# Morphologic Changes of Nose after LeFort I osteotomy of Skeletal Class III Patients

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## Abstract


# Morphologic Changes of Nose after LeFort I Osteotomy of Skeletal Class III Patients



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Unesthetic nasal changes are often resulted from maxillary advancement and/or impaction. For the purpose to inspect the morphologic change of external nose after maxillary advancement and impaction through LeFort I osteotomy with concomitant alar base cinch suture, the present study directly measured the nose of 65 (29M, 36F) adult Korean skeletal Class III patients before surgery and after surgery (6-12 months after surgery) with digital vernier caliper (Japan, Mitutoyo).

The alar width and alar base width showed significant increase of 1.24±0.93mm, 2.02±0.93mm, respectively ($P$ < .001). Nasal length showed no significant changes, nasal tip protrusion decreased by 0.94±0.66mm (*P* < .001). Nostril base width increased by 1.48±1.13mm, maximum nostril width increased by 0.15±0.16mm, and minimum nares width decreased by 0.16±0.16mm (*P* < .001). There was no sex difference in postoperative change in any measurement. In addition, alar width increased by 8.05±4.80% in narrow nose group and by 2.05±1.09% in broad nose group, and alar base width increased by 12.59±7.34% in narrow nose group and by 2.40±3.34% in broad nose group, both postoperative measurement change presenting significant difference between two groups (*P* <.01 and *P* < .05, respectively).

The present study concluded that when maxilla was advanced and impacted through LeFort I osteotomy in skeletal Class III patients, alar flaring is occurred in spite of the alar base cinch suture.

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Key words : LeFort I osteotomy, alar base cinch suture, nasal changes, alar flaring

## I. Introduction

For proper function and esthetics, surgical-orthodontic correction is often needed for the adult skeletal Class III patients. LeFort I osteotomy is often employed to correct the maxillary position combined with the mandibular setback surgery.

LeFort I osteotomies often result in unesthetic soft tissue changes including alar flaring, upturning of the nasal tip, upper lip flattening and thinning, downturning of mouth commisure.[1-16] Nose is centered in the face and postoperative change can affect to the facial esthetics.

Especially, alar flaring may be esthetically unfavorable in most cases except for those who have extremely narrow nose such as patients with long face syndrome. In order to prevent this, concomitant alar base cinch suture and/or V-Y closure or postoperative rhinoplasty have been done. Effectiveness of alar base cinch suture[17-20] and V-Y closure[7,18,21-23] technique have been studied in many previous studies but surgical techniques, suture techniques, and results varied (Table I). For example, Westermark[20] completely removed anterior nasal spine (ANS) of the maxilla and fibro-adipose tissue beneath the alar cartilage was sutured as double loop. Alar width increased by 1.6mm (4.6%) in average, which was significantly larger ($P = .04$) than that of non-suture group (2.3mm, 6.9%). Guymon[18] did not mention about ANS contouring, and his cinch suture technique was similar to that of Westermark.[20] Alar base width increased by 2.89% in suture group and 10.75% in non-suture group. Rosen[10] suggested not to perform the concomitant soft tissue modification for the possibility of adverse soft tissue reaction such as lip lengthening, incorrectness, and unpredictability. He proposed to perform the rhinoplasty after LeFort I osteotomy when the soft tissue change would have been stable. Rosen's subjects underwent no soft tissue modification and alar width increased by 3.4mm in average. In Betts' study,[24] subjects with alar base cinch suture showed even greater increase of alar base width. In the present study, all subjects underwent maxillary advancement and impaction through one-piece LeFort I osteotomy with concomitant alar base cinch suture and ANS contouring was done in some subjects. Morphologic change of external nose was examined.

Investigators have used different techniques, including cephaolmetrics, standardized full facial photographs, photocephalometry, and the fabrication of nasolabial casts, to try to quantify the nasal change. These methods are mostly two-dimensional and have problems of magnification, resolution, camera lens distortion, and landmark identification. For cast fabrication, soft tissue deformation may happen through taking impression and certain structure may not be identified on the impression and cast, also having difficulty in landmark identification.[24] In the present study, nose was directly measured.

As there is no data for Korean, the present study examined the morphologic change of external nose by direct measurement after maxillary advancement and impaction through LeFort I osteotomy with concomitant alar base cinch suture.

**Table I. Studies of alar flaring after LeFort I osteotomy**

| Study | Soft tissue management | Postoperative change | Maxillary movement | Sample size |
|---|---|---|---|---|
| Schendel[22] | Cinch suture & V-Y advancement closure | AW 0.9±0.9mm ABW 0.6±0.5mm | Superior repositioning | 8 |
| Guymon[18] | Cinch suture/ non-cinch suture | ABW 2.89±4.17%/ 10.75±7.30% | Advancement and/or superior repositioning | 28 |
| Westermark[20] | Cinch suture/ non-cinch suture | AW 1.6±1.2mm/ 2.3±1.3mm | Advancement and/or superior repositioning ANS removal | 38/17 |
| Rosen[10] | none | AW 3.4±1.1mm | Advancement and/or superior repositioning ANS conserve | 36 |
| Betts[24] | Cinch suture/ non-cinch suture | Total AW 7% ABW 9% Cinch suture group AW 10.8% ABW 10.6% | Advancement and/or superior repositioning | 32 |
| Authors | Cinch suture | AW 1.24$\pm$0.93mm ABW 2.01$\pm$0.93mm | Superior repositioning and/or advancement | 65 |

