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Nasal sill resection concomitant with maxillary orthognathic surgery for the management of alar base widening

Goksel Timarcioglu^{1*} , Ozge Sen Gursoy² , Ecem Gedik³ and Celal Candirli⁴

Abstract

Background Alar base widening is a common soft tissue change following Le Fort I osteotomy. Although alar cinch sutures are commonly used to limit this change, their long-term stability remains variable. Nasal sill resection may provide a direct resective option for managing horizontal excess at the alar base; however, its use concomitantly with maxillary orthognathic surgery has not been well described. This retrospective clinical series aimed to describe longitudinal nasal base width changes and patient-reported aesthetic outcomes following nasal sill resection performed concomitantly with maxillary orthognathic surgery.

Materials and methods Twenty-three patients who underwent nasal sill resection concomitantly with maxillary orthognathic surgery under submental intubation between 2018 and 2020 were included. Alar base width was measured from the right and left alar curvature points to the subnasale/midcolumellar point, and total nasal base width was calculated as the sum of both measurements. Measurements were recorded preoperatively (T0), following osteotomy and fixation (T1), following nasal sill resection (T2), and at 1, 3, 6, and 12 months postoperatively. The Rhinoplasty Outcome Evaluation (ROE) questionnaire was administered preoperatively and at 6 and 12 months postoperatively. Repeated measures analyses with Bonferroni correction were used for longitudinal comparisons, and intra-observer reliability was assessed using the intraclass correlation coefficient.

Results The mean preoperative total nasal base width was 39.56 ± 3.12 mm. Following osteotomy and fixation, total nasal base width increased to 47.87 ± 3.64 mm, and after nasal sill resection it decreased to 30.78 ± 2.95 mm. Nasal base width gradually increased during follow-up, reaching 36.61 ± 5.96 mm at 12 months. Although the 12-month value was descriptively lower than the preoperative baseline, this difference was not statistically significant after Bonferroni correction ($p = 0.693$). ROE scores improved from 10.91 ± 2.68 preoperatively to 17.78 ± 2.54 at 6 months and 18.09 ± 2.27 at 12 months ($p < 0.001$), with no statistically meaningful difference between the 6- and 12-month follow-ups. No major adverse outcomes related to nasal sill resection were documented during the 12-month follow-up period.

Conclusion In this retrospective clinical series, nasal sill resection performed concomitantly with maxillary orthognathic surgery was associated with maintenance of nasal base width close to the preoperative baseline at 12 months, despite an initial postoperative narrowing. Patient-reported nasal aesthetic scores improved during

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follow-up. However, because of the uncontrolled retrospective design, limited sample size, and absence of objective functional assessment, these findings should be interpreted as descriptive clinical observations and should be further investigated in prospective controlled studies.

Keywords Alar base reduction, Osteotomy, Le Fort, Submental, Intubation, Rhinoplasty Outcome Evaluation (ROE)

Introduction

Maxillary advancement and/or impaction performed with the conventional Le Fort I osteotomy causes numerous changes in the nasolabial envelope, including widening of the nasal base [1]. Various techniques are routinely used to mitigate excessive alar base widening, such as alar cinch sutures, subspinal osteotomies, and V–Y closure; however, evidence suggests that V–Y closure (often alongside alar cinch) may have a limited impact on undesirable nasolabial soft-tissue changes [2].

The use of alar cinch sutures as a preventive method to control changes in alar base and flare in orthognathic surgery has been well established in the literature [3, 4]. Alar cinching sutures have the benefit of avoiding external incisions [4] but have been shown to have little clinical impact regarding long-term alar flare or base width control [2, 5].

Nasal base reduction techniques are routinely used in rhinoplasty to address horizontal excess in nasal morphology, establishing harmony between the interalar distance and face [4, 6]. It can be applied as a secondary surgery to reduce alar base widening following orthognathic surgery [1, 7]. Rhinoplasty can also be performed concomitantly with orthognathic surgery, the airway often managed by changing from nasal to oral intubation; although primarily used in facial trauma [8], submental intubation has also been recommended in this context, as it facilitates such combined procedures while avoiding the distortion of nasal tissues and intraoperative tube exchange [9–12]. This retrospective clinical study aimed to describe nasal base width changes and patient-reported aesthetic outcomes following nasal sill resection performed concomitantly with maxillary orthognathic surgery.

Materials and methods

Included patients underwent nasal sill resection concomitant with orthognathic surgery involving the maxilla under submental intubation between 2018 and 2020 at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, University of Health Sciences, Istanbul. Alar width was measured from the right and left ‘alar curvature’ anthropometric landmark (Ac) separately to the midcolumellar point or subnasale (Sn). The total nasal base width was the summation of these two measurements (Fig. 1). Measurements were taken preoperatively (T0) (prior to injection of local anesthetic), intraoperatively (following fixation and wound closure

[T1], following nasal base narrowing [T2]), and 1st (T3), 3rd (T4), 6th (T5), and 12th (T6) months postoperatively. All measurements were taken in millimeters using a Vernier caliper by the same observer; each measurement was repeated three times, and the mean value was recorded as the final result. Prior to surgery and at the 6 and 12-month postoperative follow-ups, patients were asked to complete the ROE (Rhinoplasty Outcome Evaluation) questionnaire to evaluate nasal appearance [13, 14]. Cases were virtually planned utilizing NemoFAB software (Nemotec, Madrid, Spain).

Preoperative facial soft-tissue profile characteristics were determined based on cephalometric analysis and virtual surgical planning records using the true vertical line (TVL) as a reference. The maxillary soft-tissue profile was classified according to the position of the upper lip relative to the TVL: normal when the upper lip was in contact with the TVL, retrusive when positioned posterior to the TVL, and protrusive when positioned anterior to the TVL. Similarly, the mandibular soft-tissue profile was classified based on the position of the lower lip and soft-tissue pogonion relative to the TVL as normal, retrusive, or protrusive. The surgical procedure was also recorded and categorized as isolated Le Fort I osteotomy, bimaxillary osteotomy without rotational movement, or bimaxillary osteotomy with rotational movement; no patient underwent genioplasty.

Inclusion criteria were as follows: patients who were candidates for orthognathic surgery involving the maxilla after intraoral and cephalometric examination; those with no previous history of rhinoplasty or nasal base narrowing procedures; patients who underwent ≥ 5 mm maxillary advancement, ≥ 3 mm maxillary impaction, or combined maxillary movements including ≥ 5 mm advancement and/or ≥ 3 mm impaction; and patients without nasal deformity.

Exclusion criteria were as follows: patients who had previously undergone orthognathic surgery or rhinoplasty, those with nasal deformity, patients who underwent ≤ 5 mm maxillary advancement, or ≤ 3 mm maxillary impaction, and patients with dermatoses, connective tissue disorders, diseases that posed a risk regarding wound healing complications (dehiscence, secondary intention), or congenital syndromes affecting the mid-face, and files with incomplete records were not included in the study.

