaction cases. The presence of different amounts of maxillary advancement groups accompanying the amount of impaction was found to be important, as it indicates that this effect is caused by, independent of the advancements.

After orthognathic surgery, different changes are expected in the nasolabial angle depending on the movement made. The nasolabial angle increases with the impaction and relative retraction of the maxilla. In cases where maxillary impaction alone or maxillary impaction and maxillary advancement are performed together, it is expected to decrease slightly or remain the same.[29] However, in our study, the change in the nasolabial angle was not different between the groups. It is thought that the amounts of maxillary impaction and advancements do not create major changes clinically, and in fact, the movement of

TABLE 3. Comparison of SDV Values

	T0 – SDV		T1 – SDV		
	Mean ± SD	**Median (Min–Max)**	**Mean ± SD**	**Median (Min–Max)**	***P****
Group 1	3.38 ± 1.46	2.9 (1.9–6.4)	3.56 ± 1.65	3.05 (2–7.2)	0.090
Group 2	4.21 ± 1.84	3.9 (1.8–8)	4.34 ± 1.89	4.05 (2–8.3)	**0.049**
Group 3	3.66 ± 1.54	3.35 (1.9–6.8)	4.41 ± 1.3	4.1 (3.1–7)	**0.007**
Group 4	4.31 ± 1.32	4.45 (1.8–6)	4.51 ± 1.26	4.65 (2–6)	0.138
Group 5	3.99 ± 0.78	4.05 (2.9–5)	4.33 ± 0.81	4.8 (2.9–5.1)	**0.026**
Group 6	3.66 ± 1.83	3.1 (2–6.6)	3.64 ± 1.85	3.15 (1.8–6.2)	0.756
*P***	0.800		0.691		

Bold values indicate statistical significance as $P < 0.05$.

*One-way ANOVA.

**Paired two-sample *t* test.

Min–max, minimum–maximum; SD, standard deviation; SDV, septal deviation volume.

TABLE 4. Comparison of ΔSDA and ΔSDV Values

	ΔSDA		ΔSDV	
	Mean ± SD	Median (Min–Max)	Mean ± SD	Median (Min–Max)
Group 1	0.24 ± 0.54[b]	0 (−0.3 to 1.4)	0.19 ± 0.27	0.2 (−0.1 to 0.8)[ab]
Group 2	0.23 ± 0.8[b]	0.1 (−1.1 to 1.5)	0.13 ± 0.15	0.2 (−0.1 to 0.3)[ab]
Group 3	1.91 ± 1.15[a]	2 (0.3–4)	0.75 ± 0.56	0.7 (0.2–1.6)[a]
Group 4	0.59 ± 0.87[b]	0.5 (−1 to 1.8)	0.2 ± 0.34	0.1 (−0.2 to 0.8)[ab]
Group 5	1.14 ± 1.1[ab]	0.8 (0.2–3.5)	0.34 ± 0.34	0.3 (−0.1 to 0.8)[ab]
Group 6	0.23 ± 0.5[b]	0.25 (−0.5 to 1.1)	−0.03 ± 0.22	−0.1 (−0.4 to 0.2)[b]
P	**0.001***		**0.011****	

Bold values indicate statistical significance as $P < 0.05$.

[a, b]: No significant difference between same/common lettered groups.

*One-way analysis of variance.

**Kruskal-Wallis test.

Min–max, minimum–maximum; SD, standard deviation; ΔSDA, difference of septal deviation angle between pre- and postoperative; ΔSDV, difference of septal deviation volume between pre- and postoperative.

the maxilla in general after Le Fort I osteotomies does not create very definite changes in the nasolabial angle.

As a result of Le Fort I osteotomies, there is generally a slight increase in nasal width. Alar base width changes less.[3] However, to prevent expansion in this region, alar cinching suture is recommended in many studies after Le Fort I osteotomies.[3,30–32] When performing a classic alar cinching suture, a suture is passed bilaterally from the alar-fascial groove through the soft tissue muscle complex and tied tightly. Various modifications have also been suggested, such as fixing the suture to the ANS. There are authors who find the effect of the classical method in controlling alar width expansion limited and suggest modifications.[32] All patients in our study were treated by experienced surgeons who applied alar cinching sutures when deemed necessary. However, measurements showed that the amount of maxillary advancement and vertically downward movement or impaction makes differences for nasal width increase. In our study, alar base width and nasal width slightly increase for most of the patients in each groups, regardless of the direction and amount of movement of the maxilla.

