Nasolabial angle and nasal tip elevation changes in profile view following a Le Fort I osteotomy with or without the use of an alar base cinch suture: a long-term cohort study

Renna Mahsoub, BDS, MSc,[a] Farhad B. Naini, BDS, MSc, PhD,[b] Sameer Patel, BDS, MSc,[c] David Wertheim, MA, PhD, CEng,[d] and Helen Witherow, BDS, MBBS[e]

Objectives. Cinch sutures attempt to counteract alar base widening but may lead to unintended increases in the nasolabial angle and nasal tip elevation. The aim of this investigation was to assess nasolabial angle changes after maxillary osteotomies with and without alar base cinch sutures in the short and long terms.

Study Design. Seventy-eight patients were assessed, with 51 in the cinch group (38 females, 13 males; age range 16−39 years) and 27 in the no-cinch group (12 females, 15 males; age range 17−27 years). The upper component (nasal tip elevation), lower component (lower lip inclination), and the overall nasolabial angle were measured on preoperative, postoperative, and long-term follow-up lateral cephalometric radiographs.

Results. The overall nasolabial angle ($P = .006$) and its upper component ($P < .001$) increased significantly in the cinch group immediately postoperatively but resolved by 6 to 12 months for the overall nasolabial angle and by 12+ months (up to 5.7 years) for the upper component. There were no significant changes in the no-cinch group.

Conclusions. In the short term, the alar base cinch suture increases nasal tip elevation and the overall nasolabial angle. In the long term, there was no significant difference, suggesting that the initial nasal tip elevation resolves over time and that the cinch suture may have a limited effect on nasal tip elevation in the longer term. (Oral Surg Oral Med Oral Pathol Oral Radiol 2020;130:379−386)

Orthognathic surgical moves are accurately planned to ensure a reliable hard tissue result. However, the overlying soft tissue change is less predictable, and this can negatively affect the overall patient satisfaction with treatment.[1-3] Being able to accurately predict not only the underlying skeletal changes but also the complex soft tissue changes will enhance patient understanding of what can be achieved. It will also demonstrate the limitations of these procedures, ensuring effective management of patient expectations and allowing informed consent.[4]

Soft tissue changes in Le Fort I osteotomies are concentrated around the nasolabial complex, including the nasolabial angle. It is generally agreed that the alar base will widen with advancement or impaction of the maxilla as a result of stretching of soft tissues.[5] The benefit of these changes is dependent on the initial facial appearance and may or may not be desirable. Intraoperative surgical techniques, such as the alar base cinch suture, can aid in the control of soft tissue changes. The alar base cinch suture was described by Millard,[6] for use in patients with cleft lip and palate and was adapted by Collins and Epker,[7] for use in patients with Le Fort I osteotomy to control unwanted alar base widening. The technique involves placing a nonresorbable suture through the right and left alar bases by way of the pre-existing circumvestibular incision made for the osteotomy. The suture is tightened until the desired width is achieved. In a recent retrospective study, the alar base cinch suture has been shown to effectively control unwanted alar base widening 3 years after a Le Fort I osteotomy.[8] However, the effect on the nasolabial angle is unclear and may cause an unwanted nasal tip elevation.[9]

The nasolabial angle is defined as the angle formed between the upper lip and the base of the nasal columella in profile view. It may be divided into 2 component angles by drawing a true horizontal line intersecting through the subnasale when the patient is in natural head position (Figure 1).[10] If changes to the nasolabial angle occur, dividing it into upper and lower component parts will demonstrate which structure has contributed to the change. Variations in the upper com-

Statement of Clinical Relevance

The alar base cinch suture increases nasal tip elevation and the overall nasolabial angle after maxillary osteotomy, but this effect appears to resolve over time; therefore, the cinch suture appears to have limited effect on nasal tip elevation in the long term.

[a]Specialist Registrar, Department of Orthodontics, Maxillofacial Unit, St George's Hospital and King's College London, London, United Kingdom.
[b]Kingston and St George's Hospitals, London, United Kingdom.
[c]Consultant Orthodontist, King's College London, London, United Kingdom.
[d]Professor, Faculty of Science, Engineering and Computing, Kingston University, London, United Kingdom.
[e]Maxillofacial Unit, St George's Hospital, London, United Kingdom.
Received for publication Sep 7, 2019; returned for revision Mar 12, 2020; accepted for publication May 18, 2020.