Ethical approval was obtained from the Kocaeli Health and Technology University Institutional Review Board

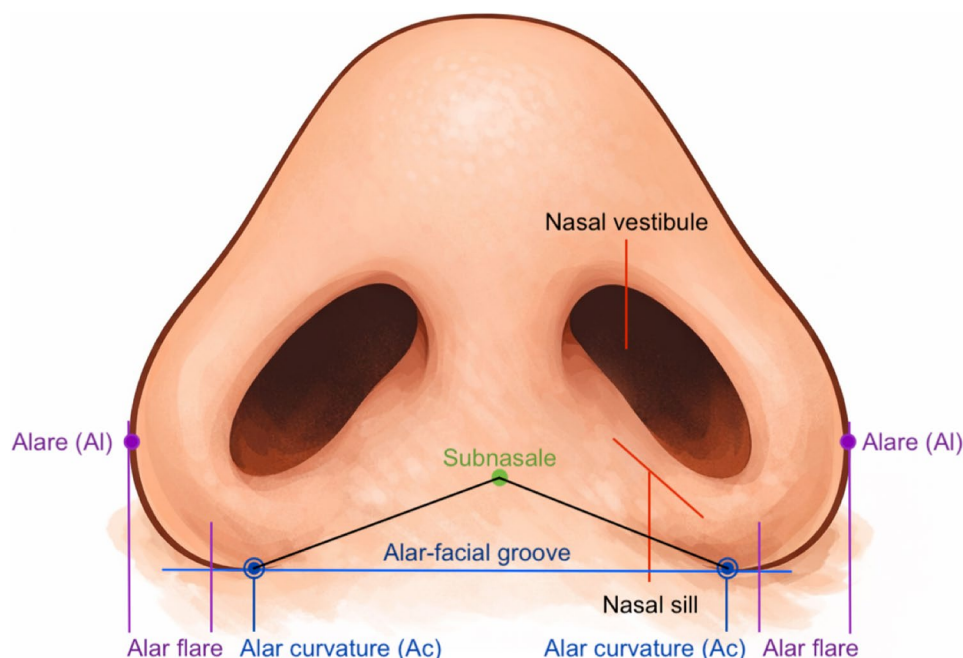


Fig. 1 Markings for the alar base measurement and relevant nasal anatomy. Alar-facial groove is the junction between the ala and the upper lip/cheek (blue line). Nasal sill is the area between the medial portion of the alar-facial groove and the medial crura (red line). Alar flare is the amount of extension of the lateral ala past the alar-facial groove (between purple lines). Alare (Al): The outermost point of ala nasi (purple points). Alar Curvature (Ac): Where the lower edge meets the alar-facial groove (blue points). Distance between ac-ac defines the interalar width. Subnasale: Located at the deepest point of the curvature between the nose and philtrum (green point). Ac-Subnasale-Ac: The alar base measurement taken in the present study

(08/09/2025-29/09). The principles of the Declaration of Helsinki were complied with.

Surgical technique

Resections were performed by the same surgeon (CC). The nasal floor and the vestibular incision were sutured first to accurately assess the amount of tissue to be excised. The distance between the midcolumnellar point and ac was measured separately on both right and left sides to determine whether there was asymmetry between the nasal bases. The amount to be excised was marked in two lines forming an inverted 'V', converging in a 'V' deep into the tissue, partly concealed within the internal nasal vestibule; care was taken to avoid disruption of the musculature beneath the skin. The same markings were performed on the other nostril, taking into consideration any difference in width between both sides. In all cases, nasal sill resection was planned and performed conservatively, as a wedge-type excision with an inverted "V" design; however, the angle/orientation of the incision, the volume of tissue removed on each side, varied on a case-to-case basis, and was individualized according to nasal morphology, nostril width, alar base asymmetry, and intraoperative morphology. Resections were planned as conservatively as permitted by the desired surgical outcome, with the intraoperative objective focused not on overcorrection, but rather on achieving controlled narrowing while meticulously

preserving nasal sill contour, alar crease integrity, and nostril symmetry.

Local anesthetic infiltration was performed after marking the planned excision area, and the resection was carried out conservatively to avoid overcorrection once postoperative edema resolved. Following local anesthesia, sill excision was performed with a No. 11 blade. A No. 15 blade was then used to detach the nasal sill from the nasal vestibule at the alar crease. The flap was then rotated medially into the vestibular floor defect and carefully reapproximated to avoid a step-off deformity. 5/0 polyglactin was initially used to prevent tension, followed by skin closure with 6/0 polypropylene suture. Sutures were removed on the 5th post-operative day [4, 15].

A conventional Le Fort 1 osteotomy was done with a horizontal incision, followed by subperiosteal dissection to expose the lateral maxillary wall, piriform aperture, and pterygomaxillary junction. V-Y closure was not performed.

Statistical analysis

Statistical analyses were performed using SPSS v22.0 for Windows (IBM Corp., Armonk, NY, USA). The normality of numerical variables was assessed using the Shapiro-Wilk test. For normally distributed variables, intergroup comparisons were performed using the Student's t-test for two groups and one-way ANOVA for three or more groups. Repeated measurements were analyzed using

repeated measures ANOVA. When appropriate, two-way repeated measures ANOVA was used to evaluate the effects of time, group, and time–group interaction. Post-hoc pairwise comparisons were performed using Bonferroni correction to control for multiple comparisons. A p -value < 0.05 was considered statistically significant.

Intra-observer reliability was evaluated using the intraclass correlation coefficient (ICC). As all measurements were performed by a single observer and repeated three times, ICC values were calculated using a two-way mixed-effects model with absolute agreement. Both single-measure and average-measure ICC values were reported. Single-measure ICC values represented the reliability of an individual measurement, whereas average-measure ICC values represented the reliability of the mean of the three repeated measurements used in the final analysis.

Results

The final sample included 23 patient records, with ages ranging from 19 to 30 years (mean $\pm$ SD: 24.09 ± 3.15), 14 women (60.9%) and 9 men (39.1%). The patients were relatively evenly distributed across groups based on maxillary movement: 6 patients underwent maxillary impaction (26.1%), 8 underwent maxillary advancement (34.8%), and 9 underwent both maxillary impaction and advancement (39.1%). According to cephalometric evaluation, 13 patients (56.5%) exhibited maxillary

skeletal hyperplasia ($SNA > 82^\circ$), while 10 patients (43.5%) demonstrated maxillary skeletal hypoplasia ($SNA < 82^\circ$) (Table 1). Preoperative facial soft-tissue profile assessment showed that the maxillary profile was classified as normal in 4 patients (17.4%), protrusive in 9 patients (39.1%), and retrusive in 10 patients (43.5%). The mandibular profile was classified as normal in 7 patients (30.5%), protrusive in 5 patients (21.7%), and retrusive in 11 patients (47.8%). Regarding surgical procedures, 12 patients (52.2%) underwent isolated Le Fort I osteotomy, 5 patients (21.7%) underwent bimaxillary osteotomy without rotational movement, and 6 patients (26.1%) underwent bimaxillary osteotomy with rotational movement.

