

Research on Macroanatomic and Histologic Characteristics of the Lower Lateral Nasal Cartilages in Vietnamese

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Abstract

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BACKGROUND: There are recently many studies about the anatomy of lower lateral cartilage (LLC). However, the microanatomic studies to identify the segments of most LLC at the nasal tip in Vietnamese are very rare.

AIM: Investigate the macroanatomic and microanatomic characteristics of the LLC and the structures of the nasal tip.

METHODS: Descriptive study, 30 cadaver noses fixed by 10% formalin, 2 cadaver noses fixed by HE in 69 Institutes in Vietnam from December 2017 to April 2019.

RESULTS: The average length of the medial crus is 12.3 mm on the right and 13.2 mm on the left. The maximum intercrural distance is 10.7 mm. The average length of the dome is 3.7 mm and 3.9 mm on the right and left side separately, with 2 subunits are the domal and lobular segment. The average thickness of the tip points is 1.0 mm. The width of the interdomal and intercrural ligaments are 0.5-fold the height and 2-fold the thickness. The thickness of the interdomal fat pad is 3mm and about 0.5-fold the wide.

CONCLUSION: The LLC has 3 parts: intermediate, medial and lateral crus. The microanatomic structures of tip consist of the interdomal ligaments, intercrural ligaments, SMAS and interdomal fat pad.

Introduction

External nasal is one of the human organs which are operated most in cosmetic surgery, especially in Asian countries due to high demands of rhinoplasty. The characteristics of the Asian nose structure are large tips and low nose bridges [1]. The rhinoplasty is not only putting an implant to lift nose bridge, but also refining tip of the nose as well as alar base reduction, and it includes nasal osteotomies, etc. The lower lateral cartilage (LLC) plays an important role in reconstructing the tip of nose; particularly the structures form pyramidal nose such as medial and lateral crus, dome of LLC including tip point, the tripod

concept as well as the definition about M-arc, the nasal tip support including interdomal ligaments, intercrural ligaments, skin cartilage make a ratio between compression and tension forces, which affect the outcome of rhinoplasty [2]. If surgeons understand clearly about these anatomies, they can choose the appropriate surgery methods for rhinoplasty of the nasal tip [3]. There are recently many studies about the anatomy of lower lateral cartilage. However, the microanatomic studies to identify the segments of most LLC at the nasal tip in Vietnamese are very rare [4], [5], [6]. Based on the upper demands, we carried out the study "Research on macroanatomic and histologic characteristics of the lower lateral nasal cartilages in Vietnamese" with two objects: 1. *Investigating the macroanatomic and histologic*

characteristics of segments of LLC: lateral, medial and intermediate crus and 2. Investigating the macroanatomic and histologic characteristics of the structures related to nasal tip in Vietnamese.

Materials and Methods

Study design

Descriptive cross-sectional study

Study population

Group 1: Investigating the macroanatomic features of 30 Vietnamese adult cadavers fixed by formalin 10% at Anatomy Department of Pham Ngoc Thach University of Medicine.

Group 2: Investigating the microanatomic features of 2 noses of Vietnamese adult cadavers fixed by hematoxylin-eosin at 69 Institute (Ha Noi).

We chose the convenience sampling method:

- Inclusive criteria: 1. Vietnamese adult cadavers who were 18 years old or more; 2. The cadavers whose pyramidal noses were integrated and they had never undergone rhinoplasty before; and 3. There were no malformation, tumour or abnormalities in facial structure.

- Exclusive criteria: we excluded the cadavers who had a malformation of the pyramidal nose, had undergone in nasal cavities or had destroyed structures due to storage method or inappropriate fixing.

Study period

From December 2017 to April 2019.

Investigating anatomic features

We revealed the tip of the nose based on open nasal surgery method, then identified LLC and the related structure around the LLC near the nasal tip. We measured the length of crus and footplate, the distance between crural, the length and width of two subunits: domal and lobular segment, the thickness of cartilage at the nasal tip, the width and height of triangular soft tissue. We investigated interdomal ligaments, intercrural ligaments and interdomal fat pad.