In our study, patients were divided into six groups, two of which included cases with impaction of the maxilla. This surgery direction is considered the most stable movement of the maxilla.[33] In these two groups with impaction, the maxilla was advanced by less than 4 mm or by 4 mm or more. If the patient's profile is appropriate, maxillary advancement may be preferred over mandibular setback or added during surgery planning to reduce the amount of mandibular setback, because maxillary advancement has been found to provide more stable results compared to mandibular setback.[34] For these reasons, maxillary advancement and impaction surgeries are frequently performed both in research and practice. However, our analysis of both septal deviation angle and septal deviation volume showed that the risk of deviation was higher in cases with maxillary impaction.

TABLE 5. Correlation Analysis Results Between ΔSDA and ΔSDV

		ΔSDV	
		r	*P*
Group 1	ΔSDA	0.053*	0.902
Group 2		0.838*	**0.009**
Group 3		0.765*	**0.027**
Group 4		0.856*	**0.007**
Group 5		0.748*	**0.033**
Group 6		0.084*	0.843
Without group discrimination		0.710**	**<0.001**

Bold values indicate statistical significance as $P < 0.05$.

*Pearson correlation coefficient.

**Spearman's ρ correlation coefficient.

ΔSDA, difference of septal deviation angle between pre- and postoperative; ΔSDV, difference of septal deviation volume between pre- and postoperative.

Orthognathic surgeries have increased in recent years, both in our hospital and worldwide. Including a larger sample group will give more accurate and reliable results because edema or problems during extubation may also have affected the study results. In addition, longer operative time could increase the likelihood of being affected by environmental factors. However, because it is not possible to observe or record all such details during surgery, the effects of environmental factors independent of the direction of maxillary movement were disregarded in this study.

Our study was conducted using three-dimensional images obtained during the planning and evaluation of orthognathic surgeries. The fact that the study was retrospective and that some patients had not yet undergone postoperative imaging also narrowed our sample group.

We used the ITK-SNAP program while making the deviation measurements and 3D Slicer for nasal profile measurements. ITK-SNAP was especially useful for volume measurements, as its machine learning algorithms were able to fill structures obtained by scanning two-dimensional sections to create a three-dimensional volume. However, the program was not sufficient for 3D soft tissue measurements, so 3D Slicer was used as a second program. It is important that such software are free, have an easy learning curve, require little user interaction, and provide results quickly.[35]

CONCLUSIONS

Unwanted changes in nasal septum position may occur after Le Fort I osteotomy. Comparisons made according to the direction and amount of maxillary movement after the surgical intervention indicated that the amount of maxillary advancement did not make a significant difference in nasal septum deviation. However, in cases with maxillary impaction, there was significantly greater deviation postoperatively. This was supported by increases in both septal deviation angle and

