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# Anatomical and Ultrasonographic Analyses of the Levator Labii Superioris Alaeque Nasi Muscle at the Level of the Nasal Ala

## Análisis Anatómico y Ecográfico del Músculo Elevador Nasolabial a Nivel del Ala Nasal

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**SUMMARY:** We aimed to determine the width of the levator labii superioris alaeque nasi muscle (LLSAN) at the level of the nasal ala through cadaveric dissections and ultrasonography (US), to provide essential anatomical information for use during both invasive and noninvasive procedures in the nasal ala region. The LLSAN was investigated in the 40 hemifaces of 20 Korean cadavers, comprising 10 males and 10 females with a mean age of 73.6 years. The LLSAN width of the 40 specimens at the level of the midpoint of the nasal ala was 5.02±2.35 mm (mean±standard deviation), and ranged from 1.45 mm to 10.11 mm. The LLSAN widths were 5.96±2.36 mm and 3.93±1.89 mm in males and females, respectively, with ranges of 2.40–10.11 mm and 1.45–6.96 mm, respectively. The LLSAN widths on the left and right sides were 4.77±2.72 mm and 5.26±1.99 mm, respectively. The proportions of the LLSAN fibers inserting into the nasal ala and upper lip were similar in 13 specimens (32.5 %), while more fibers inserted into the nasal ala in 11 specimens (27.5 %) and more fibers inserted fibers of the LLSAN into the upper lip in 16 specimens (40 %). When clinicians need to target or avoid the LLSAN, the present width and range data can be helpful for ensuring the efficacy and safely of both invasive and noninvasive procedures. In addition, the possibility of asymmetry in the width of the LLSAN in the nasal ala region should be confirmed by US before performing such procedures.

**KEY WORDS: Levator labii superioris alaeque nasi muscle; Nasal ala; Upper lip.**

## INTRODUCTION

The levator labii superioris alaeque nasi muscle (LLSAN) originates from the frontal process of the maxilla and runs parallel with the nose. As the LLSAN descends, a proportion of its fibers insert into the skin and the greater alar cartilage of the nose, while the main proportion pass obliquely downward to the skin and musculature of the upper lip (Morris, 1947; Hollinshead, 1982). According to an electromyography study of the nasal muscles, the LLSAN is more closely related to facial expression than to respiratory function (Bruintjes *et al*., 1996). The LLSAN is a superficial elevator muscle of the nose and the upper lip utilized in oral-facial expression (Delle Chiaie, 2021). Since the LLSAN is the only facial muscle that raises the upper lip and the nasal ala superiorly and medially, this muscle can play an important role in expressions involving the nose and lips moving simultaneously in the midface area.

The LLSAN is one of important muscles targeted in botulinum-toxin injections for excessive gingival display (also called gummy smile) and for modifying the nasolabial folds (NLFs) (Pessa & Brown, 1992; Hwang *et al*., 2009; Nasr *et al*., 2016; Myung *et al*., 2021). Facial reconstruction surgeries such as the pedicled LLSAN flap, LLSAN-nasalis island flap, and the LLSAN flap also utilize the LLSAN for reconstructing nasal and vermilion defects (Kuwahara *et al*., 2018; Moore 2nd *et al*., 2019; Iyer *et al*., 2021). Thus, knowledge of the width of the LLSAN is required to ensure safe and effective surgical procedures and outcomes.

In the present study, we aimed to determine the width of the LLSAN at the level of the nasal ala through cadaveric dissections and ultrasonography (US), to provide essential anatomical information for use during both invasive and noninvasive procedures in the nasal ala region.

## MATERIAL AND METHOD

Cadaveric investigation of the LLSAN at the level of the nasal ala. The LLSAN was investigated in the 40 hemifaces of 20 Korean cadavers, comprising 10 males and

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10 females with a mean age of 73.6 years (age range 40–94 years). None of the cadaveric specimens had congenital malformations, pathological findings, or a history of surgery or trauma. The study was conducted in accordance with the ethical principles for medical research involving human subjects of the Declaration of Helsinki. All authors were well informed about the WMA Declaration of Helsinki –Ethical Principles for Medical Research Involving Human Subjects, and confirmed that the present study was consistent with that declaration. The study was approved by the Institutional Review Board (IRB) of Catholic Kwandong University (IRB number CKU-21-01-0803).