Investigating micro anatomic features

With two cadavers, we cut all the nasal root area with the upper border is a line crossing through

two internal ends of supraorbital ridge, the outer borders runs along the outer border of nasal bone, alar nostril and the lower border is a line running along the lower border of alar nostril and footplate of the nose, we fixed them with formalol 10% for histopathology. Then the nasal-frontal bone samples were demineralised by acid citric 5% to become soft tissues. After blocking paraffin, we cut slices by microtome machine and collected 4 µm-width slices, then we stained the samples based on HE method (Hematoxylin – Eosin), and observed those with an optical microscope in 4, 10, 20, 40 objectives to identify the major alar nostril and the related structures.

Statistics

The histopathologic images were read by Image Pro Software at 69 Academy, Tomb Security Command. They were recorded by Olympus camera inside the microscope.

Analysing and processing the statistical tests by SPSS 19. We used the statistical tests such as t-test and χ^2 and p-value < 0.05 was considered statistically significant.

Results

Characteristics of samples: We investigated the anatomic features of 30 Vietnamese cadavers, the sample included 20 males (62.5%) and 12 females (37.5%), the average age of our sample is 67.3 ± 16.7 years old (ranging from 21 to 93 years old).

Characteristics of the lower lateral cartilage

The length of collumelar crus was more than the length of footplate crus about 2 mm, and the internal legs (tripod) in both sides were about 15 mm long, the dimensions are different between left and right side.

Table 1: The dimensions of medial crus in Vietnamese cadavers

Dimension (mm)	Right	Left	p-values
Length of medial crus	12.3 ± 2.9	13.2 ± 2.2	0.076 ^c
Width of medial crus	3.5 ± 1.2	3.2 ± 1.2	0.007 ^e
Thickness of cartilage	0.8 ± 0.2	1.0 ± 1.0	0.346 ^e
Intercrural distance	3.2 ± 1.4		
Length of footplate crus	0.5 ± 0.8		
The maximum distance between two footplate crus	10.7 ± 2.5		

c. T - student test; e. Mann - Whitney test.

The length of the medial crus in our sample was 12 – 13 mm (Table 1). We found that the prevalence of the separation of upper crus was 60%

in both sides and there was a significant difference between left and right side, the maximum distance between two crus, which is called the intercrural space, was 3.2 mm.

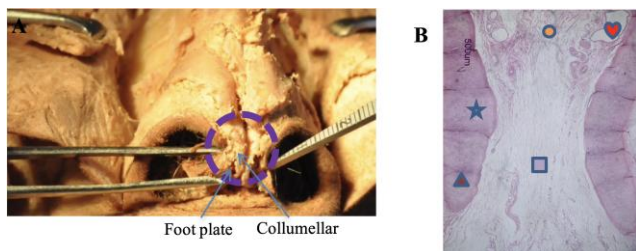


Figure 1: Medial crus in macroanatomic feature A) and in microanatomic feature, B) corresponding to the circle area in A); (*) Notes: the footplate are separated (□), the crus are converted (*), the collagen fibres run in the intercrural space (◻), the collagen fibres of interdomal ligaments (♣) and the vessels of interdomal area (♥)

Meanwhile, the part in which footplate crus (Figure 1) did not separate was very small (0.5 mm) and most of these were separated far from each other to fin nasal base, and the maximum distance between two footplates was 11 mm (about 4 times more than the intercrural space).

Table 2: The dimensions of intermediate crus in Vietnamese cadavers

Dimension (mm)	Right	Left	p-values
The length of lobular subunit	3.0 ± 1.1 mm	3.0 ± 1.1 mm	0.884 ^e
The length of domal subunit	4.9 ± 2.0 mm	5.0 ± 2.3 mm	0.655 ^e
The width of lobular subunit	3.7 ± 1.1 mm	3.9 ± 2.1 mm	0.434 ^e
The width of domal subunit	4. ± 1.4 mm	4.5 ± 1.6 mm	0.254 ^e

e. Mann-Whitney test.

The domal subunit was longer than the lobular one about 2 mm (Table 2 and Figure 2), and there was no significant difference between the dimension in both sides.