2212-4403/$-see front matter
https://doi.org/10.1016/j.oooo.2020.05.011

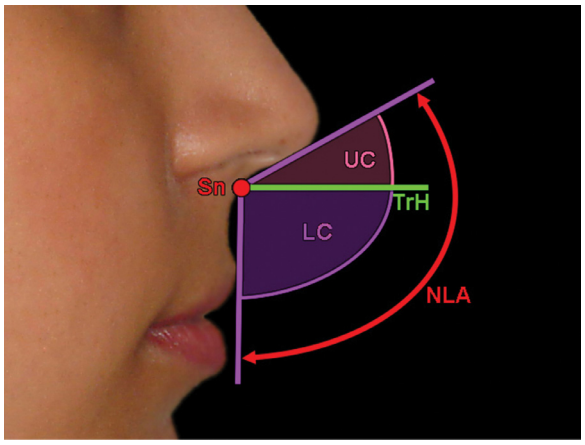

Fig. 1. The nasolabial angle (NLA) may be separated into an upper component (UC, which represents the nasal columellar angle and thereby nasal tip elevation), and a lower component (LC, which represents upper lip inclination). *Sn,* subnasale; *TrH,* true horizontal line.

ponent of the nasolabial angle would suggest a change in nasal tip elevation. Variations in the lower component of the nasolabial angle suggest a change in upper lip inclination. Better understanding of the changes to the upper and lower components of the nasolabial angle would aid in surgical treatment planning.

Although research focusing specifically on nasolabial angle changes is limited, the overall angle is commonly quoted as increasing following a Le Fort I osteotomy.[5,11] Westermark et al.[5] are the only group to have compared the overall nasolabial angle changes with or without the cinch suture. The retrospective cephalometric data of 123 patients undergoing Le Fort I osteotomy were subdivided on the basis of maxillary moves. The results demonstrated an overall increase in nasolabial angle in both the cinch and no-cinch groups (5.2 degrees and 1.4 degrees respectively); however, the cinch group had a greater increase that was statistically significant. Those authors attributed this to the cinch suture crossing the midline and compressing the nasolabial soft tissues. There was no significance in relation to the type of maxillary movement. Of note, Westermark et al. suggested that the cinch suture has a greater effect on the nasolabial angle than it has on the alar base. The study appears to be well designed, with a comparatively large sample size, although it had a short follow-up period of only 6 months. The authors only assessed the effects on the entire nasolabial angle, with no separation of the effects on the nasal columella (upper component) and on the upper lip inclination (lower component).

However, one of the original studies investigating soft tissue changes with Le Fort I osteotomy suggested that the nasolabial angle decreases or stays the same. Betts et al.[12] examined 32 patients in a prospective study based on cephalometric data and nasal casts. Those authors stated that 65% of their patients experienced a decrease or no change in the nasolabial angle after a 12-month follow-up period. Surgical adjuncts, such as the cinch suture, were used in 7 patients in this study, but the impact on the results was statistically insignificant, most likely because of the low numbers. More recently, Metzler et al.[13] performed a retrospective 3-dimensional photogrammetry study, which demonstrated that no change to the nasolabial angle occurs with Le Fort I osteotomy. In Metzler et al.'s study, 44 patients were examined over a period of 6 months, with no predictable trend seen after maxillary advancement. Two operators were involved in data collection, but reliability studies were not included. The operators were blinded to intervention, thus decreasing the risk of bias.

The existing literature is unclear on changes to the nasolabial angle after orthognathic surgery; therefore, the primary aim of this prospective cohort study was to assess the changes to the nasolabial angle after a Le Fort I osteotomy with or without the use of the alar base cinch suture, in the immediate postoperative period and after greater than 6 months. The null hypothesis was that the cinch suture has no effect on the nasolabial angle after a Le Fort I osteotomy in the short and long terms.

MATERIALS AND METHODS

Ethical approval was obtained through the National Research Ethics Service (REC reference No. 14/LO/1957). The study patients had undergone a Le Fort I osteotomy or a bimaxillary surgical procedure at St. George's Hospital, performed by the same surgeon (H. W.) between March 2006 and March 2017. Patient analysis was carried out for all by the same researcher (R.M.).