AW: Alar Width

ABW: Alar Base Width

## II. Materials and Methods

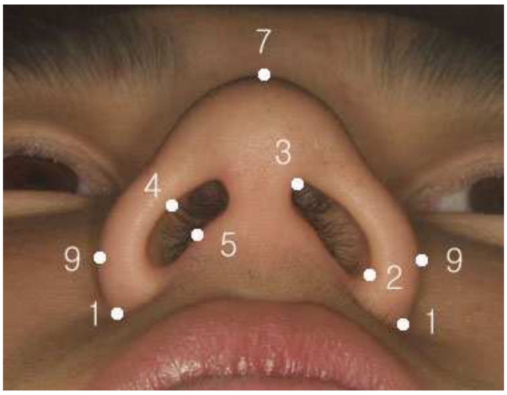
65 Korean patients (36 female, 29 male) with skeletal Class III deformity with 21.9 years of average age (17.0 to 28.0, Table II), who were planned to undergo maxillary advancement and impaction surgery were used for this study. They were all with developmental deformity, and those who had congenital or pathologic deformity, history of previous trauma to the face, history of preoperative or postoperative rhinoplasty were all excluded.

Presurgical and postsurgical orthodontic treatment and orthognathic surgery were performed by one practitioner each at Yongdong Severance Hospital. All underwent maxillary advancement and impaction through conventional one-piece LeFort I osteotomy (described by Bell[25]) with mandibular setback surgery (Vertical Ramus Osteotomy or Sagittal Split Ramus Osteotomy). Circumvestibular incision was performed from one side of first molar region to contralateral side. Mucoperiosteal flap was elevated enough to expose the lateral wall of maxilla, pyriform aperture, nasal floor and pterygomaxillary junction. Bone section and repositioning of the maxilla was performed. Maxillary osseous segments were rigidly fixed with miniplates and screws. Alar base cinch suture was performed using slowly absorbable 2-0 vicryl and mucoperiosteal flaps were reapproximated with simple vestibular closure.

Measurements were made and cephalograms were taken 1 day to 1 week preoperatively (T1) and 6 months to 1 year postoperatively (T2). The time of follow-up (T2) averaged 10.5 months. The minimum time of follow-up was 6 months because it was necessary to wait 6 months postoperatively to allow complete reduction of edema and the establishment of soft-tissue stability (1 year is preferable).[25,27] Reference points and direct measurements of nose are shown in Fig. 1, 2. Direct measurement of the nose was performed 3 times at both stages, using digital vernier caliper (Japan, Mitutoyo). After the main examiner performed the measurement, another examiner repeated, and the main examiner performed the measurement again after 3 or 4 days. Cephalograms were taken in centric relation, with the lips in repose and with the same cephalometer. Cephalograms taken at T1, T2 were traced and superimposed on the cranial base, and horizontal and vertical skeletal changes of maxilla and mandible were recorded. Frankfort horizontal plane and constructed line through Nasion, perpendicular to the Frankfort horizontal plane was established as the horizontal reference line and the vertical reference line, respectively (Fig. 3). Horizontal and vertical change of maxilla and mandible were measured parallel to the horizontal reference line and vertical reference line. As shown in Fig. 3, Subspinale (A point), tip of the Posterior Nasal Spine (PNS) were used to determine the magnitude of maxillary advance and impaction, while Supramentale (B point) was used to determine the magnitude of mandibular setback. Anterior nasal spine (ANS) was not used as a reference point because there were some subjects who underwent ANS contouring. The net movement of each point was determined, with a positive value given to anterior or superior displacements and a negative value to posterior or inferior displacements. For the cephalometric tracing and superimposition, recording of skeletal changes were done twice by the main examiner, with an interval of 2 weeks and repeated by the other examiner. Direct measurement of the nose, tracing of cephalograms and superimpositions, and recording of skeletal change were all performed by the same main examiner.

**Table II. Subjects**

| Sex | Sample number | Age (year) | | |
|---|---|---|---|---|
| | | Mean | SD | Range |
| Male | 29 | 21.86 | 2.59 | 18.00-27.00 |
| Female | 36 | 21.89 | 3.23 | 17.00-28.00 |
| Total | 65 | 21.88 | 2.94 | 17.00-28.00 |