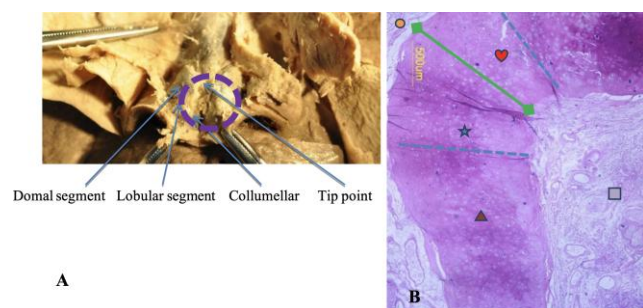


Figure 2: The boundary of lobular and domal segments in intermediate crus and tip A); the specimen of the continual zone of domal area and the medial crus B); corresponding to the circle area in A); (*) Notes: the medial crus (□), the lobular segment (*), the collagen fibres of interdomal ligaments (♣), the domal segment (♥), the triangular soft tissue is connective tissue (◻), the green arrow is the tipping point

The height of the triangular soft tissue was about 5 mm, which equals ½ the width and the dimensions in both sides were significantly different

(Table 3).

Table 3: The triangular soft tissue in the cadavers

Dimension (mm)	Right	Left	p-values
Width	10.2 ± 2.4 mm	10.5 ± 3.5 mm	0.0001 ^e
Height	4.7 ± 1.5 mm	4.6 ± 1.2 mm	0.020 ^e

e. Mann-Whitney test.

The thickness of intermediate crus was more than 1 mm; there was no significant difference between the two sides in the cadavers. The distance between tip points was 6.8 mm.

Table 4: The thickness of cartilage of intermediate crus in Vietnamese cadavers

Dimension (mm)	Right	Left	p-values
Lobular segment	1.2 ± 0.3 mm	1.2 ± 0.3 mm	0.650 ^e
Domal segment	1.2 ± 0.3 mm	1.3 ± 0.3 mm	0.065 ^e
Tip points	1.0 ± 0.5 mm	0.9 ± 0.2 mm	0.386 ^e
Distance between tip points	6.8 ± 2.7mm		

e. Mann-Whitney test.

The total length of right and left lateral crus were 18.5 and 17.5 mm, respectively; the width at the middle point of lateral crus was 8.5 mm; the dimensions of the tail of lateral crus were about ½ the dimensions of lateral crus; the thickness of cartilage was about 0.8 mm. The parallel direction of lateral crus was 40.0% (12 out of 30 cadavers), and the oblique direction was 60.6% (18 out of 30 cadavers) (Table 5).

Table 5: The dimensions of lateral crus in Vietnamese cadavers

Dimensions	Right	Left	p-values	
Length	From lateral genu to the boundary of tail	12.3 ± 2.4 mm	12.1 ± 2.3 mm	0.626 ^e
	Tail	6.1 ± 2.7 mm	5.5 ± 2.1 mm	0.150 ^e
	All lateral crus	18.5 ± 3.9 mm	17.5 ± 2.9 mm	0.305 ^e
Width	At lateral genu	8.0 ± 1.8 mm	8.1 ± 1.8 mm	0.750 ^e
	At the middle of lateral crus	8.5 ± 1.4 mm	8.5 ± 1.2 mm	0.969 ^e
	At tail	5.0 ± 1.8 mm	4.6 ± 0.9 mm	0.245 ^e
Thickness of the cartilage	At lateral genu	0.9 ± 0.2 mm	0.8 ± 0.2 mm	0.524 ^e
	At the middle of lateral crus	0.8 ± 0.2 mm	1.1 ± 1.7 mm	0.387 ^e
	At tail	0.7 ± 0.2 mm	0.7 ± 0.2 mm	0.176 ^e

e. Mann – Whitney test.