General descriptive statistics for alar base widths and longitudinal analysis are listed in Tables 2 and 3. The mean preoperative total alar base width was 39.56 ± 3.12 mm. Following osteotomy and fixation, a marked widening was observed, with total nasal base width reaching 47.87 ± 3.64 mm ($\Delta = +8.31$ mm, $p < 0.001$). The width markedly decreased to 30.78 ± 2.95 mm ($\Delta = -17.09$ mm compared with T1; $p < 0.001$) following sill resection. Repeated measures analysis showed that nasal base width varied over time ($p < 0.05$). The mean values measured were as follows: 32.70 mm at T3, 34.35 mm at T4, 35.96 mm at T5, and 36.61 mm at T6. Although nasal base width gradually increased from T2 to T6 (from 30.78 to 36.61 mm), it remained 2.95 mm below the preoperative baseline at 12 months (Fig. 2).

The intra-observer reliability analysis demonstrated good-to-excellent reliability for single measurements and excellent reliability for averaged measurements. Single-measures ICC values ranged from 0.763 to 0.897 for unilateral measurements and from 0.852 to 0.926 for total alar base width, while average-measures ICC values ranged from 0.906 to 0.974 and from 0.945 to 0.974, respectively (Table 4).

Repeated measures ANOVA confirmed a time-dependent change in nasal base width ($p < 0.001$). Bonferroni-adjusted pairwise comparisons showed clear differences between baseline measurements (T0) and early postoperative period (T1–T4) ($p < 0.001$). However, no statistically significant differences were observed between T0 and late postoperative follow-ups (T5 and T6) ($p > 0.05$). Comparisons between the immediate postoperative measurements (T1–T2) and subsequent follow-up points also remained statistically different ($p < 0.001$), whereas comparisons among later follow-up periods (T3–T6) were not statistically significant ($p > 0.05$), indicating stabilization over time (Fig. 2).

No major adverse outcomes related to nasal sill resection were recorded in the available clinical follow-up notes. In particular, no cases of clinically evident hypertrophic scarring, wound dehiscence, marked

Table 1 Descriptive statistics of demographic variables; gender, maxillary surgical movement, skeletal pattern and age

		n	%
Sex	Female	14	60.9
	Male	9	39.1
Maxillary Skeletal Profile	Hyperplasia ($SNA > 82^\circ$)	13	56.5
	Hypoplasia ($SNA < 82^\circ$)	10	43.5
Facial Soft-tissue Profile	Maxillary Normal Profile	4	17.4
	Maxillary Protrusion	9	39.1
	Maxillary Retrusion	10	43.5
	Mandibular Normal Profile	7	30.5
	Mandibular Protrusion	5	21.7
	Mandibular Retrusion	11	47.8
Type of Surgery	Le Fort I Osteotomy (only)	12	52.2
	Bimaxillary Osteotomy (without rotation)	5	21.7
	Bimaxillary Osteotomy (with rotation)	6	26.1
Maxillary Skeletal Movement	Impaction (≥ 3 mm)	6	26.1
	Advancement (≥ 5 mm)	8	34.8
	Impaction (≥ 3 mm) or/and Advancement (≥ 5 mm)	9	39.1
	Mean $\pm$ Standard Deviation	Median	
		(Minimum-Maximum)	
Age	24.09 ± 3.15	24 (19–30)	

Table 2 Changes in nasal base width (mm): right and left alar point–midcolumellar point measurements, and right alar point–midcolumellar point–left alar point measurements

Right	Mean ± SD	P	Left	Mean ± SD	P	Right + Left	Mean ± SD	P
T0-R	19.48 ± 1.59	< 0.001	T0-L	19.65 ± 1.87	< 0.001	T0-T	39.56 ± 3.12	< 0.001
T1-R	23.74 ± 1.6	< 0.001	T1-L	24.13 ± 1.87	< 0.001	T1-T	47.87 ± 3.64	< 0.001
T2-R	15.26 ± 2.0	< 0.001	T2-L	15.52 ± 2.41	< 0.001	T2-T	30.78 ± 2.95	< 0.001
T3-R	16.3 ± 2.12	< 0.001	T3-L	16.39 ± 2.41	< 0.001	T3-T	32.7 ± 4.47	< 0.001
T4-R	17.13 ± 2.42	< 0.001	T4-L	17.22 ± 2.63	< 0.001	T4-T	34.35 ± 5	< 0.001
T5-R	17.78 ± 3.04	< 0.001	T5-L	18.17 ± 3.19	< 0.001	T5-T	35.96 ± 6.2	< 0.001
T6-R	18.09 ± 2.92	< 0.001	T6-L	18.52 ± 3.07	< 0.001	T6-T	36.61 ± 5.96	< 0.001

$p < 0.05$ was considered statistically significant. Repeated measures ANOVA was used to assess overall differences over time, and Bonferroni correction was applied for pairwise comparisons

R: Measurement from the right Ac (alar point) to the Sn (subnasale)

L: Measurement from the left Ac (alar point) to the Sn (subnasale)

T: Total nasal base width (R + L)

T0: Preoperative; T1: Following osteotomy and fixation; T2: Following sill resection; T3: 1-month follow-up; T4: 3-month follow-up; T5: 6-month follow-up; T6: 1-year follow-up

Table 3 Bonferroni-adjusted pairwise comparisons of total nasal base width across all time points

	T0	T1	T2	T3	T4	T5	T6
T0	—	< 0.001	< 0.001	< 0.001	< 0.001	0.227	0.693
T1	< 0.001	—	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
T2	< 0.001	< 0.001	—	< 0.001	< 0.001	< 0.001	< 0.001
T3	< 0.001	< 0.001	< 0.001	—	0.089	0.089	0.006
T4	< 0.001	< 0.001	< 0.001	0.089	—	0.006	< 0.001
T5	0.227	< 0.001	< 0.001	0.089	0.006	—	0.012
T6	0.693	< 0.001	< 0.001	0.006	< 0.001	0.012	—

$p < 0.05$ was considered statistically significant. Repeated measures ANOVA was used to assess overall differences over time, and Bonferroni correction was applied for pairwise comparisons

R: Measurement from the right Ac (alar curvature point) to the Sn (subnasale)

L: Measurement from the left Ac (alar curvature point) to the Sn (subnasale)

T: Total nasal base width (R + L)

T0: Preoperative; T1: Following osteotomy and fixation; T2: Following sill resection; T3: 1-month follow-up; T4: 3-month follow-up; T5: 6-month follow-up; T6: 1-year follow-up