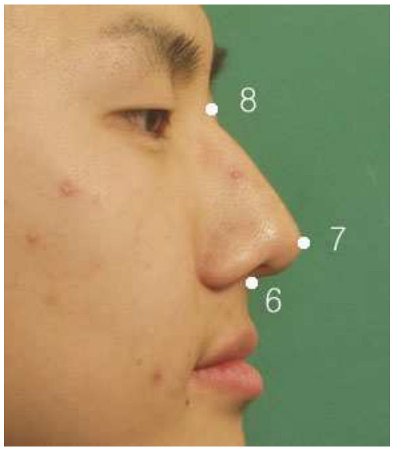




**Fig. 1. Reference points of the nose**

1) Subalare: where the alar base joins the cutaneous tissue of upper lip[24]
2) Alare: most lateral point on the outer surface of nose[24]
3) Lateral nostril point: most inferior, lateral point in the nostril
4) Superior nostril point: most superior point in the internal nostril
5) The midpoint on the medial wall of the nostril: where the bisecting line

perpendicular to the line from lateral nostril point to superior nostril point meets the medial wall of the nostril

6) The midpoint on the lateral wall of the nostril: where the bisecting line perpendicular to the line from lateral nostril point to superior nostril point meets the lateral wall of the nostril
7) Pronasale: most protruded point on the tip of the nose[24]
8) Subnasale: midpoint of the columella and upper lip junction[24]
9) n (soft tissue Nasion): point of deepest concavity of the soft tissue contour of the root of the nose

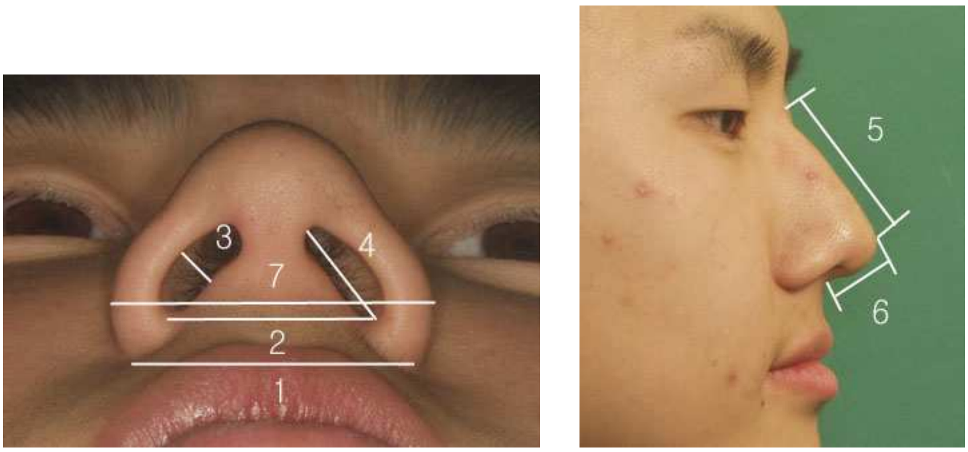



**Fig. 2. Direct measurements of the nose**

1) Alar Base Width (ABW): Subalare – Subalare[24]
2) Nostril Base Width (NBW): Lateral nostril point - Lateral nostril point
3) Alar Width: Alare – Alare
4) Maximum Nostril Width: Superior nostril point - Lateral nostril point
5) Minimum Nostril Width: midpoint on the lateral wall of the nostril – midpoint on the medial wall of the nostril
6) Nasal Tip Protrusion: Subnasale - Pronasale[24]
7) Nasal Length: Pronasale – n (soft tissue Nasion)

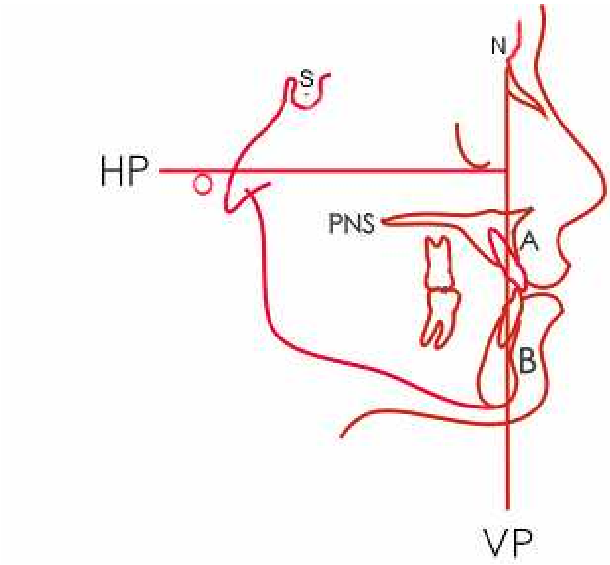



**Fig. 3. Hard tissue reference points and reference planes**

1) N (Nasion): the most anterior point of the frontonasal suture
2) A point (Subspinale): the most retruded point of the anterior maxilla
3) PNS: tip of the posterior nasal spine
4) B point (Supramentale): the most retruded point of the anterior mandible
5) HP (Horizontal Reference Plane): Frankfort horizontal plane
6) VP (Vertical Reference Plane): constructed by drawing a line through Nasion, perpendicular to the FH plane

**Statistical Analysis**

Means and standard deviations of the pre- and postoperative measurements of nose, postoperative change of the measurements, and skeletal change were calculated and paired *t* test was performed. Student *t* test was performed to examine the sex difference. The percentage changes in alar base width and alar width were recalculated and compared in two groups identified. One group comprised of subjects with a large preoperative alar base width and alar width (narrow nose group), and the other included subjects with a small preoperative alar base width and alar width (broad nose group) both subjects were included out of the range of standard deviations. To assess measurement reliability, an intraclass correlation coefficient was computed for each measured variable calculated. The standard error of measurement for each measure was also calculated. Interrater reliability was also assessed using correlation coefficient.