The facial skin, subcutaneous layer, and midface muscles were carefully dissected. The LLSAN width was measured from the midpoint of the nasal ala to the lateral margin of the muscle. All measurements were made using digital calipers (Digital Electronic Caliper, Fine Science Tools, Heidelberg, Germany).

Differences in the LLSAN width between males and females or between left and right sides were analyzed statistically using the Kruskal–Wallis test, with $P<0.05$ considered to indicate statistical significance. Statistical calculations were carried out using PRISM software (version 3.0.3, GraphPad Software, San Diego, CA, USA).

US of the LLSAN at the level of the nasal ala. US scans of four volunteers (two males and two females; mean age 34.3 years) were obtained with a real-time two-dimensional B-mode US device (ECUBE 15, Alpinion Medical Systems, Seoul, Korea) with a high-frequency hockey-stick transducer (8–15 MHz; IO8-17T, Alpinion Medical Systems). Each volunteer was placed in the Fowler's position, and facial landmarks were marked on the face. Nontoxic ultrasonic gel (Meditop Sono Jelly, Meditop, Seoul, Korea) was applied before the US scanning process. Volunteers were recruited via a bulletin-board announcement by Catholic Kwandong University. All volunteers were given detailed verbal and written explanations about the experiment, and the researchers in charge answered any questions that the volunteers had before the experiment started. Volunteers who had undergone orthopedic surgery or cosmetic surgery in the facial region were excluded, as were patients with allergies related to ultrasonic gels or diseases such as skin cancer. US scanning was performed at the midpoint of the nasal ala.

## RESULTS

The LLSAN width of the 40 specimens at the level of the midpoint of the nasal ala was 5.02±2.35 mm (mean±standard deviation), and ranged from 1.45 mm to 10.11 mm (Fig. 1). The LLSAN widths were 5.96±2.36 mm and 3.93±1.89 mm in males and females, respectively, with ranges of 2.40–10.11 mm and 1.45–6.96 mm, respectively. The LLSAN widths on the left and right sides were 4.77±2.72 mm and 5.26±1.99 mm, respectively (Table I). The LLSAN widths on the left and right sides exceeded 5 mm in seven cadavers (35.0 %; five males and two females), and were smaller than 3 mm in three cadavers (15.0 %; two females and one male). The LLSAN was