Participants were included if they had undergone a maxillary osteotomy (advancement +/− impaction +/− rotation); patient age was 16 years or greater at the time of surgery, and all had the capacity to consent. Good-quality lateral cephalometric radiographs were required at:

- T0 (preoperatively)
- T1 (<30 days postoperatively)
- T2 (6−12 months postoperatively)
- T3 (>12 months postoperatively)

In this investigation, the eventual range was 12 months to 5.7 years, with a median of 2.0 years. Participants were excluded if they had cleft lip, cleft palate, or other congenital abnormalities or had undergone postoperative rhinoplasty or secondary procedures, which

we considered would affect the nasolabial angle in the long-term analysis.

All the surgical procedures were undertaken by the same surgeon (H.W.), who used the technique of submental intubation, thereby avoiding any nasolabial distortion from the nasotracheal tube, which was traditionally used for orthognathic surgery. Treatment planning for each patient was undertaken clinically and was based on achieving improvement in facial aesthetics and dental occlusion. The direction and amount of maxillary movement were decided clinically on the basis of the results of patient examination and verified by using traditional model surgery techniques and wafer splint construction in the laboratory. Intraoperatively, the sagittal and vertical positions of the maxilla was also assessed directly on the patient; this is permitted because the submental intubation technique does not distort the upper lip and nasal regions.

Intraoperatively, the cinch suture was placed subcutaneously by using 3-0 prolene. Small incisions of 1 to 2 mm at the ala were made by using a #11 blade and the suture passed in the intraoral to extraoral direction. The suture was then passed back through the incision in the alar groove into the mouth, directed across the septum to the opposite side, and moved in the intraoral to extraoral direction through the alar base incision. The suture was passed back to the intraoral area, tightened to create the desired alar-base width, and tied below the nasal septum. To ensure that the pull of the suture was across the alar base, a small notch at the caudal end of the septum was made to prevent anterior displacement.

The nasolabial angle was measured by using the lateral cephalometric radiographs taken throughout treatment and follow-up in accordance with the British Orthodontic Society and British Association of Oral and Maxillofacial Surgeons minimum required data set for treatment of orthognathic patients.[14] The images were assessed in a random order, and the assessor was blinded to a cinch suture having been placed or not. An angular difference of 4 degrees was considered clinically significant; this was based on a previous study examining changes to the nasolabial angle.[10]

Most lateral cephalograms were available for analysis on the hospital's radiographic images viewing software (IntelliSpace PACS Enterprise, version 4.4.516.15; Philips Healthcare, The Netherlands). All of these images were analyzed in a darkened room on the same computer to ensure a standardized screen resolution (1440 by 900 pixels). In the case of 11 preoperative images, digital radiographs were unavailable, so film radiographs were analyzed instead by using a lightbox in a darkened room. The nasolabial angle was measured by using protractor software (Ondesoft Screen Rulers, version 1.12.1; Ondesoft) (Figure 2). The horizontal reference line was constructed by using the nasion horizontal plane (S-N plane minus 7 degrees) because of ease of landmark identification.[15] The raw data were recorded on a Microsoft Excel spreadsheet (Microsoft Corp, Redmond, WA).

To ensure that the measurements were reliable, intrarater repeatability testing was undertaken. Twenty randomly selected digital lateral cephalometric radiographs from both preoperative and postoperative periods were selected by using a computer random number generator. These images were traced, and after a 2-week wash-out period, they were traced for a second time.

Statistical analysis

Minitab version 18 (Minitab Inc., State College, PA), statistical package was used for analysis of the results. To test for intrarater reliability, the Bland-Altman method and Lin's concordance correlation coefficient were used. Data were tested for consistency with a normal distribution by using the Ryan-Joiner test in Minitab version 18 (Minitab Inc., State College, PA). The tables III-V show significance levels with no changes applied for multiple testing; in cases of multiple testing, the Benjamini-Hochberg procedure[16] was applied, with the value for false discovery rate at 0.25, and *P* values remaining significant are indicated.