## III. Results

The horizontal and vertical change of Subspinale (A point) was 3.48$\pm$1.58mm (0 to 7mm) and 0.61$\pm$1.29mm (0 to 5mm), respectively. The vertical change of tip of the posterior nasal spine was 4.11$\pm$1.86mm (0 to 9.50mm) (Table III). For the 16 subjects who actually underwent anterior impaction, vertical change of A point was 2.47$\pm$1.50mm (1 to 5mm). Most common vector of maxillary movement was advancement and posterior impaction (n=49). Few subjects underwent concomitant anterior impaction (n=16), but posterior impaction was greater than anterior impaction, resulting in occlusal steepening. In all cases, occlusal planes were steepened. Although it can be different according to the center of rotation, occlusal plane steepening can influence the amount of alar flaring and upturning of nasal tip because anterior nasal spine may advance more. If maxillary posterior impaction is done with advancement, nasal change may be greater. The horizontal change of Supramentale (B-point) was -4.96$\pm$4.84mm in average (-19 to -1mm).

Alar width and alar base width significantly increased by 1.24$\pm$0.93mm and 2.02$\pm$0.93mm, respectively ($P < .001$). Nasal length did not show any significant change and nasal tip protrusion decreased by 0.94$\pm$0.66mm ($P < .001$). Nostril base width increased by 1.48$\pm$1.13mm, maximum nostril width increased by 0.15$\pm$0.16mm, and minimum nostril width decreased by 0.16$\pm$0.16mm ($P < .001$). There was no sex difference in postoperative change in any measurements (Table IV, V). As shown in Table VI, alar width increased by 8.05$\pm$4.80% in narrow nose group (n=10) whose subjects had small alar width and increased by 2.05±1.09% in broad nose group (n=10) whose subjects had large alar width presenting significant difference in the amount of alar width increase ($P < .01$). Alar base width also showed significant difference in the amount of increase with 12.59±7.34% in narrow nose group (n=10) and 2.40±3.34% in broad nose group (n=7) ($P < .05$).

Intraclass correlation ranged from r=0.91 to 0.97 ($P < .001$). Correlation coefficient for the interrater reliability ranged from r=0.88 to 0.90 ($P < .01$). Measurements and recordings were highly reliable.

**Table III. Horizontal and Vertical Changes (mm) of Hard Tissue Landmarks (T2-T1)**

| | Maxilla | | | Mandible |
|---|---|---|---|---|
| | Post imp | Ant imp | Advance | Setback |
| Mean | 4.11 | 0.61[a]/2.47[b] | 3.48 | -4.96 |
| SD | 1.86 | 1.29[a] /1.50[b] | 1.58 | 4.84 |

[a]: total subjects

[b]: 16 subjects who underwent anterior impaction

Post imp: the amount of maxillary posterior impaction, vertical change of tip of the posterior nasal spine (PNS)

Ant imp: the amount of maxillary anterior impaction, vertical change of Subspinale (A point)

Advance: the amount of maxillary advancement, horizontal change of Subspinale (A point)

Setback: the amount of mandibular setback, horizontal change of Supramentale (B point)

**Table IV. Means and Standard Deviations of pre-, postoperative, and postoperative change of measurements (mm) of Male and Female Subjects**

| Measure-ments | Male (n=29) | | | Female (n=36) | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T2-T1 | T1 | T2 | T2-T1 |
| Alar | 28.32 | 29.59 | 1.26 | 26.41 | 27.63 | 1.22 |
| Width | ±3.89 | ±3.58 | ±0.99 | ±2.97 | ±2.92 | ±0.86 |
| | | | *** | | | *** |
| Alar | 39.20 | 41.36 | 2.16 | 35.83 | 37.73 | 1.90 |
| Base | ±2.25 | ±2.20 | ±0.95 | ±1.97 | ±1.84 | ±0.91 |
| Width | | | *** | | | *** |
| Nostril | 24.09 | 25.70 | 1.62 | 22.23 | 23.61 | 1.38 |
| Base | ±2.82 | ±2.62 | ±1.16 | ±2.45 | ±2.37 | ±1.11 |
| Width | | | *** | | | *** |
| Minimum | 6.72 | 6.50 | -0.21 | 6.46 | 6.34 | -0.13 |
| Nostril | ±1.27 | ±1.26 | ±0.16 | ±0.88 | ±0.90 | ±0.15 |
| Width | | | *** | | | *** |
| Maximum | 12.80 | 13.00 | 0.21 | 11.90 | 12.01 | 0.11 |
| Nostril | ±1.91 | ±1.90 | ±0.15 | ±1.29 | ±1.30 | ±0.15 |
| Width | | | *** | | | *** |
| Nasal | 18.64 | 17.74 | -0.90 | 18.16 | 17.19 | -0.97 |
| Tip | ±1.56 | ±1.56 | ±0.47 | ±1.87 | ±1.56 | ±0.79 |
| Protrusion | | | *** | | | *** |
| Nasal | 46.92 | 46.67 | -0.25 | 42.22 | 42.15 | -0.08 |
| Length | ±3.88 | ±4.00 | ±0.79 | ±3.62 | ±3.65 | ±0.60 |