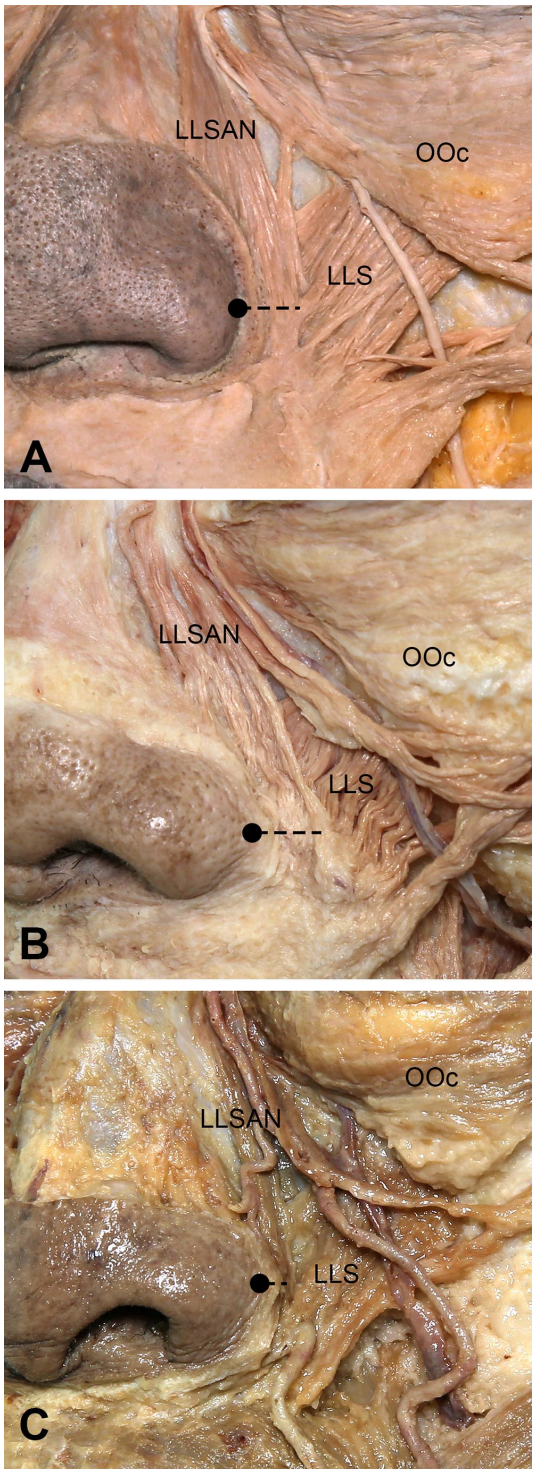


Fig. 1. Width (dashed lines) of the levator labii superioris alaeque nasi muscle (LLSAN) at the level of the midpoint (black dots) of the nasal ala. (A) A specimen with an LLSAN width of 5.19 mm, which is close near to its mean value of 5.02 mm. (B) A specimen with the widest LLSAN width of 10.11 mm. (C) A specimen with the narrowest LLSAN width of 1.45 mm. LLS, levator labii superioris muscle; OOc, orbicularis oculi muscle.

Table I. LLSAN width at the midpoint of the nasal ala (unit: mm).

| | Males | | | Females | | | |
|---|---|---|---|---|---|---|---|
| | Right | Left | Total | Right | Left | Total | Total |
| Mean±SD | 5.66±2.17 | 6.27±2.64 | 5.96±2.36 | 4.80±1.80 | 3.06±1.65 | 3.93±1.89 | 5.02±2.35 |
| Minimum | 2.40 | 2.61 | 2.40 | 2.35 | 1.45 | 1.45 | 1.45 |
| Maximum | 8.36 | 10.11 | 10.11 | 6.96 | 5.25 | 6.96 | 10.11 |

