Understanding the Anatomy of the Transverse Nasalis Aponeurotic Fibers and Its Importance in Asian Rhinoplasty

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Background: A complete release of the transverse nasalis aponeurotic fibers (TNAFs) during Asian rhinoplasty is critical for accurate positioning of the nasal implant and lengthening of the short nose. The objectives of this article are to clarify the anatomy of the TNAFs using cadaveric dissections and to present the clinical results after complete TNAF release in Asian rhinoplasty.

Methods: An anatomical dissection was performed in 8 cadavers to study the TNAFs, specifically the origin, insertion, and boundary of the TNAFs and the effect of the TNAF release on nasal length. Between January 2012 and December 2014, 2314 open implant augmentation rhinoplasties (1777 primary and 537 secondary) were performed by the senior author (J.J.). The records of these patients were retrospectively reviewed for results of TNAF release. A separately designed prospective clinical study was performed to document the nasal envelope extension after TNAF release in 52 consecutive patients.

Results: In the cadaver study, the anatomy and the boundaries of the TNAFs were clearly visualized and documented. With accurate release of the TNAFs, the ideal pocket for nasal implant can be defined, and the effect of the release of the TNAFs recorded. Release of the TNAFs also allows extension of the nasal envelope. However, measurements of the nasal envelope were not studied in the cadaver because the skin was degloved.

From the clinical study with a follow-up ranging from 6 months to 1.5 years, the overall complication of open rhinoplasty using silicone implants incorporating TNAF release was 6%. In this group, 3.4% of patients required revision rhinoplasty. Releasing the TNAFs ensures an accurate implant pocket reducing the risk of implant deviation and implant visibility and increases the nasal length by 2.1 mm.

Conclusions: Complete release of the TNAFs is especially important in Asian rhinoplasty to facilitate accurate pocket dissection, allowing the extension of the nasal envelope in order to correct short nose or secondary contracted nose.

Key Words: Asian rhinoplasty, TNAFs, transverse nasalis aponeurotic fibers, short nose

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In performing Asian rhinoplasty, the 2 major challenges for rhinoplasty surgeons are augmenting the flat nasal dorsum and lengthening the short nose. Nasal implants, such as silicone, Gore-Tex, and chimeric implants, are very commonly used for dorsal augmentation in Asian rhinoplasty. The key for successful augmentation depends on first identifying the right implant based on shape and length; second, minor sculpting of the implant for a precise fit; and third, making an accurate pocket for the implant. The importance for exact implant pocket dissection cannot be overemphasized as this is critical to avoid the complications of implant visibility or migration (Fig. 1).

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The senior author (J.J.) has refined his paradigm shift behind implant augmentation—implant dorsal onlay is performed instead of insertion. A precise implant pocket is dissected under direct vision, and the transverse nasalis aponeurotic fibers (TNAFs) are released sharply. The implant has to be stable after placement and fit snugly within the pocket. The nasal envelope is then redraped in a tension free manner after implant placement.

Creation of the nasal implant pocket requires understanding of the anatomical structures that make up the implant pocket. From the experience of the senior author, we understand that the TNAFs are a critical component that forms the boundaries of the implant pocket. Without the precise release of this structure, one would not be able to place the implant accurately. We evaluate this structure in a cadaveric study and document the clinical significance of releasing the TNAFs in 52 open rhinoplasty patients.

MATERIALS AND METHODS

This study is divided into 2 parts: (1) a cadaver dissection and (2) a clinical study.

Cadaver Dissection

Eight fresh Korean cadavers (5 males and 3 females; obtained from Chungnam National Medical University, Daejeon, South Korea, via an educational grant approved by the ethic committee) were used for our anatomic research. All cadavers were screened to exclude previous surgery or trauma to the nose and facial area. The heads were stored at −20°C, thawed at 4°C for 24 hours prior to dissection and subsequently thawed at room temperature for 4 hours prior to dissection.