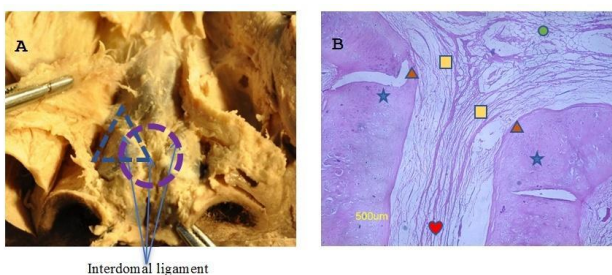
The nasal tip supports

The width of the interdomal ligaments was about 4 mm (Table 6 and Figure 3 and Figure 4), which equals ½ the height and two times the thickness.

Table 6: The dimensions of interdomal ligament in Vietnamese cadavers

Dimension	Average value
Height	8.0 ± 4.8 mm
Width	4.2 ± 2.4 mm
Thickness	1.8 ± 1.0 mm

The intercrural ligament in cadavers was average 3.1 ± 1.3 mm wide, which equals ½ the length (5.8 ± 1.6 mm) and two times the average thickness of the intercrural ligament (1.6 ± 0.8 mm).



Interdomal ligament

Figure 3: The interdomal ligament runs from interdomal area to the upper border of LLC and the lateral nasal valve (based on the new point of view) in anatomic feature A) and in microanatomic feature B); corresponding to the circle area in A); (*) Notes: the tip point of domal area (intermediate crus) (*), the fat cells of the interdomal fat pad (*), the collagen fibres in the intercrural ligament (♥), which continue with the interdomal ligament (□)

The interdomal fat pad in cadavers was average 7.9 ± 3.8 mm wide, and 11.5 ± 3.8 mm long, however, the average thickness of it was just 1.5 ± 1.1 mm.

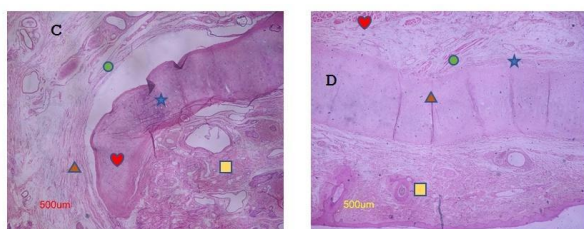
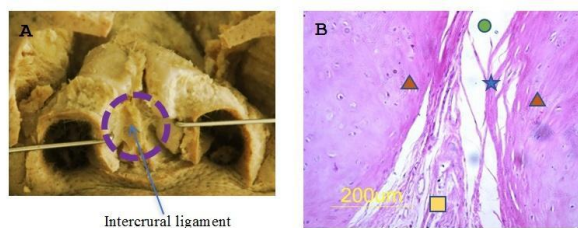


Figure 4: The microanatomic feature of the lateral crus at the tail C) and the lateral nasal valve D); corresponding to the triangle area in A); (*) Notes for C): the interdomal ligament (*), which includes many collagen fibres running in the upper face of LLC (*), lasts long and covers the lateral crus, lateral nasal valve and the tail of lateral crus (♥), the subcutaneous tissues in the inner face of nasal vestibule (□); (*) Notes for D): the specimen of lateral crus and lateral nasal valve; B) the lateral nasal valve area (△), which has a place for attachments of the collagen fibre bundles of nasal SMAS and the interdomal ligament, that ligament supports to the lateral nasal valve (*), nasal muscles (♥), the collagen fibres of interdomal ligament running toward the lateral crus (*), skin and subcutaneous tissues of the mucosa in the inner nose have a hair follicle structure (□)

The thickness of the interdomal fat pad was 3 mm, which equals $\frac{1}{2}$ the width (6.5 mm), and this fat pad runs along from the interdomal area up to the nose bridge about 15 mm and the thickness was 3.3 mm (Figure 5 and Figure 6).