*$P < .05$, ** $P < .01$, *** $P < .001$

T1: preoperative measurement

T2: postoperative measurement

T2-T1: postoperative change of the measurement

**Table V. Means and standard deviations of pre-, postoperative, and postoperative change of measurements (mm) of Total Subjects**

| Measurements | Total (n=65) | | |
|---|---|---|---|
| | T1 | T2 | T2-T1 |
| Alar Width | 27.26±3.51 | 28.50±3.35 | 1.24±0.93*** |
| Alar Base Width | 37.33±2.68 | 39.35±2.70 | 2.02±0.93*** |
| Nostril Base Width | 23.06±2.76 | 24.54±2.68 | 1.48±1.13*** |
| Minimum Nostril Width | 6.58±1.07 | 6.41±1.07 | -0.16±0.16*** |
| Maximum Nostril Width | 12.30±1.65 | 12.45±1.66 | 0.15±0.16*** |
| Nasal Tip Protrusion | 18.37±1.74 | 17.43±1.57 | -0.94±0.66*** |
| Nasal Length | 44.93±4.39 | 44.75±4.41 | -0.18±0.71 |

*$P < .05$, ** $P < .01$, *** $P < .001$

T1: preoperative measurement

T2: postoperative measurement

T2-T1: postoperative change of the measurement

**Table VI. Comparison of postoperative changes (%) between Narrow nose group and Broad nose group**

| Measurements | Narrow nose | | | Broad nose | | | *P* |
|---|---|---|---|---|---|---|---|
| | Mean | SD | n | Mean | SD | n | |
| Alar Width | 8.05 | 4.80 | 10 | 2.05 | 1.09 | 10 | ** |
| Alar Base Width | 12.59 | 7.34 | 10 | 2.40 | 3.34 | 7 | * |

*$P < .05$, ** $P < .01$, *** $P < .001$

## IV. Discussion

LeFort I osteotomy is skeletally stable and widely used when there is horizontal and/or vertical maxillary problem and/or asymmetry.[28-30] LeFort I osteotomy is often employed to correct the maxillary position combined to the mandibular setback surgery for skeletal Class III patients. Morphologic change of external nose is often accompanied by positional change of maxilla through LeFort I osteotomy.[1-24] In the present study, this is inspected by direct measurement of nose.

Alar base cinch suture can reduce the amount of nasal flaring.[9,17-22] In the present study, transverse nasalis muscle reconstruction[9,21,22] of Schendel and colleagues was performed. Because all subjects of this study seemed to be esthetically unfavorable if alar flaring occurred, concomitant alar base cinch suture was done in all.

Alar width presents the maximum length of the nasal lobule and is important because this part is easily seen on the frontal view.[10] This may be the reason why previous studies examined the change of this measurement.[10,18,20] Edema, anterior and superior spatial change of the supportive bone of the nasal base, release of muscle attachment and periosteum near nose can be explanations for the alar flaring.[31] When muscle origin or insertion is detached, muscle contracts and reattaches to the shorter length[21,32,33] and this results in alar flaring. To reduce this effect, transverse nasalis muscle reconstruction is performed in all subjects and ANS contouring was performed in a few cases to reduce the anterior movement of the supportive bone at the nasal base area. All showed significant increase in alar width and alar base width by 1.24$\pm$0.93mm and 2.02$\pm$0.93mm, respectively ($P$ < .001). Westermark[20] completely removed ANS and performed alar base cinch suture to all the subjects, although the cinch suture technique was different from the present study. Fibro-adipose tissue beneath the alar cartilage was sutured as double loop. The amount of maxillary impaction was 4.2mm and the amount of maxillary advancement was 5.2mm in average, which were greater than that of this study. Alar width increased by 1.6mm (4.6%) and this is greater than that of this study (1.24mm). Guymon[18] didn't mention about the ANS contouring and his cinch suture technique was done in similar way to that of Westermark's[20] study. Alar base width increased by 2.89% in average. Schendel[22] emphasized on the importance of soft tissue modification. In his subjects who underwent maxillary superior repositioning with concomitant cinch suture and V-Y closure showed only 0.9mm increase in alar width and 0.6mm increase in alar base width. The amount of increase in alar width and alar base width were smaller than our study. To compare with this study, maxillary movement vector was different and adjunctive V-Y closer was done and there was also racial difference. In some subjects who did not undergo any soft tissue modification showed greater increase in alar base width and alar width. For example, non-cinch suture group in Westermark's study[20] showed 2.3mm of alar base width increase which was significantly greater ($P$ = .04) than 1.6mm in cinch suture group. Rosen's[10] subject showed even greater increase, 3.4mm in average. To compare the two studies, Westermark[20] completely removed the ANS and Rosen[10] didn't contour the ANS. The amount of maxillary impaction and advancement were greater in Rosen's[10] subjects. Guymon's[18] non-cinch suture group showed lesser amount of maxillary impaction and advancement and showed alar base increase of 10.75% in average.