The dissection was performed under 2.5× loupe magnification. The nasal muscular structure and superficial musculoaponeurotic system (SMAS) were exposed using a midline vertical skin incision from the glabella to columella base. It was fundamentally important that the dissection was performed using the anatomical approach (midline vertical incision) as the surgical approach (transcolumellar) would cause disruption of the anatomy and make the study impossible. The skin and dermis were elevated to expose the nasal muscles and to delineate its origin and insertion (Fig. 2). Upon identification of the nasal SMAS, an open rhinoplasty was used to expose the lower lateral cartilages, upper lateral cartilage, and the nasal bone. Using this approach, the nasal-SMAS pocket can be identified clearly, and the boundaries of the TNAFs can be visualized. With the use of an Aufricht retractor, the potential pocket for the nasal implant can be demonstrated (Fig. 3). After the release of the TNAF, the ideal pocket for nasal implant can be visualized, and the effect of the release of the TNAFs observed. Release of the TNAFs also allows extension of the nasal envelope, translating to an increase in nasal length. However, this was not studied in the cadaver model because the skin and the nonvital tissue were degloved off the nasal SMAS, and thus, measurements would not be accurate.

Clinical Study

From 2012 to 2014, the senior author (J.J.) performed 2314 open rhinoplasties (1777 primary and 537 secondary) using a similar technique. All patients were followed up for a minimum period of 6 months, and the results and complications were recorded for analysis.

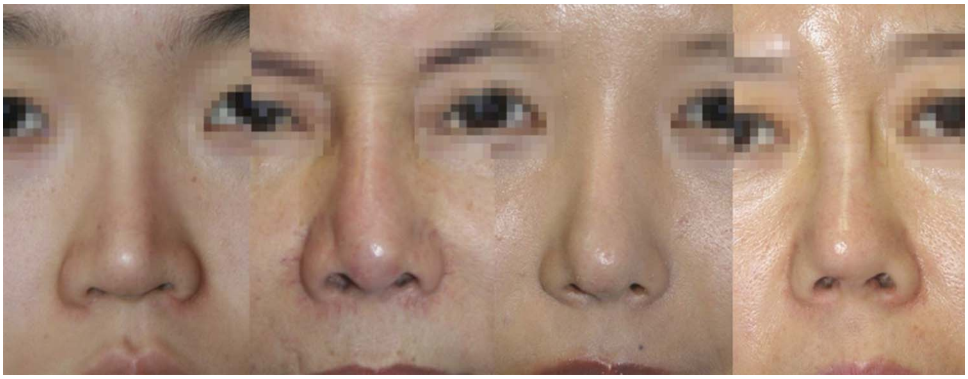

FIGURE 1. Various complications of implant visibility or malposition.

The outcome data included infection, implant visibility, implant malposition, implant extrusion, capsule contraction, revision rhinoplasty, and patient satisfaction.

A transcolumellar open rhinoplasty approach was used for all cases. Upon exposure of the lower lateral cartilages, supraperichondrial dissection was performed to expose the upper lateral cartilages. A subperiosteal pocket was then dissected from the keystone to the radix using the Joseph elevator. The fibers were divided sharply with scissors from the cartilaginous and bony base to create an adequate pocket for implant placement. The distal fibers (Fig. 4A) were released first prior to the proximal fibers (Fig. 4B). Under direct vision, an accurate pocket for nasal implant can be made. For a small pocket, only the TNAFs were released. To obtain a wider pocket for correction of short or secondary contracted nose, the muscles coherent to the hinge areas were also released.

Intraoperative measurements of the effects of TNAF release were carried out on 52 consecutive cases. In these 52 patients, the length of the nasal envelope was divided into 3 points: A (sellion), B (rhinion), and C (tip defining point) (Fig. 5). The points were marked preoperatively and measured, giving rise to A–B (sellion to rhinion), B–C (rhinion to tip defining point), and A–C (sellion to tip defining point) measurements. A spring scale with 3 N was used to standardize the force of traction applied to the nose before and after the release of the TNAF. Measurements were made with traction on the nasal tip before and after release of the TNAFs (Fig. 5).

Prior to implant insertion, the pocket was gently irrigated with first-generation cephalosporin, gentamicin, and saline. A silicone I-shaped implant was inserted after precise carving, and the adequacy of the pocket dissection was checked. Stabilization sutures to the implant were done with 5-0 PDS if required. After refining the nasal tip with suture techniques, the rhinoplasty was completed, and the columellar incisions were closed in a standard fashion.