RESULTS

Sample demographic characteristics

Seventy-eight patients were included in this investigation (age range for females 16 to 45 years and for males, 17 to 52 years; mean age 21 years for both groups) (Table I). To ensure that the cinch and no-cinch groups could be analyzed equally, they were assessed on the basis of differences in age, gender, and maxillary move. Sex data were compared by using the Fisher's exact test. Age and maxillary moves were compared by using the Mann-Whitney tests.

Repeatability testing

Intrarater reliability was analyzed by using 2 methods: Lin's concordance correlation coefficient and the Bland-Altman method. Lin's calculations demonstrate almost perfect agreement in the majority of measurements (Table II). The Bland-Altman analysis also confirmed high levels of agreements.

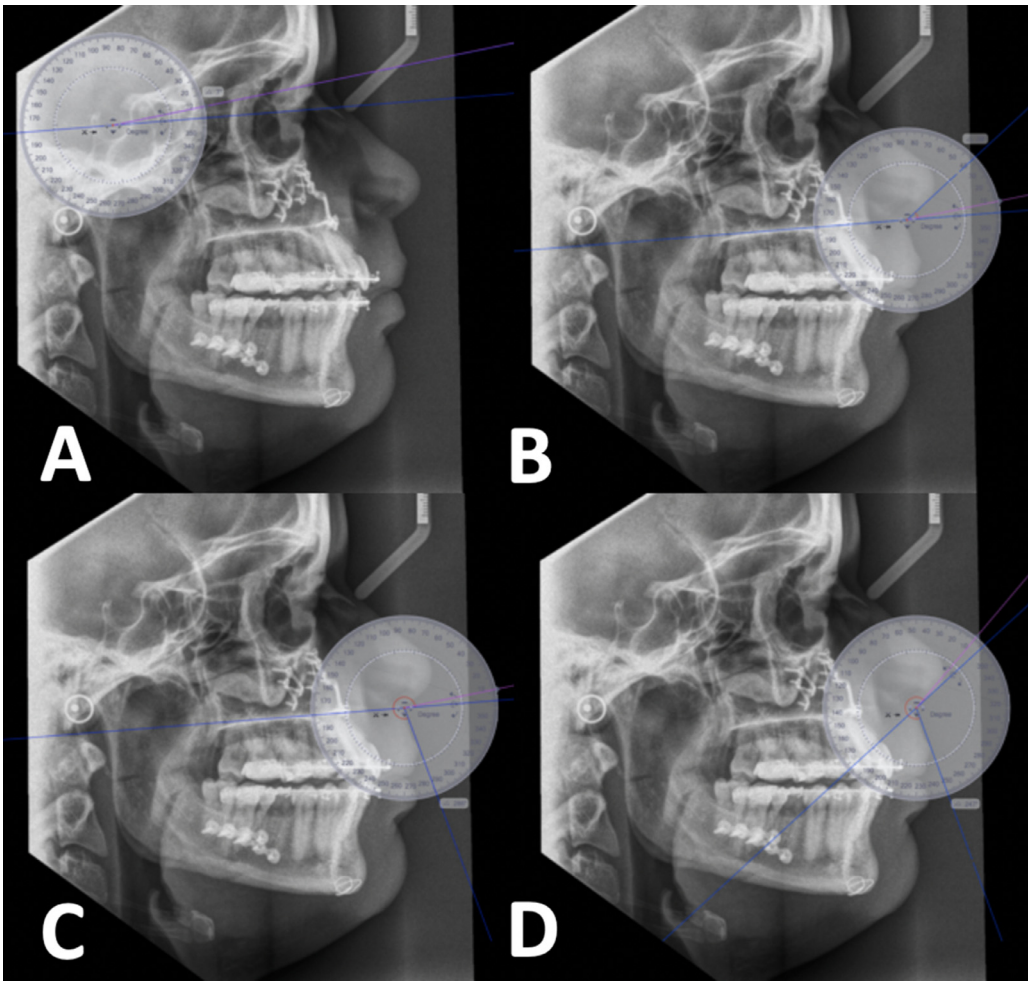

Fig. 2. Examples of nasolabial angle (NLA) measurements using the Ondesoft Screen Rulers. **(A)** Nasion horizontal plane identified. **(B)** Upper component of the NLA measured. **(C)** Lower component of the NLA measured. **(D)** Overall NLA measured.