In the present study, nasal length was measured from the soft tissue nasion to the nasal tip and did not show significant change. Upward and forward movement of nasal tip was observed accompanied by maxillary impaction and/or advancement in the previous studies.[6,7,10,20,22,34-37] Carlotti et al[9] stated that changes in the position of the nasal tip was not significant although there was a tendency for the tip to move forward and upward (1.4mm and 1.6mm, respectively) with maxillary advancement. Westermark[20] observed that the degree S-N plane to Nasion-Pn showed 1.9° change in cinch suture group and 1.4° change in non-cinch suture group, presenting no significant difference. Bell[34,35] wrote that alar base widening and nasal tip elevation accompany both anterior and/or superior maxillary repositioning. Radney and Jacobs[6] wrote that nasal tip will elevate 1mm for every 6mm of superior maxillary repositioning. Schendel and Williamson[22] observed an average of 2.4mm of elevation of the nasal tip in

10 patients undergoing an average of 6.4mm of maxillary intrusion, provided that the transverse nasalis muscle was repositioned and that the circumvestibular incision was closed in a V-Y fashion. Mansour[7] also observed upward and forward movement of the nasal tip in subjects with maxillary advancement and impaction through LeFort I osteotomy although it was non-significant change. According to McFarlane,[37] vertical nasal tip deflection of 1.51mm was observed when LeFort I osteotomy, cinch suture and V-Y closure were done. Ming's cephalometric study[38] showed 1.0mm of horizontal and 0.9mm of vertical movement of Pronasale. Subjects of Ming's study[38] were all Chinese while subjects of other studies mentioned above were all Caucasian. Direct comparison was impossible because skeletal movement vector, soft tissue modification technique, measurement technique were different. Upward and forward movement of nasal tip was observed in all subjects but nasal length remained of reduced of increased by 1.5mm maximum according to the presurgical nasal length and movement vector of the nasal tip. For the reason that Pronasale was hard to find in direct measurement, nasal length change was verified by cephalometric measurement. There was no significant error between two measurements.

There has been no previous study discussing about the nostril change. The present study inspected the nostril by measurement of nostril base width, maximum nostril width and minimum nostril width. Nostril base width increased by 1.48±1.13mm, maximum nostril width increased by 0.15±0.16mm, and minimum nostril width decreased by 0.16±0.16mm ($P$ < .001), presenting morphologic change of nostril flaring laterally.

Nasal tip protrusion decreased by 0.94±0.66mm in average ($P$ < .001). This is because the Subnasale advances more than the nasal tip. [9,24,36] As a result, nasal tip is protruded in relation to the cranial base but the length to the Subnasale decreases. Cephalometric study of Carlotti[9] showed horizontal change of 3.9mm in Subnasale and 1.4mm in nasal tip. Soncul[36] observed horizontal change of 2.43mm in Subnasale, and 0.86mm in nasal tip in his study using optical surface scan. The present study measured nasal tip protrusion from Subnasale to nasal tip parallel to the collumela and this cannot be directly compared to those measurements on cephalograms or scanned images measured parallel to the horizontal planes in previous studies.

According to the study of Betts,[24] noses that were narrow preoperatively widened more than broad noses did. He stated that although this observation was not statistically significant because the sample size was too small, the preoperative morphology of the nose can be an important information to the treatment planning. The present study also observed the similar result. Alar width increased by 8.05±4.80% in narrow nose group whose subjects had small alar width and increased by 2.05±1.09% in broad nose group whose subjects had large alar width presenting significant difference between the two groups in the amount of alar width increase ($P$ < .01). Alar base width also showed significant difference between the two groups in the amount of increase with 12.59±7.34% in narrow nose group and 2.40±3.34% in broad nose group ($P$ < .05). Difference in postoperative change in alar base width and alar width cannot be explained only by preoperative morphology of nose. This might be as a result of difference in amount of maxillary movement or in alar base cinch suture technique.

The present study concluded that when maxilla was advanced and impacted through LeFort I osteotomy in skeletal Class III patients, alar flaring is occurred in spite of the alar base cinch suture. In the future, more accurate prediction would be possible if using the subjects with exact same amount of skeletal movement and soft tissue management.

## V. Conclusion

1. There was no sex difference in postoperative change in any measurements.
2. Alar width and alar base width showed significant increase of $1.24 \pm 0.93$mm and $2.02 \pm 0.93$mm, respectively ($P < .001$).
3. Nasal length did not show significant change.
4. Nasal tip protrusion decreased by $0.94 \pm 0.66$mm ($P < .001$).
5. Nostril base width increased by $1.48 \pm 1.13$mm, maximum nostril width increased by $0.15 \pm 0.16$mm, and minimum nostril width decreased by $0.16 \pm 0.16$mm ($P < .001$).
6. Alar width and alar base width of the narrow nose group and broad nose group showed significant difference ($P < .01$ and $P < .05$, respectively), with $8.05 \pm 4.80$%, $12.59 \pm 7.34$% in narrow nose group and $2.05 \pm 1.09$%, $2.40 \pm 3.34$% in broad nose group, respectively.