RESULTS

Cadaver Dissection

The cadaver dissection (Video 1, http://links.lww.com/SAP/A287) confirmed that the nasal muscles and the nasal SMAS (comprising the transverse nasalis, procerus, anomalus nasi, and levator labii superioris alaque nasi) insert to the nasal bone above the keystone area. The transverse nasalis muscle covers the keystone area with contributions from the procerus muscle proximally. The proximal fibers of the transverse nasalis at its origin are confluent with the procerus and levator labii superioris alaque nasi muscle. These fibers extend laterally over the upper lateral cartilage toward the opposite piriform aperture. The distal fibers of transverse nasalis muscle attach laterally to the hinge area, which defines the lateral limit of the nasal SMAS. Under 2.5× loupe magnification, the aponeurotic fibers can be visualized to be arranged in a crisscross pattern

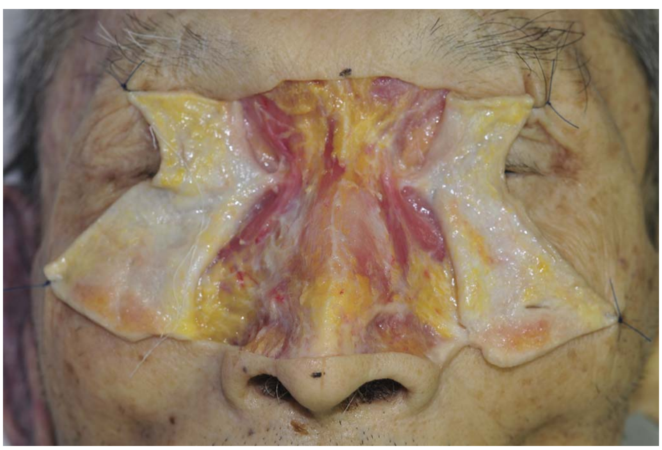

FIGURE 2. Midline approach to deglove the nasal skin, exposing the origin and insertion of the nasal SMAS.

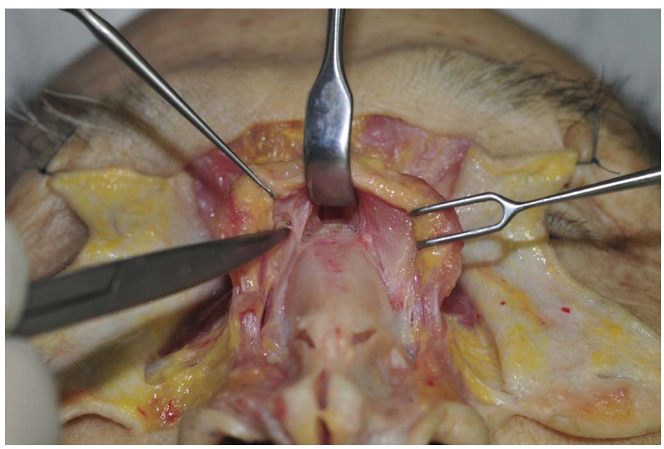

FIGURE 3. Dissection under the nasal SMAS to reveal the pocket for dorsal onlay of the nasal implant.