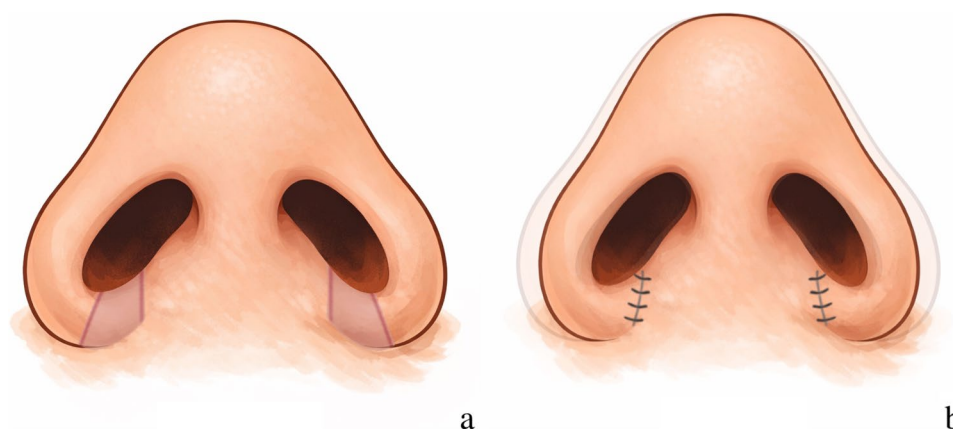


Fig. 2 (a) Incision placement and (b) suturing

nostril asymmetry, alar notching, step-off deformity, external nasal valve compromise, or patient-reported nasal obstruction were documented during the 12-month follow-up period.

The mean preoperative ROE score was 10.91 ± 2.68 (45.46 ± 11.17), which increased to 17.78 ± 2.54 at T5 and 18.09 ± 2.27 (75.37 ± 9.46) at T6 (Table 5). ROE scores improved overall ($p < 0.001$). The difference between T5 and T6 was not statistically significant ($p = 0.382$), suggesting that patient satisfaction reached a plateau by T5 (Table 6).

Discussion

The present retrospective clinical study describes longitudinal changes in nasal base width and patient-reported nasal aesthetic outcomes following nasal sill resection performed concomitantly with maxillary orthognathic surgery under submental intubation. The study sample consisted of 23 young adult patients, with a predominance of female patients, and included heterogeneous skeletal, soft-tissue, and surgical characteristics. This demographic profile is broadly comparable to previous orthognathic surgery series, in which young adult patients and female predominance have commonly been reported, and in which facial esthetics and soft-tissue balance are important components of treatment demand and outcome perception [16–18]. In the present study, sex, maxillary skeletal profile, maxillary movement type, maxillary and mandibular soft-tissue profile, surgical procedure type, and rotational movement were recorded to better characterize the sample. However, because the sample was small and distributed across multiple subgroups, subgroup analyses of nasal base measurements and ROE scores were not performed. These variables were therefore used only for descriptive characterization and not for subgroup-specific outcome interpretation.

Alar base widening is a well-recognized consequence of Le Fort I osteotomy, resulting from the release of

perinasal musculature and soft-tissue attachments, repositioning of the anterior nasal spine, and alterations in the maxillary component of the nasal floor [19, 20]. Alar cinch sutures are commonly used to counteract nasal base widening by re-approximating the perinasal musculature; however, their long-term stability may be influenced by soft-tissue dynamics, anchorage, suture design, knotting technique, and postoperative tissue remodeling, which may contribute to variable outcomes and relapse over time [20, 21].

Airway management is an important consideration in simultaneous orthognathic and nasal base reduction procedures. Nasotracheal intubation, although standard for isolated orthognathic surgery, makes the assessment of surgically induced nasal changes a challenge, obstructs the nasal field, and has occasionally required conversion to oral intubation mid-procedure, thereby prolonging operative time and risking edema or distortion of nasal soft tissues [9–12, 22]. Soylu et al. analyzed postoperative nostril asymmetry in patients who underwent Le Fort I surgery with nasotracheal intubation and concluded that the nasotracheal intubation side may influence postoperative nostril width [23]. Submental intubation is described to provide a safe, efficient, and reproducible alternative that avoids the morbidity from tracheostomy and risks associated with tube exchange [10]. It is most often recommended for one-stage approaches because it avoids distortion and allows direct observation of nasal structures, avoids intraoperative tube exchange, and maintains a secure airway during complex “full-face” procedures [9, 10]. In our patients, submental intubation was used exclusively, allowing accurate assessment of alar base changes and providing unobstructed access for sill excision.

Sill resection has long been recognized in rhinoplasty procedures as a reliable method for reducing interalar distance and achieving proportionate nasal harmony [4, 6]. Its potential place in orthognathic surgery, however,

Table 4 Intra-observer reliability of repeated right, left, and total alar base width measurements across all time points

	Single ICC Right	Average ICC Right	Single ICC Left	Average ICC Left	Single ICC Total	Average ICC Total
T0	0.805	0.925	0.879	0.956	0.917	0.971
T1	0.763	0.906	0.764	0.907	0.852	0.945
T2	0.897	0.963	0.881	0.957	0.926	0.974
T3	0.829	0.936	0.839	0.940	0.911	0.969
T4	0.854	0.946	0.865	0.951	0.924	0.973
T5	0.854	0.946	0.892	0.961	0.921	0.972
T6	0.815	0.930	0.827	0.935	0.916	0.970

ICC analysis was performed using a two-way mixed-effects model with absolute agreement

ICC intraclass correlation coefficient, single ICC single-measures ICC, average ICC average-measures ICC, Total right + left alar base measurements

T0: Preoperative; T1: Following osteotomy and fixation; T2: Following sill resection; T3: 1-month follow-up; T4: 3-month follow-up; T5: 6-month follow-up; T6: 1-year follow-up

Table 5 Changes in ROE scores between preoperative and follow-up time points

	Mean $\pm$ SD	P
ROE T0	10.91 $\pm$ 2.68	< 0.001
ROE T5	17.78 $\pm$ 2.54	< 0.001
ROE T6	18.09 $\pm$ 2.27	< 0.001

ROE Rhinoplasty Outcome Evaluation

p < 0.05 was considered statistically significant. Repeated measures ANOVA was used for overall comparisons, and Bonferroni correction was applied for pairwise comparisons

T0: Preoperative; T5: 6-month follow-up; T6: 1-year follow-up

Table 6 Pairwise comparisons of ROE scores across time points with unadjusted and Bonferroni-adjusted *p*-values

	uncorrected <i>p</i> -value	Bonferroni <i>p</i>
T0 – T5	< 0.001	< 0.001
T0 – T6	< 0.001	< 0.001
T5 – T6	0.397	1.000

ROE: Rhinoplasty Outcome Evaluation

p < 0.05 was considered statistically significant. Repeated measures ANOVA was used for overall comparisons, and Bonferroni correction was applied for pairwise comparisons

T0: Preoperative; T5: 6-month follow-up; T6: 1-year follow-up

has not been well established. In the present study, nasal base resection performed concomitantly with orthognathic surgery under submental intubation resulted in increased patient satisfaction in subjective evaluations and may represent a feasible adjunctive technique for managing selected cases of alar flare and nasal base widening.