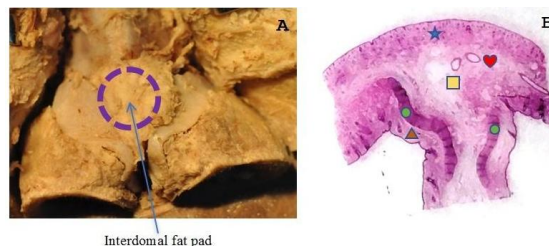


Intercrural ligament

Figure 5: The intercrural ligament in anatomic feature A) and in microanatomic feature B), corresponding to the circle area in A); (*) Notes: the medial crus of the LLC (△), the collagen fibers of the intercrural ligament (*), the fibers run across the intercrural area (♥), the connective tissues, fat cells, vessels and the footplate (□)

Discussion

The length of medial crus in our sample was 12-13 mm, which was shorter than Polselli R. [7]; his result was 16 – 24 mm. The difference is easily explained due to the difference in races so that the crus is longer and affects to the protruding of the nose.



Interdomal fat pad

Figure 6: The interdomal fat pad in anatomic feature A) and in microanatomic feature B); corresponding to the circle area in A); (*) Notes: the thickened skin on the nasal tip (*), and the thickened subcutaneous area (♥) mixed with the interdomal fat tissues (□), which lied on the dome of LLC (□)

The length of footplate crus, which is rarely described in standard books, in our study was about 5 – 5.7 mm and the distance between two crus was 10.7 mm. This was consistent with the results of Byrd H.S. [3], the result was 4 – 7.5 mm (average 11.4 mm). Moreover, we noticed that the prevalence of the separation of upper crus was 60% in both sides and there was a significant difference between left and right side, the maximum distance between two crus, which is called the intercrural space, was 3.2 mm. Meanwhile, the part in which footplate crus did not separate was very small (0.5 mm) and most of these were separated far from each other to fin nasal base, and the maximum distance between two footplates was 11 mm (about 4 times more than the intercrural space).

Tailing W [8] found that the distance between two tip points was the most important factor. However, it is noticed that the effect of this factor is not strong, this effect is from many other factors such as the angle of subunits, the interdomal fat pad, the thickness of skin on nasal tip and the thickness of nasal SMAS so based on one or more coherent factors, we chose the different processes. Burren S [9] concluded that the interdomal distance of the tip points was variously based on sex and race, there was no significant difference in that distance, however, there was statistically different in the distance between the interdomal subunit with tip point of nose, that meant the smaller the distance was, the higher the tipping point was. Moreover, two tip points of the pair of LLC were made of a triangular soft tissue without cartilage in the superior-inferior LLC.

The height of this triangle in our study was about 5 mm, which equals $\frac{1}{2}$ the width and the area was about 25 mm^2 , the dimensions of this triangle

were significantly different on both sides. This is the place which a surgeon does not notice much, and it can affect to nasal gap when we sew the wound after surgery procedure with a strict suture tightening force.

Moreover, Tai-ling W. [8] noted that the distance between two average tip points was about 5 or 6 mm if the distance was more than 6 mm, that meant the patient nasal tip was big. In our study, this distance in the cadavers was 6.8 mm, which was more than the distance measured in human by sonography (5.6 mm). Thus, if we based on this result, we could assume that the Vietnamese nasal tip had not been big. However, when being measured by anthropometry, most Vietnamese has a big nasal tip. So which factors can affect the size of the Vietnamese nasal tip although the distance between two tip points is not more than 6mm? This can be explained partly based on the reason that two domal subunits and the medial line made an angle about 80° , which affected the distance between two tip points. The thickness of the skin in the tip is one of the negative factors for the procedure to refine the nasal tip; this thickness was investigated by observation, touch or using sonography to measure.

The lateral crus ran parallel to the border of the nostril, the outer part ran toward and made an angle 15° with the border of nostril [5]. However, Constantian M.B. [2] found that after moving out of lateral genu, the lateral crus ran parallel to $\frac{1}{3}$ border of nostril and then toward with an angle $30-45^{\circ}$ or more; Sheen noticed that this change would make the tip of nose bigger, the result was consistent with our study's result that 60% lateral crus run obliquely. Thus, investigating the dimensions of lateral or medial crus will help to build data for rhinoplasty in Vietnamese, the length is ranged 16 – 24 mm, the width is ranged 4 – 10 mm, the distance from the lower border of LLC to the border of nostril varies based on the measured point and the measurer, about 6mm when we chose the middle point of domal cartilage, 5 mm when we measured from the middle point of lateral crus, 13 mm when we measured from the farthest point of the end of lateral crus [5], these results are consistent with our results (the length was 18 mm, the width at the middle point was 8.5 mm and the thickness was 1 mm).