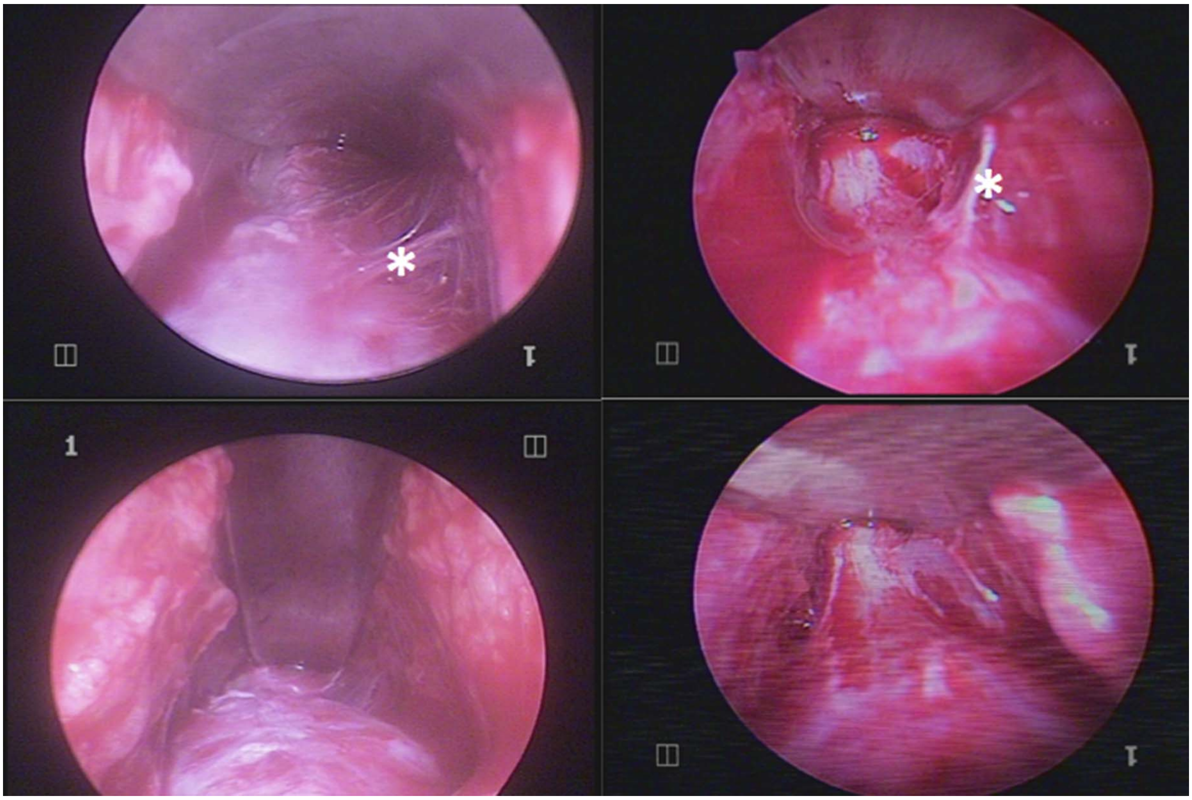

FIGURE 4. Top left, The distal TNAF fibers (*) on the right are released sharply to create a space for dorsal onlay augmentation (bottom left). Subsequently, the proximal TNAF fibers (top right) are released sharply to complete the dissection of the space for dorsal onlay augmentation (bottom right).

(Fig. 6). Proximally, the TNAF fibers fuse with the periosteum, and distally, they fuse with the perichondrium over the upper lateral cartilages.

Upon creation of the subperiosteal pocket using the Joseph elevator, the aponeurotic fibers of the TNAFs to the bony-cartilaginous framework can be identified. There are multiple aponeurotic

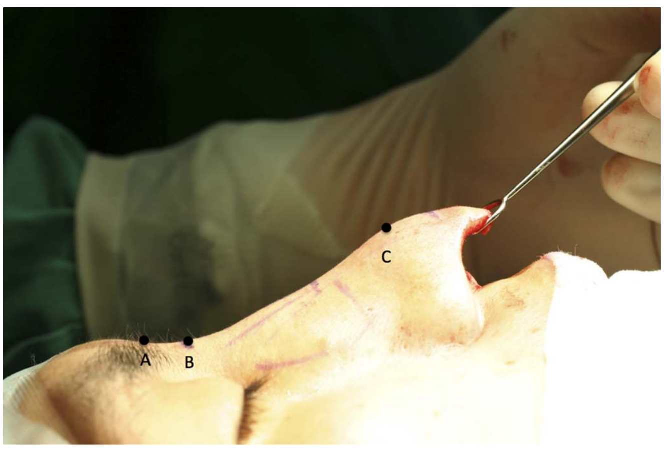

FIGURE 5. Points A (sellion), B (rhinion), and C (supratip point) used to measure nasal length before and after surgery. A spring scale with 3 N was attached to a double hook, and measurements of the nasal length were made before and after release of the TNAF. An average of 2.1-mm increase in nasal length was noted with the TNAF release.