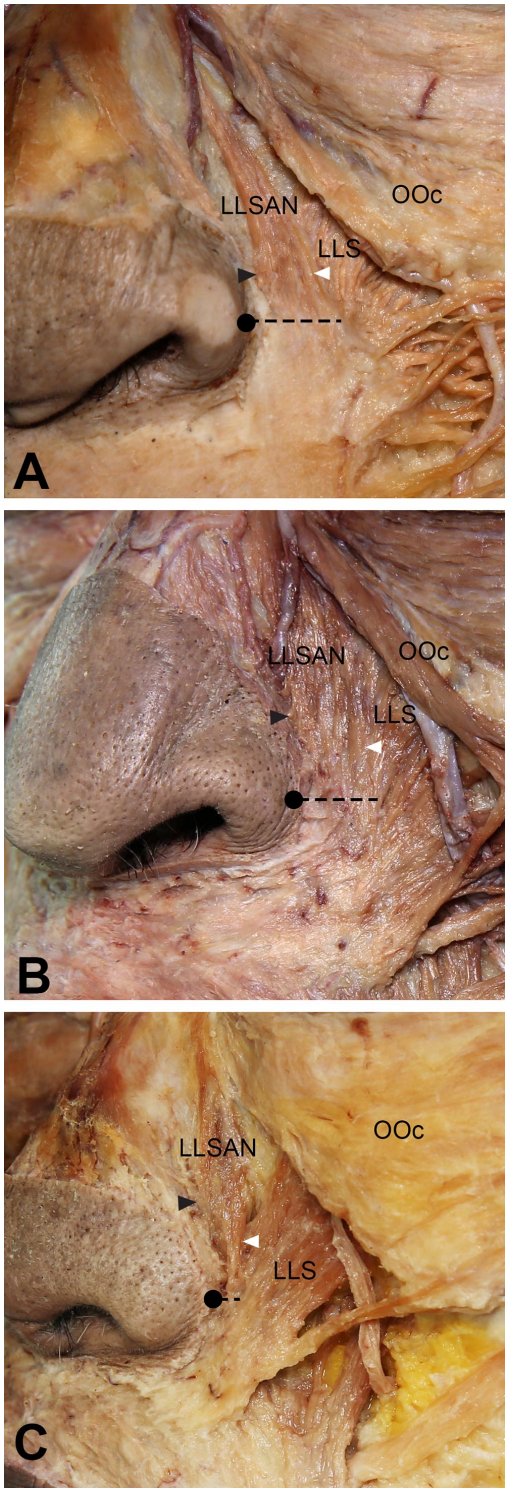


Fig. 2. Proportion of levator labii superioris alaeque nasi muscle (LLSAN) fibers inserting into the nasal ala and upper lip. (A) A specimen with most of the LLSAN fibers inserting into the upper lip. (B) A specimen with approximately half of the LLSAN fibers inserting into the nasal ala and the other half inserting into the upper lip. (C) A specimen with most of the LLSAN fibers inserting into the nasal ala. Black arrowheads indicate the medial fibers of the LLSAN that insert into the nasal ala. White arrowheads indicate the lateral fibers of the LLSAN that insert into the upper lip. Dashed lines indicate width of the LLSAN at the level of the midpoint (black dots) of the nasal ala.

significantly wider (by approximately 1.5-fold) in males than in females, but there was no statistically significant difference between the left and right sides.

Width asymmetries exceeding 3 mm between the left and right sides were found in 5 of 20 cadavers (25 %; 2 males and 3 females). The width asymmetry of the LLSAN between the left and right sides was 2.0±1.8 mm (range 0.1–7.7 mm). There was no significant difference in the asymmetry ratio between males and females.

The proportions of the LLSAN fibers inserting into the nasal ala and upper lip were similar in 13 specimens (32.5 %), while more fibers inserted into the nasal ala in 11 specimens (27.5 %) and more fibers inserted fibers of the LLSAN into the upper lip in 16 specimens (40 %) (Fig. 2).

The US scans at the midpoint of the nasal ala revealed that the total thickness of the skin, subcutaneous tissue, and LLSAN was 0.43±0.08 mm (range 0.33–0.49 mm), while the thickness of the skin and subcutaneous tissue was 0.37±0.07 mm (range 0.25–0.42 mm), and the thickness of the LLSAN was 0.06±0.01 mm (range 0.04–0.07 mm) (Fig. 3 and Table II).

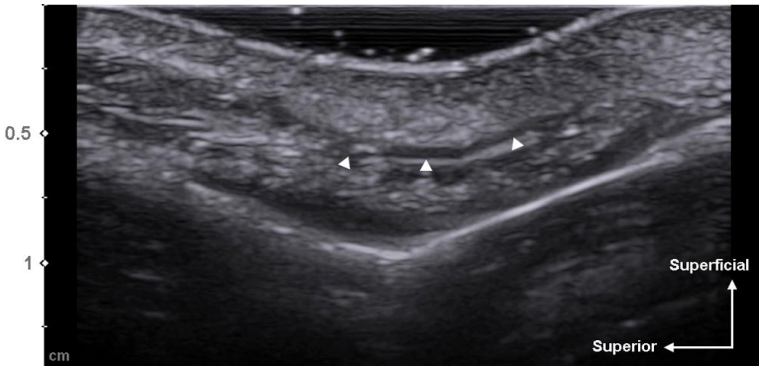


Fig. 3. Ultrasonography (US) image of the levator labii superioris alaeque nasi muscle (LLSAN) at the level of the midpoint of the nasal ala showing the longitudinal view used in the LLSAN analyses. The LLSAN (arrowheads) appeared as a thin muscle layer deep to the skin and subcutaneous tissue.

Table II. Thicknesses of the skin, subcutaneous tissue, and LLSAN.

| | Skin, subcutaneous tissue, and LLSAN | Skin and subcutaneous tissue | LLSAN |
|---|---|---|---|
| Mean±SD | 0.43±0.08 | 0.37±0.07 | 0.06±0.01 |
| Minimum | 0.33 | 0.25 | 0.04 |
| Maximum | 0.49 | 0.42 | 0.07 |

## DISCUSSION

This study investigated the width and depth of the LLSAN at the level of the nasal ala, where several procedures are performed that target this muscle. The LLSAN width varied markedly at the level of the nasal ala, from 1.45 mm to 10.11 mm, with a mean of 5.02 mm. This means that the difference between the minimum and maximum LLSAN widths was approximately 10 mm, and that the maximum LLSAN width was almost twice the mean width. The combined depth of the skin and subcutaneous tissue was a mean of 0.37 mm, while the total depth of the skin, subcutaneous tissue, and LLSAN was a mean of 0.43 mm. Thus, the LLSAN is very close to the skin (within 0.4 mm) at the level of the nasal ala.