In rhinoplasty literature, nasal base reduction has been described as a technique for reducing alar flare and nasal base width, with potential contributions to nasal proportion and aesthetic harmony. Various techniques, including Weir excision, sill resection, and alar wedge resection, have been shown to provide predictable narrowing of the alar base and improvement in nasal symmetry [24–26]. Despite its aesthetic benefits, alar base reduction is associated with several potential complications that must be carefully considered. The most frequently reported adverse outcomes include visible scarring, notching of the nasal sill, asymmetry of the nostrils, and loss or blunting of the alar crease [26]. In particular, hypertrophic or conspicuous scarring remains a notable concern given the incisions' external location. In addition, structural complications, such as nostril distortion and alar malposition, may occur, especially with excessive tissue resection [25]. Importantly, functional complications have also been described, such as external nasal valve narrowing/obstruction and/or nasal airway compromise due to over resection, and cicatricial stenosis due to poorly placed incisions, which may lead to varying degrees of nasal obstruction [24, 27]. These findings suggest that over-resection or improper surgical planning can compromise both aesthetic and functional outcomes.

Therefore, precise patient selection, conservative resection, and preservation of nasal valve integrity are essential to minimize complications and optimize surgical results. Accordingly, several authors have specifically emphasized the importance of avoiding over-resection and advocated for conservative, stepwise tissue excision to prevent functional impairment and aesthetic deformities [6, 26, 28]. The literature reporting relapse following resective alar base reduction remains limited [25, 29–31]. In the presence of orthognathic surgery-induced changes of alar flare and the alar base, alar reduction may have served to restore soft tissue to or closer to its preoperative state, yielding no net reduction; or surgical base width control, along with soft tissue changes over time, may have resulted in a reduction that remained below the preoperative baseline. In both of these instances, a relapse, a postoperative widening exists, with a favorable outcome still maintained [29]. Over the 12-month follow-up period, an increase in the postoperative nasal base width was seen in the present study, but the nasal base width remained below baseline. In the present study, no major adverse outcomes related to nasal sill resection, including clinically evident hypertrophic scarring, wound dehiscence, marked nostril asymmetry, alar notching, step-off deformity, external nasal valve compromise, or patient-reported nasal obstruction, were documented during the 12-month follow-up period. However, because safety outcomes were assessed retrospectively from clinical records rather than by a standardized complication checklist or objective nasal airflow testing, minor or subjective symptoms may have been underreported. Therefore, the absence of documented complications should not be interpreted as definitive evidence that such complications did not occur.

Nostril asymmetry should be considered a potential complication after nasal sill resection, because alar base narrowing requires bilateral soft-tissue excision in a cosmetically sensitive region [25, 26]. To reduce this risk, right and left alar base widths should be assessed separately, and the amount of sill resection should be individualized when preoperative or intraoperative asymmetry is present. An inverted V-shaped wedge excision placed partly within the internal nasal vestibule may allow controlled adjustment of nostril contour while preserving the alar crease and nasal sill architecture. The resection should be conservative and side-specific, as excessive or identical bilateral excision in patients with pre-existing asymmetry may accentuate nostril imbalance, alar notching, or nasal sill distortion. In Le Fort I osteotomy, maxillary mobilization and repositioning may alter the relationship between the nasal septum, anterior nasal spine, and nasal floor; therefore, nostril symmetry should be reassessed after maxillary fixation and closure of the nasal floor/vestibular incision [32]. Careful preservation

of the alar crease, avoidance of over-resection, and individualized right–left adjustment are essential to minimize this potential complication. Nevertheless, despite these technical precautions, nostril asymmetry remains a potential complication of nasal sill resection.

Postoperative outcomes of alar cinch sutures remain a subject of debate in the current literature with conflicting results [2, 9, 20, 29, 33–37]. Measurement methods (calipers, 2D standardized photographs, 3D imaging), landmarks (Al–Al, Ac–Ac [Alar curvature], alar base width, interalar width, or photographic landmarks), follow-up periods (6 months, 12 months, 18 months, up to 3 years), techniques (where the cinch is anchored, whether septal purchase is taken, and how alar-fibroareolar tissue is captured) and surgical context (subspinal and/or isolated LF1 or bimaxillary surgery, degree and direction of advancement/impaction/setback, the extent of soft tissue dissection, adjuncts like V-Y closure) vary significantly, affecting the outcomes [5, 9, 37]. Subspinal osteotomy is of importance in the surgical context, as it preserves perinasal structures and is associated with less alar base widening [38–40]. Nasal reduction from an alar cinch suture is rarely reported as narrowing below baseline, most long-term studies (with ≥ 6 months follow-up periods) report residual widening between 0.5 and 3 mm [2, 9, 20, 38–42] some studies reporting higher [28] and/or the intraoperative widening (dissection and osteotomy-induced increase) prevented/mitigated [2, 9, 33, 39]. Modified techniques in order to enhance the outcomes of the traditional alar cinch technique have been suggested, with some employing dermal and nasalis muscle capture and others utilizing transseptal fixation [3]. Reports between modified (including the dermis and nasalis muscle) and conventional (including the nasalis muscle only) methods also show conflicting results [19, 35, 43–45]. A meta-analysis of data pooled from 4 RCTs reports no clear superiority of modified over conventional cinch methods; a systematic review including 3 studies with 146 participants found that modified methods were superior [5, 46]. The type of deformity is also a consideration in the use of alar cinch sutures; in cases of alar flare with a wide alar base, it may cause excessive alar rounding or bunching at the nasal base, and symmetric medialization will be an ineffective correction of asymmetric nostrils [4]. In the present series, alar cinch sutures were intentionally not used. The rationale was to evaluate the dimensional changes associated with nasal sill resection without the confounding influence of an additional soft-tissue narrowing maneuver. Moreover, although alar cinch sutures are widely used as a preventive technique after Le Fort I osteotomy, their long-term effect on alar base width remains variable in the literature, and they may be less predictable in patients with pronounced alar flare, wide alar bases, or asymmetry. Therefore, nasal sill

resection was selected as a direct resective approach to address horizontal excess at the alar base. Nevertheless, the absence of a cinch-only control group is a major limitation and prevents direct comparison with the standard of care.