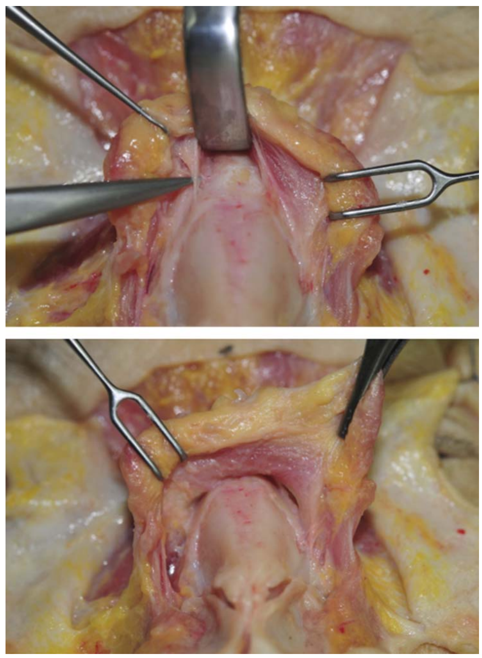

FIGURE 6. Under 2.5× loupe magnification, the TNAF fibers are seen to be arranged in a crisscross pattern (tip of scissors points at the TNAF). The TNAFs is released sharply (above) from distal and proximal to increase the footprint of the pocket (below).

TABLE 1. Results of Open Rhinoplasty Using TNAF Release and Implant Augmentation

	Primary Rhinoplasty	Secondary Rhinoplasty	Total (%)
No. patients	1777	537	2314 (100)
Inflammation and infection (minor or major)	16	18	34 (1.47)
Implant visibility	26	5	31 (1.34)
Implant deviation/malposition	14	3	17 (0.73)
Implant extrusion	2	2	4 (0.17)
Inappropriate dorsal height	23	7	30 (1.29)
Capsular contracture	9	5	14 (0.6)
Revision surgery	48	29	77 (3.35)

TABLE 2. Measurement of Nasal Length Before and After Release of the TNAFs

	A–B	B–C	A–C
Preoperative (average)	41.2 mm	24.8 mm	66.0 mm
Postoperative (average)	43.2 mm	24.9 mm	68.1 mm
Length increase (average)	2.0 mm	0.1 mm	2.1 mm

attachments running from the transverse nasalis to the nasal bone, forming the lateral insertion of the TNAF.

These aponeurotic fibers are robust and not easily detached by blunt dissection using periosteal dissectors. Sharp scissors are used to separate the aponeurotic attachments of the TNAFs from a distal-to-proximal direction. Separation of the TNAFs extends the footprint of the pocket (Fig. 6).

Clinical Study

All 2314 patients were followed up for a minimum of 6 months and an average duration of 7.5 months. There were 31 cases (1.3%) of visible implant and 17 cases (0.7%) of implant deviation. The other complications were wound inflammation and infection (34 cases [1.5%]), implant extrusion (4 cases [0.17%]), and capsular contracture (14 cases [0.6%]). Seventy-seven patients (3.35%) required revision rhinoplasty (Table 1).

With the release of the aponeurotic attachments of the TNAFs (Video 2, http://links.lww.com/SAP/A288), the nasal envelope is also able to extend further. There is an average increase of 2.1 mm after release of the TNAFs (using a 3-N weight as a standardized traction on the nasal tip) (Table 2). It is also noted that the increase in nasal length occurs predominantly between A (sellion) and B (rhinion). A 95.2% of the increase in nasal length occurred between A and B. Redraping the nasal soft tissue over the bony and cartilage framework was also noted to be smoother.

Clinical Cases

Case 1: Primary Rhinoplasty (Short Nose)

A 22-year-old female patient underwent primary open rhinoplasty with TNAF release and dorsal onlay silicone implant augmentation. Septal cartilage was harvested and used as a septal extension graft with tip plasty. Figure 7 shows her results at 12 months after operation, showing an increase in nasal length and a well-positioned nasal implant.

Case 2: Secondary Rhinoplasty (Nasal Contracture)

A 31-year-old male patient had previous rhinoplasty and developed upturned tip from nasal contracture. He underwent secondary open rhinoplasty with TNAF release. Figure 8 shows his results at 8 months after operation, showing an increase in nasal length.

Case 3: Secondary Rhinoplasty (Deviated Nasal Implant)

A 28-year-old woman had previous rhinoplasty with nasal deviation. She underwent secondary open rhinoplasty with TNAF release and dorsal onlay silicone implant augmentation. Figure 9 shows her results at 6 months after operation, showing the correction of the nasal deviation and augmentation of nasal dorsum without implant visibility.