The LLSAN has clinical implications in aesthetic procedures and reconstructive surgeries. Moore 2nd *et al*. (2019), reported that the source of the vascular pedicle was the superior labial artery just deep to the LLSAN and that the pedicled LLSAN flap provides a durable reconstructive option that only requires a single stage of reconstruction. Those authors reported that the mean distance from the lateral margin of the nasal sill laterally to the pedicle was 6.3 mm (range 0–12 mm) and that almost all pedicles were located were within 1 cm laterally to the nasal sill, while there was more variation in the depth of the pedicle. In the present study, the mean width of the LLSAN at the level of the nasal ala was 5.02 mm (range 1.45–10.11 mm). The most prominent point of the nasal ala is located slightly lateral to the nasal sill. Thus, it is thought that the artery of the pedicle is located near the lateral margin of the LLSAN at the level of the nasal ala.

Hwang *et al*. (2009), reported that the LLSAN is the target of treatments for gummy smile. The three lip elevator muscles—levator labii superioris muscle (LLS), LLSAN, and zygomaticus minor muscle—converge in the area lateral to the ala. A safe and reproducible injection point for botulinum toxin around the converging area of the three muscles was proposed, and was demonstrated to be effective for clinically treating gummy smile. In addition, the LLSAN is an excellent target structure for treatments aimed at modifying the NLFs. Pessa and Brown (1992) reported the LLSAN as the primary facial muscle responsible for producing the medial NLF, and also suggested that the LLSAN and LLS contribute significantly to the etiology of the prominent NLFs that occur with aging. In addition, the constant pull of the LLSAN will deepen the NLFs over time (Chiaie, 2021).

## CONCLUSION

This study investigated the width, depth, and insertion ratio of the LLSAN at the midpoint of the nasal ala, which is a frequently used injection point for botulinum-toxin treatments and a major surgical area in nose and upper-lip reconstruction. When targeting the LLSAN at the level of the nasal ala, it is suggested that needle injections be performed within 5 mm laterally and at a depth of 0.4 mm. When clinicians need to target or avoid the LLSAN, the present width and range data can be helpful for ensuring the efficacy and safety of both invasive and noninvasive procedures. In addition, the possibility of asymmetry in the width of the LLSAN in the nasal ala region should be confirmed by US before performing such procedures (Fig. 3).

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**RESUMEN:** Nuestro objetivo fue determinar el ancho del músculo elevador nasolabial (MENL) a nivel del ala nasal mediante disecciones cadavéricas y ecografía, para proporcionar información anatómica esencial, para su uso durante procedimientos invasivos y no invasivos, en la región del ala nasal. El MENL se estudió en 40 hemicaras de 20 cadáveres coreanos (10 hombres y 10 mujeres) con una edad media de 73,6 años. El ancho de MENL de las 40 muestras a nivel del punto medio del ala nasal fue de 5,02 ± 2,35 mm (media ± desviación estándar) y osciló entre 1,45 mm y 10,11 mm. Los anchos de MENL fueron 5,96 ± 2,36 mm y 3,93 ± 1,89 mm en hombres y mujeres, respectivamente, con rangos de 2,40 a 10,11 mm y 1,45 a 6,96 mm, respectivamente. Los anchos de MENL en los lados izquierdo y derecho fueron 4,77 ± 2,72 mm y 5,26 ± 1,99 mm, respectivamente. Las proporciones de fibras de MENL que se insertaban en el ala nasal y en el labio superior fueron similares en 13 muestras (32,5 %), mientras que se insertaron más fibras en el ala nasal en 11 muestras (27,5 %) y además, se insertaron fibras de MENL en el labio superior en 16 ejemplares (40 %). Cuando los médicos necesitan apuntar o evitar el MENL, los datos actuales de ancho y rango pueden ser útiles para garantizar la eficacia y seguridad de los procedimientos, tanto invasivos como no invasivos. Además, la ecografía puede ser utilizada para confirmar una posible asimetría en el ancho del MENL en la región del ala nasal antes de realizar los procedimientos.

**PALABRAS CLAVE: Músculo elevador nasolabial; Ala nasal; Labio superior.**

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