To sum up, Vietnamese noses have the medial and lateral crus, which are shorter than the white ones. Thus, most of the rhinoplasty is grafting cartilage to lengthen the legs of the tripod. It should notice that the shape of lateral crus, as well as the flexure of medial crus, will affect the dimensions. We also investigated the relationship between the lateral crus and outer leg with the shape of lateral crus to examine if the deformation of lateral crus affected these dimensions in both sides and we discovered that the deformation did not affect the length of lateral crus as well as an outer leg of the tripod.

The width of the interdomal ligaments is about 4 mm, which equals $\frac{1}{2}$ the height and two times the

thickness. Based on the dissection procedure in cadavers and the results of Saban Y. [6], we noticed that the definition of Anderson was not correct when we widen the origin of domal ligament.

The reason is that most of the investigated milestones were cut off during rhinoplasty along the outer incision. With the inner incision in nasal augmentation, when dissecting to put the implant, the implant may be upper or lower the domal ligament. In our study, the best position was lower the domal ligament so that the implant did not appear in the nasal tip when nasal augmentation. In other words, the interdomal ligament was just in the interdomal area, Saban Y. [6] confirmed that there was no widen interdomal area, it is just the nasal SMAS, so within the limit of our study, we cannot demonstrate that in histopathology. So, we offer more studies about the role of this area in histopathology and Vietnamese patients.

The intercrural ligament in cadavers is average 3.1 ± 1.3 mm wide, which equals $\frac{1}{2}$ the length (5.8 ± 1.6 mm) and two times the average thickness of the intercrural ligament (1.6 ± 0.8 mm). During the dissection procedure, we found that this ligament was under the interdomal ligament and linked these ligaments together, there often had a fat pad being between two medial crus, that fat pad was less or more. This result was consistent with other studies [10], [11].

In our result, the thickness of the interdomal fat pad was 3mm, which equals $\frac{1}{2}$ the width (6.5 mm), and in fact, this fat pad runs along from the interdomal area up to the nose bridge about 15 mm and the thickness is 3.3 mm (Pic 4). This fat pad is in most of the cadavers we investigated; it is different from the result of El-Shaarawy E.A.A [5], the researcher found that about 6.5% sample had no interdomal fat pad. However, most of the other studies found that the fat pad often exits in spite of the size of the nasal tip. In some foreign studies, this fat pad is subcutaneous, which is the thickest on the nasal tip, it covers all the interdomal area, about 50% patients with skin thickness from medium level and above always have this fat pad and even patients with thin skin still have [10], [11]. In our study, both cadaver and patient groups had the interdomal fat pad whose size ranged 1.8 – 3.2 mm, and this pad lied in the interdomal area about 2.9 mm, this result was consistent with Copcu E., in which the size of fat pad was 1.8 x 3.2 mm [4], the thickness of this in the nasal tip of male and female are 0.38 mm and 0.19 mm, respectively.

In conclusion, the lower lateral cartilages include 3 subunits: the lateral, the intermediate – domal and the medial crus. The direction of the lateral crus was running obliquely upward, that was 60% of the sample. Thus, the distance between lateral genu equals $\frac{1}{2}$ the distance from the tail of LLC to the anterior border of the nostril. The intermediate crus was 8 mm long; the domal area was 4.5 mm wide, the

characteristic of Vietnamese domal area was that the angle of subunits was wide and obtuse, while two domal areas concentrate on the medial line, so the angle of two subunits is less than 90°, it is highest at the dome called the tipping point, the interdomal ligament covers that area. Between two parts of the medial crus, there are connective ligament fibres.

With the nasal tip supporting: the width of the interdomal and intercrural ligaments equals ½ the height and two times more than the thickness. The thickness of the interdomal fat pad is 3 mm, which equals ½ the width. In histopathology, we could observe these structures which the nasal tip supports.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Pham Ngoc Thach University research committee with No 003.

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