Postoperative facial edema is an expected consequence of orthognathic surgery. Edema begins to develop immediately following soft tissue trauma and is already present after surgery in the earliest postoperative assessments, peaks at roughly 48 to 72 h before gradually subsiding [47, 48]. Kau et al. reported a decrease of approximately 60% in the first month [49]. van der Vlis et al. reported that 20% of the initial edema remained at the end of 3 months, 11.2% was present at the end of 6 months [50]. Postoperative facial dimensions are affected by the transient soft-tissue expansion due to edema, especially during the first postoperative week and month [51, 52]. As such, early nasal base width changes may represent a mixture of true structural change and temporary edema, affecting the intra- and postoperative measurements in the present study. While it is not possible to determine how much of the width change was edema, it is an important factor to further extend outcome assessment up to 12-months [37]. Intraoperative measurements, particularly T1 and T2, should therefore be interpreted with caution, as they may be affected by local anesthetic infiltration, vasoconstriction, soft-tissue manipulation, and early surgical edema. For this reason, these measurements were primarily used to document the immediate dimensional change after osteotomy and sill resection, whereas the 6- and 12-month measurements were considered more clinically relevant for evaluating postoperative stability after soft-tissue recovery.

The gradual increase in nasal base width from T2 to T6 should not necessarily be interpreted as true relapse. Because T2 represents an immediate intraoperative measurement, it may reflect temporary tissue tension, local anesthetic infiltration, vasoconstriction, and early surgical manipulation. The subsequent increase observed during follow-up may therefore represent soft tissue rebound and natural settling of the nasolabial complex rather than loss of surgical correction alone. Accordingly, the intraoperative goal was not overcorrection, but rather conservative narrowing with careful preservation of nasal sill contour, alar crease integrity, nostril symmetry, and external nasal valve patency.

A recent systematic review and meta-analysis of 17 studies on the ROE questionnaire in rhinoplasty reported a mean preoperative ROE score of 33.50, which increased to 80.25 at 12-month postoperatively. The mean difference between pre- and post-treatment ROE scores was found to be statistically significant [51]. A recent retrospective study including 189 patients reported a mean ROE score of 30.2 preoperatively and 76.7 12-month

postoperatively; the mean difference of 45.6 was found to be statistically significant [52]. These findings were consistent with our study, which demonstrated that nasal sill resection performed with orthognathic surgery preserved patient-reported nasal aesthetic satisfaction. The main limitation of the ROE questionnaire is that it is a subjective, patient-reported outcome measure (PROM) that reflects patient perception rather than an objective morphometric assessment of nasal soft tissue [51, 52]. It is influenced by the patient's baseline self-perception, psychosocial profile, and communication between the patient and physician regarding postoperative outcomes, as these factors may affect the patient's perception and thereby influence the interpretation of surgical success based on patient-reported outcomes [51, 53, 54].

Combining alar base resection with orthognathic surgery may offer the practical advantages of rhinoplasty concomitantly with orthognathic surgery, a single operative session under general anesthesia, one hospitalization and recovery period, and potentially reduced overall cost and morbidity [22, 55]. Patient preference also appears to favor combined treatment [55, 56]. Because alar base reduction is one of the nasal deformities that may be addressed during nasal surgery, these same advantages may be cautiously extended to alar base resection at the time of orthognathic surgery, although this extrapolation should be interpreted cautiously because procedure-specific outcome studies remain limited. Predictability of nasal changes after maxillary movement remains a challenge; edema and nasal intubation further complicate intraoperative assessment. Assessment after tissue stabilization and staged correction still remains appropriate when these challenges make simultaneous correction unsuitable [22].

This study has several limitations. Its retrospective design, limited sample size, and lack of a control group limit generalizability. The absence of a control group, particularly a cohort treated with conventional techniques, prevents direct comparison with the standard preventive approach and limits any definitive conclusion regarding the superiority or independent effectiveness of nasal sill resection. Functional aspects (nasal airflow, obstruction) were not studied, which is another limitation. Outcome assessment relied on caliper-based measurements and subjective esthetic evaluations, which, while clinically relevant, lack the precision of three-dimensional photogrammetry. Due to these limitations, it is difficult to directly attribute the study findings to nasal base narrowing surgery.

Another limitation is that, although preoperative facial soft-tissue profile characteristics were assessed using TVL-based measurements on cephalometric radiographs, the small sample size did not permit subgroup analysis according to sex- or ethnicity-specific norms.

Arnett's soft tissue cephalometric analysis emphasizes the interpretation of facial soft-tissue balance using True Vertical Line references and population-specific normative values. Therefore, although maxillary and mandibular soft-tissue profile patterns and the direction of maxillary movement were recorded, the present study could not determine the independent effects of sex, ethnicity, individual soft-tissue variability, bimaxillary movements or rotational movements on nasolabial soft-tissue response. Accordingly, the findings should be interpreted as descriptive observations of nasal base width changes after concomitant nasal sill resection rather than as the results of a fully standardized orthognathic outcome analysis.

Future studies should prioritize larger cohorts, inclusion of an appropriate control group, validated patient-reported outcome measures (PROMs), objective 3D imaging, and extended follow-up. Functional assessments, such as nasal obstruction and breathing quality, would extend our understanding of the outcomes regarding resective techniques in the context of orthognathic surgery.

Conclusion

Nasal sill resection performed concomitantly with maxillary orthognathic surgery demonstrated preservation of nasal base width close to or below preoperative values over a 12-month follow-up period, despite a gradual increase following the immediate postoperative narrowing. This gradual postoperative change should not necessarily be interpreted as surgical failure, but may instead reflect soft-tissue adaptation, edema resolution, and tissue settling during healing. However, because the absence of a concurrent control group remains a fundamental limitation, these findings should be interpreted with caution. Larger prospective studies with appropriate control groups are needed to further evaluate the clinical value of nasal sill resection.

Acknowledgements

Not applicable.

Authors' contributions

CC: Conceptualization, Methodology, Project administration, Resources, Supervision, Validation, Writing-Original draft. GT: Conceptualization, Methodology, Data collection, Formal analysis, Validation, Writing-Original draft. EG, ÖŞ: Formal analysis, Validation, Writing- Original draft, Review and Editing. All authors have read and approved the final version of the manuscript.

Funding

None.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Kocaeli Health and Technology University Institutional Review board (08/09/2025-29/09), all participants (or their legal guardians) provided written informed consent for the use of their clinical data for research purposes in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 20 January 2026 / Accepted: 10 June 2026