DISCUSSION

The transverse nasalis muscle, which forms the major component of the nasal SMAS,[1–4] covers the nasal dorsum along with the procerus,

FIGURE 7. Primary rhinoplasty. The patient underwent primary open rhinoplasty with TNAF release and dorsal onlay augmentation with silicone implant. Far left, middle left, Preoperative profile view and postoperative profile view at 12 months. Middle right, far right, Preoperative side view and postoperative side view at 12 months. Note the increase in nasal length.

FIGURE 8. Secondary rhinoplasty. Male patient who had upturned tip due to contracture after previous rhinoplasty and irregular dorsum. Patient underwent primary open rhinoplasty with TNAF release and dorsal onlay augmentation with silicone implant. Middle right, far right, Preoperative side view and postoperative side view at 12 months. Note the increase in nasal length.

anomalus nasi, and levator labii superioris alaque nasi muscles. The transverse nasalis muscle originates from the lateral side of incisive fossa and upper portion of the maxilla. Some of the fibers are contributed by the superior alaque nasi muscle as they insert onto the lateral crura in the nasal hinge area (Fig. 10). It also interdigitates with the procerus proximally to form a fibrous crisscross pattern over the osteocartilaginous area of nasal dorsum. Based on the cadaver dissection, the roof of the implant pocket is formed by the procerus muscle and fascia proximally, and the transverse nasalis muscle and fascia distally. Both the bony lateral nasal walls are dense aponeurotic insertions of the transverse nasalis muscle. Our findings are in concordance with the work of Saban et al[4] as they described the nasal SMAS extending from the frontalis to the nostril rim and columella. Similar to the SMAS of the face, the SMAS of the nose is an investing fascia that interconnects nasal musculature, condensing into closely packed parallel collagenous bundles in areas of deficient muscle. The nasal SMAS has fibers connecting it both to the overlying dermis and underlying bone or cartilage. It is crucial to understand this anatomy to prepare the pocket for nasal augmentation using alloplastic implant.

Several surgeons have described the technique of implant pocket creation using a blind subperiosteal approach with the Joseph elevator. The limitation of this technique is first the Joseph elevator avulses the fibrous attachment of the TNAFs instead of cutting it precisely, which leads to the pocket being overdissected or underdissected. Second, without direct vision, it is difficult to estimate the size of the pocket through the overlying nasal skin, which is thicker in Asian patients. The fibers of the TNAFs are robust, and thus accurate division can be achieved only with sharp release using a blade or scissors. Inadequate pocket release can lead to a pocket that is smaller than the implant, which leads to implant visibility and palpability. Similarly, asymmetric release of the pocket can lead to implant deviation. Overdissection of the pocket leads to higher incidence of implant mobility, which can also lead to implant migration, eventually resulting in nasal deviation. In the cadaveric dissection, it is noted clearly that these aponeurotic fibers run

FIGURE 9. Secondary rhinoplasty. Female patient who had previous rhinoplasty with deviated nasal implant. Patient underwent primary open rhinoplasty with TNAF release and dorsal onlay augmentation with silicone implant. Middle right, far right, Preoperative side view and postoperative side view at 12 months. Note the correction of the nasal deviation and augmentation of nasal dorsum.