Table I. Demographic characteristics of patients included in the study*

Demographic	*Cinch group (n = 51)*	*No-cinch group (control, n = 27)*	*P value*
Gender (F:M)	38:13	12:15	.013
Median (range) age	20 y (16−39 y)	20 y (17−27 y)	.916
Median (range) maxillary advancement	4 mm (0−12 mm)	4 mm (0−8 mm)	.838
Median (range) maxillary impaction	2 mm (0−7 mm)	2 mm (0−8 mm)	.681

*The *P* values indicate there is no significant difference ($P < .05$) between the groups besides a higher proportion of females in the cinch group.

Nasolabial angle changes with or without the cinch suture

Data were assessed at the following time points:

1. Each stage (e.g., preoperatively in the cinch group [T0] and preoperatively in the no-cinch group [T0]); with the Mann-Whitney test.
2. Each change in time point (e.g., postoperatively compared with preoperatively in the cinch group [T1 − T0] and postoperatively compared with preoperatively in the no-cinch group [T1 − T0], with the Wilcoxon signed rank test.

Descriptive statistics at each time point are shown in Table III.

The effect of the cinch suture on the nasolabial angle at each time point and the change in measurements compared with preoperative values were compared with no-cinch suture measurements (Table IV).

The Mann-Whitney tests showed wide confidence intervals and no significant changes ($P < .05$) to the

Table II. Intrarater reliability testing demonstrating high levels of concordance

	Angle	*Mean difference*	*95% limits*	*Lin's CCC*	*95% confidence interval of Lin's CCC*	*Strength of agreement*
Digital	Overall NLA	1.5	−8.8	0.991	0.980−0.996	Almost perfect
	Upper component	0.2	−9.4	0.99	0.980−0.996	Almost perfect
	Lower component	1.5	−12.1	0.998	0.996−0.999	Almost perfect
Film	Overall NLA	−0.25	−5.3	0.991	0.980−0.996	Almost perfect
	Upper component	0	−6.6	0.97	0.939−0.985	Substantial
	Lower component	−0.2	−8.4	0.984	0.966−0.994	Substantial

CCC, concordance correlation coefficient; *NLA,* nasolabial angle.

Table III. Descriptive statistics for the overall NLA, upper and lower components in both the cinch and no cinch groups at each stage of analysis and the changes occurring in between

Angle	*Time point*	*Cinch suture*	*Sample size*	*Min (degrees)*	*Median (degrees)*	*Max (degrees)*
Overall NLA	T0	No	27	78	105	131
		Yes	51	68	104	121
	T1	No	13	82	108	120
		Yes	38	75	104.5	129
	T2	No	10	86	110	125
		Yes	18	80	104	124
	T3	No	17	75	100	124
		Yes	36	72	99	118
	Change in	No	13	−45	4	19
	T1−T0	Yes	38	−19	3.5	35
	Change in	No	10	−11	3	19
	T2−T0	Yes	18	−20	0	23
	Change in	No	17	−19	−2	11
	T3−T0	Yes	36	−20	0	8
Upper component	T0	No	27	10	26	40
		Yes	51	6	25	41
	T1	No	13	15	26	39
		Yes	38	8	31.5	50
	T2	No	10	11	29.5	46
		Yes	18	16	30	44
	T3	No	17	9	25	35
		Yes	36	2	22.5	39
	Change in	No	13	−13	4	10
	T1−T0	Yes	38	−33	8	16
	Change in	No	10	−9	−1	20
	T2−T0	Yes	18	−10	4	16
	Change in	No	17	−11	−2	10
	T3−T0	Yes	36	−32	−2	16
Lower component	T0	No	27	59	76	99
		Yes	51	47	77	105
	T1	No	13	65	73	94
		Yes	38	47	73	97
	T2	No	10	60	81	99
		Yes	18	52	78	94
	T3	No	17	60	80.5	99
		Yes	36	53	79	94
	Change in	No	13	−32	−1	19
	T1−T0	Yes	38	−20	−3	43
	Change in	No	10	−17	0	24
	T2−T0	Yes	18	−17	−4	18
	Change in	No	17	−10	−2	12
	T3−T0	Yes	36	−11	−0.5	20

Values are given in degrees. T0: preoperative; T1: postoperative; T2: 6- to 12-month follow-up; T3: greater than 12-month follow-up. The results demonstrate the preoperative values for all 3 angles are similar, confirming pretreatment equivalence.
Min, minimum value; *Max,* maximum value; *NLA,* nasolabial angle.