Published online: 19 June 2026

References

1. Sun AH, Steinbacher DM. Orthognathic Surgery and Rhinoplasty: Simultaneous or Staged? *Plast Reconstr Surg*. 2018;141(2):322–9.
2. Gil PdeS, Guijarro-Martínez A, Haas R, Hernández-Alfaro OLJ. Three-dimensional analysis of nasolabial soft tissue changes after Le Fort I osteotomy: a systematic review of the literature. *Int J Oral Maxillofac Surg*. 2019;48(9):1185–200.
3. Rauso R, Tartaro G, Nicoletti GF, Fragola R, Lo Giudice G, Santagata M. Alar cinch sutures in orthognathic surgery: scoping review and proposal of a classification. *Int J Oral Maxillofac Surg*. 2022;51(5):643–50.
4. Gandolfi S, Laloze J, Chaput B, Auquit-Auckbur I, Grolleau JL, Bertheuil N, et al. Nostril Surgery: Indications, Surgical Procedures and Outcomes-A Systematic Review of Published Cases. *Aesthetic Plast Surg*. 2020;44(6):2219–29.
5. Yang JR, Chu YY, Liao HT, Lee CH. Comparison of the Effectiveness Between Conventional and Modified Cinch Suture Techniques in LeFort I Osteotomy: A Systematic Review and Meta-Analysis of Randomized Control Trials. *Ann Plast Surg*. 2023;90(1 Suppl 1):S2–9.
6. Cerkas N. Alar Base Reduction: Nuances and Techniques. *Clin Plast Surg*. 2022;49(1):161–78.
7. KHAMASHTA-LEDEZMA L, NAINI FB, REVIEW OF NASAL CHANGES MANISALIM, WITH MAXILLARY ORTHOGNATHIC SURGERY. *J Istanbul Univ Fac Dent*. 2017;51(3 Suppl 1):52–61.
8. Goh EZ, Loh NHH, Loh JSP. Submental intubation in oral and maxillofacial surgery: a systematic review 1986–2018. *Br J Oral Maxillofac Surg*. 2020;58(1):43–50.
9. Raithatha R, Naini FB, Patel S, Sherriff M, Witherow H. Long-term stability of limiting nasal alar base width changes with a cinch suture following Le Fort I osteotomy with submental intubation. *Int J Oral Maxillofac Surg*. 2017;46(11):1372–9.
10. Vellone V, De Tomaso S, Marianetti TM, Sabelli V, Ramieri V. Use of Submental Intubation in the Full-Face Makeover (Orthognathic Surgery, Facial Prosthesis Combined With Rhinoplasty). *J Craniofac Surg*. 2023;34(2):723–7.
11. Keyhan SO, Fallahi HR, Adham G, Cheshmi B. Concomitant Dorsal Preservation Rhinoplasty and Orthognathic Surgery: A Technical Note. *J oral Maxillofac Surg Off J Am Assoc Oral Maxillofac Surg*. 2020;78(9):1630.e1–1630.e10.
12. Ramaraj PN, Singh R, Sharma M, Patil V, Arjun KR, Roy B. Clinical evaluation of submental intubation as an alternative airway management technique in midface osteotomy. *J Stomatol oral Maxillofac Surg*. 2019;120(5):410–3.
13. Alsarraf R. Outcomes research in facial plastic surgery: a review and new directions. *Aesthetic Plast Surg*. 2000;24(3):192–7.
14. Çelik M, Altıntaş A. The Turkish Version of the Rhinoplasty Outcomes Evaluation Questionnaire: Validation and Clinical Application. *Balkan Med J*. 2019;36(2):129–33.