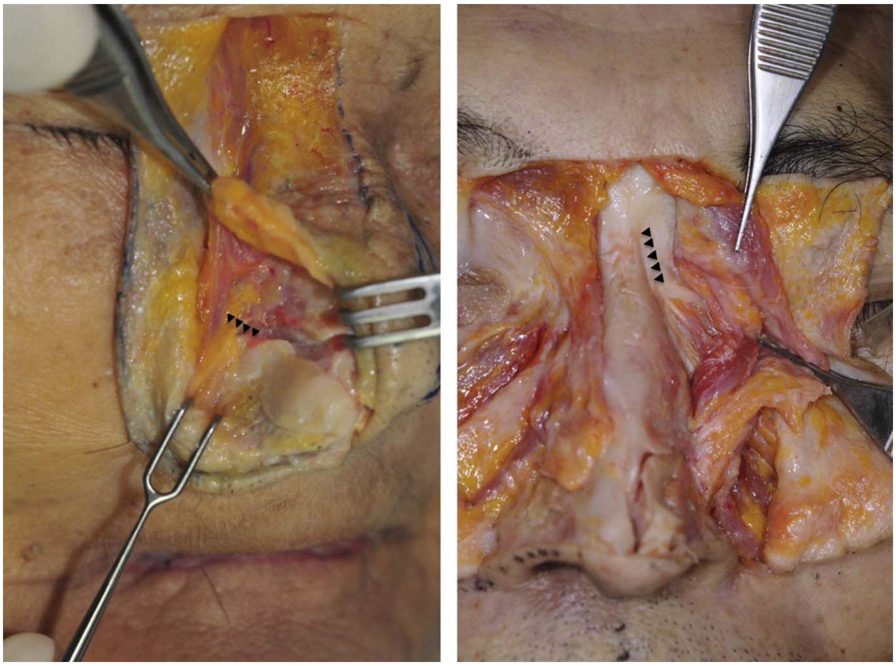

FIGURE 10. Left, Distal insertions (marked by black triangles) of the TNAFs to the lateral crura of the lower lateral cartilage. Right, Lateral insertions (marked by black triangles) of the TNAFs to the nasal bone.

from distal to proximal and attach to the nasion. This anatomy can be appreciated with the use of loupe magnification or endoscopic instruments. Starting distally, a convergent release of these fibers is necessary to ensure a snug pocket fit for the implant.

The SMAS is a well-described entity in the neck and face region.[5–8] Manipulation of the SMAS by either plication or release and repositioning has become a keystone in face-lift surgery. The authors aimed to explain the significance of the extension of the SMAS in the nasal region. The TNAFs and the nasal SMAS have fibrous attachment to the bony and cartilage framework and also contribute to the nasal envelope synonymous to the SMAS. In patients who have a short or constricted nose, separation of the TNAFs is essential so that the nasal envelope is released sufficiently. Numerous surgeons have suggested wide dissection and release of soft tissue in the management of the short nose; however, few have suggested or defined the extent of the dissection area. The TNAFs act as a restriction band, preventing the envelope from expanding caudally or redraping over the implant. By releasing the TNAFs from a proximal-to-distal direction, the skin tension is released, and there is a definite nasal elongation. In our study, we have demonstrated that the extension in nasal length is predominantly from the sellion to the rhinion, and up to 2.1 mm of extension can be achieved. Whilst the nasal SMAS extends from the sellion to the columella, the TNAFs are released proximal to the tip defining point, and most of the release is done along their attachments to the nasal side wall (Fig. 11). Through a transcolumellar and open rhinoplasty approach, the dissection is performed in the subperichrondral plane over the lower lateral cartilages until the keystone area is reached. Keeping within this deep plane is important to ensure that the vascularity of the nasal SMAS is preserved. This helps to prevent scarring and thinning of the nasal-SMAS flap, which in turn reduces the risk of implant visibility or deviation.

Constantian[9] mentioned that a "surgeon who controls postoperative equilibrium controls postoperative results." During this procedure, the most important factor is the balance between the soft tissue envelope and the cartilage framework.

It is extremely useful to understand the TNAFs for augmentation rhinoplasty, especially in Asian noses. Accurate release of the aponeurotic attachment allows accurate pocket dissection and prevents implant malposition. Release of the TNAFs also allows extension of the nasal skin, which is essential for managing patients with a short nose or secondary contracted nose.

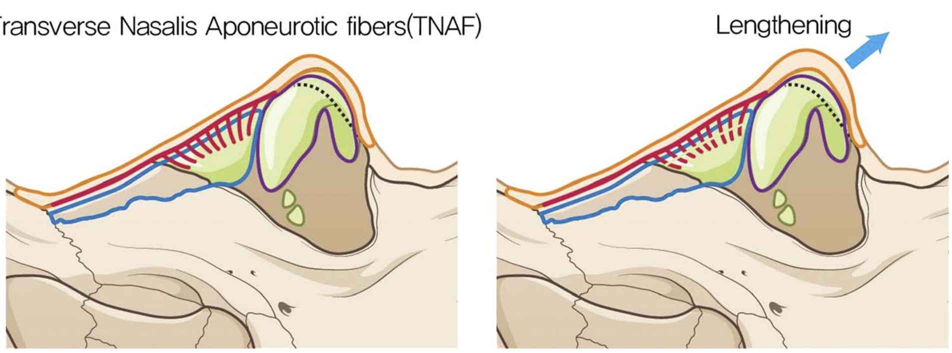

FIGURE 11. Diagrammatic illustration of the releaase of the TNAFs and elongation of the nasal length.

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