## VI. References


1. Lines PA., Steinhauser FW. (1974). Soft tissue changes in relationship to movement of hard structures in orthognathic surgery: a preliminary report. *Journal of Oral Surgery* **32**: 891
2. Dann JJ, Fonesca RJ, Bell WH. (1976). Soft tissue changes associated with total maxillary advancement: a preliminary study. *Journal of Oral Surgery* **34**: 19
3. Freihofer HPM. (1977). Changes in nasal profile after maxillary advancement in cleft and non-cleft patients. *Jounal of maxillofacial Surgery* **5:** 20
4. Araujo A, Schendel SA, Wolford LM, Epker BN. (1978). Total maxillary advancement with and without bone grafting. *Journal of Oral Surgery* **36:** 849
5. Engel GA, Quan RE, Chaconas SJ. (1979). Soft-tissue changes as a result of maxillary surgery. A preliminary study. *American Journal of Orthodontics* **75:** 291
6. Radney LJ, Jacobs JD. (1981). Soft-tissue changes associated with surgical total maxillary intrusion. *American Journal of Orthodontics* **80**: 191
7. Mansour S, Burstone C, Legan H. (1983). An evaluation of soft-tissue changes resulting from Le Fort I maxillary surgery. *American Jounal of Orthodontics* **84:** 37
8. Bandgard M, Melsen S, Terp S. (1986). Changes during and following total

maxillary osteotomy (Le Fort I procedure): a cephalometric study. *European Journal of Orthodontics* **8**: 21

9. Carlotti AE, Aschaffenburg PH, Schendel SA. (1986). Facial changes associated with surgical advancement of the lip and maxilla. *Journal of Oral and Maxillofacial Surgery* **44**: 593

10. Rosen HM. (1988). Lip-nasal aesthetics following Le Fort I osteotomy. *Plastic Recontructive Surgery* **81**: 173

11. Gassmann CJ, Nishioka GJ, van Sickels JF, Thrash WJ. (1989). A lateral cephalometric analysis of nasal morphology following Le Fort I osteotomy applying photometric analysis techniques. *Journal of Oral and Maxillofacial Surgery* **47**: 926

12. Sarver DM, Weissman SMN. (1991). Long-term soft tissue response to Le Fort I maxillary superior repositioning. *Angle Orthodontics* **61**: 267

13. O'Ryan F, Schendel S. (1989). Nasal Anatomy and maxillary surgery. I. Esthetic and anatomic principles. *International Journal of Orthognathic Surgery* **4**: 27

14. O'Ryan F, Schendel S. (1989). Nasal Anatomy and maxillary surgery. II. Unfavorable nasolabial esthetics following the Le Fort I osteotomy. *International Journal of Orthognathic Surgery* **4**: 75

15. O'Ryan F, Schendel S. (1989). Nasal Anatomy and maxillary surgery. III. Surgical techniques for correction of nasal deformities in patients undergoing

maxillary surgery. *International Journal of Orthognathic Surgery* **4**: 157

16. Schendel SA, Carlotti AE. (1991). Nasal consideration in orthognathic surgery. *American Journal of Orhodontics and Dentofacial Orthognathic Surgery* **100:** 197

17. Collins PC, Epker BN. (1982). The alar base cinch: A technique for prevention of alar base flaring secondary to maxillary surgery. *Journal of Oral Surgery* **53**: 549

18. Guymon M, Crosby D, Wolford LM. (1988). The alar base cinch suture to control nasal width in maxillary osteotomies. *International Journal of Adult Orthodontics and Orthognathic Surgery* **3**: 89

19. Wolford LM. (1988). Lip-nasal aesthetics following Le Fort I osteotomy-discussion. *Plastic Reconstructive Surgery* **81**: 180

20. Westermark AH, Bystedt H, von Konow L. et al. (1991). Nasolabial morphology after LeFort I osteotomies. Effect of alar base cinch suture. *International Journal of Oral and Maxillofacial Surgery* **20**: 25

21. Schendel SA, Delair J. (1980). Facial muscles: Form, function, and reconstruction in dentofacial deformities. In: Bell WH (eds). *Surgical Correction of Dentofacial Deformities. Philadelphia: Saunders* 259

22. Schendel SA, Williamson LW. (1983). Muscle reorientation following superior repositioning of the maxilla. *Journal of Oral and Maxillofacial Surgery* **41**: 235

23. Hackney FL, Nishioka GJ, Van Sickels JE. (1988). Frontal soft tissue morphology with double V-Y closure following Le Fort I osteotomy. *Journal of Oral and Maxillofacial Surgery* **46**: 850