15. Kridel RWH, Castellano RD. A simplified approach to alar base reduction: a review of 124 patients over 20 years. *Arch Facial Plast Surg*. 2005;7(2):81–93.
16. Naini FB, Donaldson ANA, Cobourne MT, McDonald F. Assessing the influence of mandibular prominence on perceived attractiveness in the orthognathic patient, clinician, and layperson. *Eur J Orthod*. 2012;34(6):738–46.
17. Akdeniz BS, Ergezen Arık E, Öz S, Altıparmak N, Akdeniz SS. A comparative study of new Barcelona line and traditional method for 3D planning of orthognathic surgery. *BMC Oral Health*. 2025;25(1):1537.
18. Erdem ME, Çoban G, Öztürk T, Yağcı A, Yavuz İ, Irgin C, et al. Skeletal deformities and surgical procedures in orthognathic surgery patients: a 10-Year retrospective analysis of 1095 cases. *BMC Oral Health*. 2025;25(1):1852.
19. Rauso R, Gherardini G, Santillo V, Biondi P, Santagata M, Tartaro G. Comparison of two techniques of cinch suturing to avoid widening of the base of the nose after Le Fort I osteotomy. *Br J Oral Maxillofac Surg*. 2010;48(5):356–9.
20. Stewart A, Edler RJ. Efficacy and stability of the alar base cinch suture. *Br J Oral Maxillofac Surg*. 2011;49(8):623–6.
21. Orozco-Fernández M, Torres C, Mejía JP, Malaver A, Arias-Ortiz WA, López JP. Comparative analysis of the nasal effects of two alar cinch suture techniques in LeFort I osteotomy. A retrospective longitudinal study. *Clin Oral Investig*. 2026;30(2):65.
22. Seah TE, Ilankovan V. Rhinoplasty as an Adjunct to Orthognathic Surgery: A Review. *Oral Maxillofac Surg Clin North Am*. 2023;35(1):115–26.
23. Soyulu E, Çelebi S, Yener B, Öztürk T, Çoban G, Günay Canpolat D, et al. Postoperative nostril asymmetry after Le Fort I osteotomy: an analysis of the interplay between alar cinch sutures and intubation side. *BMC Oral Health*. 2026;26(1):225.
24. Constantian MB. The incompetent external nasal valve: pathophysiology and treatment in primary and secondary rhinoplasty. *Plast Reconstr Surg*. 1994;93(5):913–9.
25. Gruber RP, Freeman MB, Hsu C, Elyassnia D, Reddy V. Nasal base reduction by alar release: a laboratory evaluation. *Plast Reconstr Surg*. 2009;123(2):709–15.
26. Rohrich RJ, Savetsky IL, Suszynski TM, Mohan R, Avashia YJ. Systematic Surgical Approach to Alar Base Surgery in Rhinoplasty. *Plast Reconstr Surg*. 2020;146(6):1259–67.
27. Choi JY. Complications of alar base reduction in Asians. *J Cosmet Med [Internet]*. 2023/06/30. 2023;7(1):9–12. Available from: <https://www.jcosmetmed.org/journal/view.html?doi=10.25056/JCM.2023.7.1.9>
28. Nahai FR. Dallas Rhinoplasty: Nasal Surgery by the Masters. *Aesthetic Surg J [Internet]*. 2015;35(5):NP137–8. Available from: <https://doi.org/10.1093/asj/sju066>
29. Bennett GH, Lessow A, Song P, Constantinides M. The long-term effects of alar base reduction. *Arch Facial Plast Surg*. 2005;7(2):94–7.
30. ZHAO QIUY, CHEN Q, SHEN Z, LUO Y, QIU M et al. Q. Three-Dimensional M-Shaped Resection for Nasal Alar Hypertrophy in Asian Patients. *Chinese J Plast Reconstr Surg [Internet]*. 2021;3(1):1–4. Available from: <https://www.sciencedirect.com/science/article/pii/S2096691121000716>
31. Xu Y, Fan F, You J, Zheng R, Wu L, Zhang X, et al. Application of Modified V-Y Advancement Flap in Alar Base Reduction. *J Craniofac Surg*. 2023;34(8):2522–5.
32. Yousefi-Koma AA, Moschowchi A, Kadkhodazadeh M, Tabrizi R. Nasal septum deviation after orthognathic Le Fort I osteotomy: a systematic review and meta-analysis. *Maxillofac Plast Reconstr Surg*. 2025;47(1):29.
33. Murugan R, Rajiah D, Prasad C, Kamalakaran A, Palani T, Raghavan P. Clinical Evaluation of Modified Technique of Alar Base Cinch Suture to Prevent Widening of Alar Base. *J Maxillofac Oral Surg*. 2023;22(4):827–32.
34. van Loon B, Verhamme L, Xi T, de Koning MJJ, Bergé SJ, Maal TJJ. Three-dimensional evaluation of the alar cinch suture after Le Fort I osteotomy. *Int J Oral Maxillofac Surg*. 2016;45(10):1309–14.
35. Chen CYH, Lin CCH, Ko EWC. Effects of two alar base suture techniques suture techniques on nasolabial changes after bimaxillary orthognathic surgery in Taiwanese patients with class III malocclusions. *Int J Oral Maxillofac Surg*. 2015;44(7):816–22.
36. Jeong HI, Lee HS, Jung YS, Park HS, Jung HD. Nasal Soft Tissue Change Following Bimaxillary Orthognathic Surgery. *J Craniofac Surg*. 2017;28(7):e605–8.
37. Tomomatsu N, Nakamura T, Matsumoto S, Takahara N, Nakakuki K, Sakaki Y, et al. Factors affecting postoperative nasal morphology after Le Fort I osteotomy on multiple regression analysis. *Sci Rep*. 2025;15(1):9708.
38. Gil APS, Machado-Fernández A, Guijarro-Martínez R, Hernández-Alfaro F, Haas OJL, de Oliveira RB. Le Fort I osteotomy and soft tissue response: A retrospective cohort study comparing three different techniques. *J cranio-maxillo-facial Surg Off Publ Eur Assoc Cranio-Maxillo-Facial Surg*. 2022;50(2):107–13.
39. Trevisiol L, Lanaro L, Favero V, Lonardi F, Vania M, D'Agostino A. The effect of subspinal Le Fort I osteotomy and alar cinch suture on nasal widening. *J Cranio-Maxillofacial Surg [Internet]*. 2020;48(9):832–8. Available from: <https://www.sciencedirect.com/science/article/pii/S1010518220301542>
40. Meira CLS, Bueno SC, de Toledo GL, de Oliveira Chiavaioli GM, Silveira RL, Amaral MBF. Does Subspinal Le Fort I Osteotomy Reduce Nasolabial Soft Tissue Changes Compared to the Conventional Technique? *J Oral Maxillofac Surg [Internet]*. 2025;83(11):1363–72. Available from: <https://doi.org/10.1016/j.joms.2025.08.004>
41. Nirvikalpa N, Narayanan V, Wahab A, Ramadorai A. Comparison between the classical and a modified trans-septal technique of alar cinching for Le Fort I osteotomies: a prospective randomized controlled trial. *Int J Oral Maxillofac Surg*. 2013;42(1):49–54.
42. Shoji T, Muto T, Takahashi M, Akizuki K, Tsuchida Y. The stability of an alar cinch suture after Le Fort I and mandibular osteotomies in Japanese patients with Class III malocclusions. *Br J Oral Maxillofac Surg*. 2012;50(4):361–4.
43. Howley C, Ali N, Lee R, Cox S. Use of the alar base cinch suture in Le Fort I osteotomy: is it effective? *Br J Oral Maxillofac Surg*. 2011;49(2):127–30.
44. Wang Zqi, Wang X, xia, Li Z li, Yi B, Liang C, Wang X. [Comparison of three surgical techniques for controlling nasal width after Le Fort I osteotomy]. *Beijing da xue xue bao Yi xue ban = J Peking Univ Heal Sci*. 2015;47(1):104–8.
45. Ritto FG, Medeiros PJ, de Moraes M, Ribeiro DPB. Comparative analysis of two different alar base sutures after Le Fort I osteotomy: randomized double-blind controlled trial. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2011;111(2):181–9.
46. Liu X, Zhu S, Hu J. Modified versus classic alar base sutures after LeFort I osteotomy: a systematic review. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2014;117(1):37–44.
47. Sakane K, Hasegawa S, Nakao H, Sasaki J, Miyachi H, Nagao T. Factors affecting progressive facial swelling immediately after orthognathic surgery: A retrospective cohort study. *J cranio-maxillo-facial Surg Off Publ Eur Assoc Cranio-Maxillo-Facial Surg*. 2023;51(11):692–5.
48. El-Karmi A, Hassfeld S, Bonitz L. Development of swelling following orthognathic surgery at various cooling temperatures by means of hilotherapy-a clinical, prospective, monocentric, single-blinded, randomised study. *J cranio-maxillo-facial Surg Off Publ Eur Assoc Cranio-Maxillo-Facial Surg*. 2018;46(9):1401–7.
49. Kau CH, Cronin AJ, Richmond S. A three-dimensional evaluation of postoperative swelling following orthognathic surgery at 6 months. *Plast Reconstr Surg*. 2007;119(7):2192–9.
50. n der Vlis M, Dentino KM, Vervloet B, Padwa BL. Postoperative swelling after orthognathic surgery: a prospective volumetric analysis. *J oral Maxillofac Surg Off J Am Assoc Oral Maxillofac Surg*. 2014;72(11):2241–7.
51. Rot P, Krzywdzińska S, Grab P, Jurkiewicz D, Chloupek A, Sobol M. The Rhinoplasty Outcome Evaluation (ROE) Questionnaire in Rhinoplasty: A Systematic Review and Meta-Analysis. *J Clin Med*. 2024;13(16).
52. Bouaoud J, Mathieu O, Mure C, Belloc JB. Evaluation of the aesthetic and functional effectiveness of primary closed rhinoseptoplasty: A study of 189 cases. *J Stomatol oral Maxillofac Surg*. 2025;126(5):102301.
53. Abbas OL. Revision rhinoplasty: measurement of patient-reported outcomes and analysis of predictive factors. Springerplus. 2016;5(1):1472.
54. İnan S, Yigman F. The Effect of Acceptance of Cosmetic Surgery, Body Appreciation, and Nasal Obstruction on Patient Satisfaction After Rhinoplasty. *Facial Plast Surg aesthetic Med*. 2023;25(3):206–11.
55. Raffaini M, Cocconi R, Spinelli G, Agostini T. Simultaneous Rhinoseptoplasty and Orthognathic Surgery: Outcome Analysis of 250 Consecutive Patients Using a Modified Le Fort I Osteotomy. *Aesthetic Plast Surg*. 2018;42(4):1090–100.
56. Waite PD, Matukas VJ, Sarver DM. Simultaneous rhinoplasty procedures in orthognathic surgery. *Int J Oral Maxillofac Surg*. 1988;17(5):298–302.

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