Table IV. Results of the Mann-Whitney tests used to assess estimated differences between the cinch and no-cinch groups*

Angle	*Time point*	*Difference*	*95% confidence interval*	*P value*
Overall NLA	T0	3	(−3, 10)	.334
	T1	0	(−10, 8)	.948
	T2	7	(−4, 16)	.172
	T3	5	(−3, 12)	.23
	T1−T0	−2	(−9, 4)	.574
	T2−T0	3	(−6, 10)	.472
	T3−T0	0	(−4, 4)	.939
Upper component	T0	2	(−1, 6)	.209
	T1	−6	(−10, 0)	.037
	T2	−2	(−10, 5)	.615
	T3	3	(−3, 8)	.299
	T1−T0	−5	(−9, −1)	.01
	T2−T0	−5	(−10, 1)	.103
	T3−T0	0	(−4, 5)	.939
Lower component	T0	2	(−4, 8)	.532
	T1	4	(−4, 12)	.393
	T2	7	(0, 14)	.072
	T3	2	(−4, 7)	.746
	T1−T0	1	(−6, 8)	.787
	T2−T0	6	(−3, 13)	.144
	T3−T0	−1	(−4, 4)	.746

*Significant *P* value after applying the Benjamini-Hochberg procedure shown in red.*NLA,* nasolabial angle.

Table V. Wilcoxon signed rank tests with the paired estimated median changes in nasolabial angle following a Le Fort I osteotomy over time*

	Value	*Time point*	*N*	*Median*	*P value*
No cinch	Overall NLA	T1−T0	13	2.5	.594
		T2−T0	10	3	.415
		T3−T0	17	−0.5	.653
	Upper component	T1−T0	13	2	.224
		T2−T0	10	−1	.799
		T3−T0	17	−1	.492
	Lower component	T1−T0	13	−1	.78
		T2−T0	10	3	.61
		T3−T0	17	−0.5	.85
Cinch	Overall NLA	T1−T0	38	4.5	.006
		T2−T0	18	0.5	.755
		T3−T0	36	**−0.5**	.551
	Upper component	T1−T0	38	7	< .001
		T2−T0	18	4	.024
		T3−T0	36	−1.5	.318
	Lower component	T1−T0	38	−2	.169
		T2−T0	18	−3.5	.136
		T3−T0	36	0	.864

*The overall nasolabial angle and upper component are significantly higher immediately postoperatively in the cinch group; however, this was not seen in the follow-up measurements. Significant *P* values after applying the Benjamini-Hochberg procedure are shown in red. *NLA,* nasolabial angle.

nasolabial angle after a Le Fort I osteotomy with or without the cinch suture in the long term. In the short term, there was a suggestion of a difference between the cinch and no-cinch groups in the immediate postoperative period; however, after applying the Benjamini-Hochberg procedure, this did not reach significance. The postoperative change in the upper component angle was higher in the cinch group, with a median change of 8 degrees and estimated difference of 5 degrees compared with the no-cinch group. Both the T2 and T3 analyses demonstrated no statistically significant differences.

To assess the effect of the cinch suture over time after Le Fort I osteotomy, Wilcoxon's signed rank test was used on paired samples (Table V). There was an increase in the postoperative period (T1) compared with the preoperative period (T0) in the overall and upper components in the cinch group, with an estimated median change of 4.5 degrees and 7 degrees, respectively. However, there was no such significant change in the overall angle in the 6- to 12-month follow-up measurements, and the difference was only just significant for the upper component at that time, with an estimated median change of 4 degrees. There was no significant change for the 12+-month measurements (T3 measurements ranging from 12 months to 5.7 years, with a median of 2 years).