24. Betts NJ, Vig KWL, Vig P, Spalding P, Fonesca RJ. (1993). Changes in the nasal and labial soft tissues after surgical repositioning of the maxilla. *International Journal of Adult Orthodontics and Orthognathic Surgery* **8:** 7

25. Bell WH. (1975). Le Fort I osteotomy for correction of maxillary deformities. *Journal of Oral Surgery* **33**: 412

26. Freihofer HPM. (1976). The lip profile after correction of retromaxillism in cleft and non-cleft patients. *Journal of Maxillofacial Surgery* **4**: 136

27. Sarver DM, Weissman SM. (1991). Long-term soft tissue response to Le Fort I maxillary superior repositioning. *Angle Orthodontics* **61**: 267

28. Schendel SA, Eisenfeld JH, Bell WH, et al. (1976). Superior repositioning of the maxilla: Stability and soft tissue osseous relations. *American Journal of Orthodontics* **70:** 663

29. Epker BN. (1981). Superior surgical repositioning of the maxilla: long-term results. *Journal of Maxillofacial Surgery* **9**:237

30. Proffit WR, Philips C, Turvey TA. (1987). Stability following superior repositioning of the maxilla by Le Fort I osteotomy. *American Journal of Dentofacial Orthopedics* **92**: 151

31. Wolford LM. (1988). Lip-nasal aesthetics following Le Fort I osteotomy-

discussion. *Plastic Reconstructive Surgery* **81**: 180

32. McNamara JA, Carlson DS, Yellich GM, Hendricksen RP. (1978). Mucoskeletal adaption following orthognathic surgery. *in the Craniofacial region. Ann Arbor, The University of Michigan*

33. Schendel SA, Williamson LW. (1983). Surgical maxillary superior repositioning and facial muscles. *Journal of Oral Surgery* **41**:235

34. Bell WH, Proffit WR, Jacobs J. (1980). Maxillary and Midface Deformity. In Bell WH, Proffit WR, White RP (eds.). *Surgical Correction of Dentofacial Deformities Philadelphia: Saunders* 475

35. Bell WH, Proffit WR, Jacobs J. (1980). Maxillary and Midface Deformity. In Bell WH, Proffit WR, White RP (eds.). *Surgical Correction of Dentofacial Deformities Philadelphia: Saunders* 386

36. Murat S, Mohammad AB. (2004). Evaluation of Facial Soft Tissue Changes With Optical Surface Scan After Surgical Correction of Cl III Deformities. *Journal of Oral and Maxillofacial Surgery* **62**: 1331

37. R Bruce McFarlane, William LF, Scott BM, Antonios MM. (1995). Identification of nasal morphologic freatures that indicate susceptibility to nasa tip defection with the LeFort I osteotomy. *American Journal of Orthodontics and Dentofacial Orthopedics* **107**: 259

38. Ming TC. (2005). Soft and hard tissue changes after bimaxillary surgery in Chinese class III patients. *Angle Orthodontics* **75**: 769

국문초록

# 골격성 제 III급 부정 교합자에서 LeFort I 골절단술 후 코의 형태 변화

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상악골의 상방 및 전방 이동시 alar base가 넓어지는 등 비심미적인 코 형태 변화가 종종 관찰된다. 본 연구에서는 alar base cinch suture를 동반한 LeFort I 골절단술을 통한 상악골의 상방 및 전방 이동 후 코의 형태 변화를 알아보기 위하여 한국인 성인 골격성 제 III급 부정 교합자 65명(29남, 36녀)을 대상으로 술전과 술후 follow-up 시기(6-12개월)에 digital vernier caliper(Japan, Mitutoyo)를 이용하여 코에 대한 직접 계측을 시행하였다.

Alar width는 1.24±0.93mm, alar base width는 2.02±0.93mm의 유의한 증가를 보였다 ($P < .001$). Nasal length는 유의한 차이를 나타내지 않았고 nasal tip protrusion은 0.94±0.66mm 감소하였다 ($P < .001$). Nostril base width는 1.48±1.13mm 증가했고 maximum nostril width는 0.15±0.16mm 증가했으며 minimum nostril width는 0.16±0.16mm 감소하였다

(*P* < .001). 모든 측정치의 술후 변화량에 있어서 남녀 차이는 보이지 않았다. 또한 alar width는 narrow nose group에서 8.05±4.80%, broad nose group에서 2.05±1.09% 증가하여 유의차를 나타내었고 (*P* < .01) alar base width는 narrow nose group에서 12.59±7.34% 증가하였으며 broad nose group에서는 2.40±3.34% 증가하여 그룹간 유의차를 보였다 (*P* < .05).

이상의 연구에서 악교정 수술을 요하는 골격성 제 III급 부정교합자에서 상악골의 LeFort I 골절단술에 의한 상방 및 전방 이동이 행해질 때 alar base cinch suture를 시행하더라도 코의 alar width와 alar base width가 증가하여 alar flaring이 일어난다는 것을 알 수 있었다.

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핵심되는 말 : LeFort I 골절단술, alar base cinch suture, 코의 형태 변화, alar flaring