TABLE 6. Nasal Profile Measurements in T0 and T1

	T0 – Nasolabial Angle	T1 – Nasolabial Angle	T0 – Alar Base Width	T1 – Alar Base Width	T0 – Nasal Width	T1 – Nasal Width
	Mean ± SD Median (Min–Max)	Mean ± SD Median (Min–Max)	Mean ± SD Median (Min – Max)	Mean ± SD Median (Min – Max)	Mean ± SD Median (Min – Max)	Mean ± SD Median (Min – Max)
Group 1	100.86 ± 18.38 104.15 (68.6–126.6)	94.86 ± 12.84 88.8 (82–114.5)	31.43 ± 3 32.38 (27.62–36.28)	36.5 ± 2.87[c] 38.07 (32.19–39.6)	37.16 ± 3.55 37.45 (32.51–41.03)	40.91 ± 3.27 41.06 (36.81–45.3)[b]
Group 2	103.15 ± 21.88 109.85 (64–128.2)	101.38 ± 18.53 104.45 (67.9–122.4)	31.45 ± 3.85 31.91 (25.51–36.96)	34.23 ± 3.68[bc] 34.18 (28.16–40.49)	35.51 ± 5.13 35.61 (26.53–43.19)	38.07 ± 4.52 37.29 (32.18–45.88)[ab]
Group 3	106.85 ± 14.85 102.65 (91.5–137.7)	104.35 ± 8.7 106.5 (95.2–116.2)	30.65 ± 3.86 30.54 (24.88–37.58)	33.77 ± 2.42[bc] 34.29 (29.44–37.03)	34.92 ± 2.28 34.19 (32.95–38.49)	36.65 ± 1.98 36.37 (33.13–38.1)[ab]
Group 4	105.88 ± 19 109.95 (66.6–125.5)	102.4 ± 16.09 106.9 (77.9–121.1)	30.55 ± 3.29 30.8 (25.41–35.81)	32.62 ± 3.72[abc] 32.96 (25.73–37.81)	36.39 ± 2.98 37.35 (30.75–39.48)	38.5 ± 3.55 38.79 (33.53–42.47)[ab]
Group 5	111.09 ± 12.82 110.55 (97–131.2)	104.95 ± 14.22 108.75 (80.3–126.7)	26.83 ± 3.32 26.38 (22.66–31.64)	28.3 ± 2.48[a] 27.87 (25.38–32.69)	32.28 ± 3.02 31.56 (28.83–37.44)	34.16 ± 3.27 33.69 (30.8–40.13)[a]
Group 6	99.41 ± 8.34 103.8 (83.5–106.2)	102.68 ± 10.41 96.65 (93.8–119.8)	28.95 ± 3.18 28.37 (23.56–32.65)	30.7 ± 3.04[ab] 30.83 (25.55–34.79)	35.38 ± 3.17 36.17 (28.54–38.9)	36.54 ± 3.49 37.63 (28.99–40.09)[ab]
P	0.704	0.684	0.075	**<0.001****	0.117	**0.017***

Bold values indicate statistical significance as $P < 0.05$.
[a, b, c]: No significant difference between same/common lettered groups.
*Kruskal-Wallis test.
**One-way ANOVA.
Min–max, minimum–maximum; SD, standard deviation.

TABLE 7. Nasal Profile Differences Between T0 and T1 Values

	Δ Nasolabial Angle	Δ Alar Base Width	Δ Nasal Width
	Mean ± SD Median (Min–Max)	Mean ± SD Median (Min–Max)	Mean ± SD Median (Min–Max)
Group 1	6 ± 9.7 4.85 (−13.4 to 16.6)	−5.07 ± 2.39 −5.12 (−9.29 to −0.97)	−3.75 ± 0.75[b] −3.82 (−4.64 to −2.58)
Group 2	1.78 ± 4.9 3 (−5.4 to 7.3)	−2.79 ± 1.69 −2.23 (−6.35 to −1.01)	−2.56 ± 2.24[ab] −2.06 (−7.48 to −0.37)
Group 3	2.5 ± 9.22 3.7 (−10.8 to 21.5)	−3.08 ± 3.69 −3.15 (−8.93 to 2.52)	−1.73 ± 1.99[ab] −1.81 (−5.15 to 1.13)
Group 4	3.48 ± 8.08 3.25 (−11.3 to 14.4)	−2.07 ± 2.25 −2.38 (−5.14 to 2.58)	−2.11 ± 1.85[ab] −2.52 (−4.16 to 0.41)
Group 5	6.14 ± 6.68 4.7 (−2 to 19.1)	−1.48 ± 2.63 −2.11 (−4.24 to 3.23)	−1.88 ± 1.61[ab] −1.17 (−4.74 - -0.51)
Group 6	−3.26 ± 9.08 −5.95 (−13.6 to 10.1)	−1.74 ± 1.87 −2.07 (−5.03 to 0.97)	−1.16 ± 0.98[a] −0.99 (−3.01 to 0.19)
P	0.284	0.090	**0.001***

Bold values indicate statistical significance as $P < 0.05$.
[a, b, c]: No significant difference between same/common lettered groups.
*One-way ANOVA.
Min–max, minimum–maximum; SD, standard deviation.

septal deviation volume. In this respect, the parameters of septal deviation angle and volume are positively correlated. Additionally, it was observed that alar base width and nasal width tended to increase after Le Fort I osteotomies. Although the nasolabial angle decreased slightly after surgery in most groups, there were also cases where it increased slightly. It is of great importance for physicians to take the necessary precautions during surgery to prevent the nasal width from increasing too much and should consider the potential increase in the risk of nasal septum position changes in procedures that involve superior maxillary repositioning during orthognathic surgical planning. Orthodontists should also be aware of these risks.

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