DISCUSSION

The nasal alar base cinch suture, used by some clinicians to reduce unwanted alar base widening resulting from maxillary advancement, also has the effect of elevating the nasal tip, which may also be detrimental to nasal aesthetics in patients with an already obtuse nasolabial angle. The aim of this investigation was to assess the changes to the nasolabial angle upper component, lower component, and overall angle after a Le Fort I osteotomy with or without the use of the alar base cinch suture. This suture is used intraoperatively to preserve the alar base width and has been shown to be effective in the short and long terms.[8] The nasolabial angle was assessed at 3 time points: immediately postoperatively (T1); 6 to 12 months postoperatively (T2); and at greater than 12 months postoperatively (T3). The results showed that the overall nasolabial angle and upper component increased immediately postoperatively (median increase in angle of 4.5 degrees; $P = .006$) and for the upper component with an estimated median increase of 7 degrees ($P < .001$). This difference persisted at the 6- to 12-month follow-up for the upper component (estimated median increase in angle of 4 degrees; $P = .024$) but was not apparent for the overall angle at that stage. The lower component demonstrated a reduction in angle (estimated median reduction of 3.5 degrees), but this was not statistically significant. The significance

for the upper component was lost by the 12+-month follow-up. There were no significant differences in the no-cinch group.

The results of this study show that immediately after a Le Fort I osteotomy, with a cinch suture, patients will experience an increase in the overall nasolabial angle and upper component. The lower component undergoes a reduction in angle, although this was not statistically significant. These angles change as anticipated after Le Fort I osteotomy, with an increase in nasal tip elevation and upper lip inclination in the immediate postoperative period. With healing, the overall angle reduces by the 6- to 12-month follow-up and the upper component by the 12+-month follow-up.

A limitation of the study is that the time range of T3 radiographs is extensive, from 12 months to 5.7 years (median 2 years). Because this group was analyzed together, it is difficult to pinpoint when the upper component starts to reduce back to the preoperative value. Patients are informed that swelling will largely resolve by 6 months and completely resolved by 12 months postoperatively.[17] The results of this study suggest that nasal changes should be expected even beyond this point.

It can be assumed that the reduction in the upper component of the nasolabial angle is related to a drop in nasal tip elevation with further postoperative healing. In addition, patient numbers were higher in the long-term analysis, providing a more reliable result. From a surgical perspective, the magnitude of septoplasty could also play a role in the immediate appearance of the nasolabial angle. With further postoperative healing and reduction of swelling, this change fades with time. An alternative theory to explain the reduction in the upper component angle could be that the cinch suture loosens over time. This would be accompanied by an increase in alar base width. Raithatha et al.[8] confirmed the stability of the alar base with the use of the cinch suture in a 3-year follow-up study. This reinforces that the cinch suture itself appears to remain stable up to this point.

The results of this study are in line with Vasudavan et al. and Metzler et al.[1,13] These studies assessed nasolabial angle changes after Le Fort I osteotomy without a cinch suture at 6 months and with a cinch suture at 12 months, respectively. Neither study assessed the nasolabial angle by dividing it into component parts. However, both studies found that the nasolabial angle did not change significantly after Le Fort I osteotomy. Comparing the results with those of Westermark et al.'s study,[5] in which the effect of the cinch suture was formally assessed, a clinically significant increase in the overall nasolabial angle was found by both groups.

In this current investigation, because the period of review spanned a significantly longer term, up to 5.7 years postoperatively, the results indicate that nasal tip elevation and overall nasolabial angle may revert to the preoperative measurement in a longer time frame. This information is important both for the surgeon with regard to planning and for patients with regard to informed consent.

This observational cohort study was designed to assess the impact of the alar base cinch suture on the upper component, lower component, and overall nasolabial angle after Le Fort I osteotomy. The changes were assessed immediately postoperatively, 6 to 12 months postoperatively (short term), and 12 months to 5.7 years postoperatively (long term).

CONCLUSIONS

The conclusions from this study are as follows:

1. The overall nasolabial angle and the upper component (nasal tip elevation) of the nasolabial angle increased significantly from preoperative period to the immediate postoperative period with use of the cinch suture (median increase in angle of 4.5 degrees ($P = .006$) and 7 degrees ($P < .001$), respectively).
2. The preoperative to postoperative change in the upper component of the nasolabial angle appeared to be higher in the cinch group compared with the no-cinch group, suggesting that the cinch suture leads to greater elevation of the nasal tip in the immediate postoperative period and in the short term (<6 months).
3. There was no significant change in the overall angle with respect to the preoperative value by the 6- to 12-month follow-up and no significant change in upper component by the 12+-month follow-up, suggesting that the nasal tip elevation changes resolve in the long term.
4. The lower component of the nasolabial angle (i.e., the inclination of the upper lip) in the cinch suture group decreased, but this was not statistically significant.
5. There were no significant differences in nasolabial angle in the no-cinch suture group after Le Fort I osteotomy.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Vasudavan S, Jayaratne YS, Padwa BL. Nasolabial soft tissue changes after Le Fort I advancement. *J Oral Maxillofac Surg*. 2012;70:e270-e277.

2. Ryan FS, Barnard M, Cunningham SJ. What are orthognathic patients' expectations of treatment outcome—a qualitative study. *J Oral Maxillofac Surg*. 2012;70:2648-2655.
3. Mansour S, Burstone C, Legan H. An evaluation of soft-tissue changes resulting from Le Fort I maxillary surgery. *Am J Orthod*. 1983;84:37-47.
4. Gill DS, Lloyd T, East C, Naini FB. The facial soft tissue effects of orthognathic surgery. *Facial Plast Surg*. 2017;33: 519-525.
5. Westermark AH, Bystedt H, Von Konow L, Sallstrom KO. Nasolabial morphology after Le Fort I osteotomies. Effect of alar base suture. *Int J Oral Maxillofac Surg*. 1991;20:25-30.
6. Millard D.R. Jr. The alar cinch in the flat, flaring nose. *Plast Reconstr Surg*. 1980;65:669-672.
7. Collins PC, Epker BN. The alar base cinch: a technique for prevention of alar base flaring secondary to maxillary surgery. *Oral Surg Oral Med Oral Pathol*. 1982;53:549-553.
8. 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;46:1372-1379.
9. Muradin MS, Rosenberg AJ, van der Bilt A, Stoelinga PJ, Koole R. The influence of a Le Fort I impaction and advancement osteotomy on smile using a modified alar cinch suture and V-Y closure: a prospective study. *Int J Oral Maxillofac Surg*. 2012;41:547-552.
10. Naini FB, Cobourne MT, McDonald F, Wertheim D. The aesthetic impact of upper lip inclination in orthodontics and orthognathic surgery. *Eur J Orthod*. 2015;37:81-86.
11. Conley RS, Boyd SB. Facial soft tissue changes following maxillomandibular advancement for treatment of obstructive sleep apnea. *J Oral Maxillofac Surg*. 2007;65:1332-1340.
12. Betts NJ, Vig KW, Vig P, Spalding P, Fonseca RJ. Changes in the nasal and labial soft tissues after surgical repositioning of the maxilla. *Int J Adult Orthodont Orthognath Surg*. 1993;8:7-23.
13. Metzler P, Geiger EJ, Chang CC, Sirisoontorn I, Steinbacher DM. Assessment of three-dimensional nasolabial response to Le Fort I advancement. *J Plast Reconstr Aesthet Surg*. 2014;67:756-763.
14. British Orthodontic Society and British Association of Oral & Maxillofacial Surgeons. *BOS/BAOMS Minimum Dataset Proforma for Surgical-Orthodontic Patients. British Othodontic Society and British Association of Oral and Maxillofacial Surgeons Announcement*. London, UK: BOS/BAOMS; 2004.
15. Zebeib AM, Naini FB. Variability of the inclination of anatomic horizontal reference planes of the craniofacial complex in relation to the true horizontal line in orthognathic patients. *Am J Orthod Dentofacial Orthop*. 2014;146:740-747.
16. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Stat Soc Series B Stat Methodol*. 1995;57:289-300.
17. Bailey LJ, Dover AJ, Proffit WR. Long-term soft tissue changes after orthodontic and surgical corrections of skeletal class III malocclusions. *Angle Orthod*. 2007;77:389-396.

Reprint requests:

Helen Witherow
Consultant Maxillofacial Surgeon
St George's Hospital
Blackshaw Road
London
UK, SW17 0QT
Helen.Witherow@stgeorges.nhs.uk