

Clinical anatomic considerations of the  
zygomaticus minor and depressor anguli  
oris muscle based on the morphology for  
botulinum toxin injection

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Directed by Professor Hee-Jin Kim, D.D.S., Ph.D.

The Doctoral Dissertation  
submitted to the Department of Dentistry,  
and the Graduate School of Yonsei University  
in partial fulfillment of the requirements for the degree of  
Doctor of Philosophy

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December 2013

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December 2013

## ACKNOWLEDGEMENTS

본 논문이 나오기까지 부족한 저를 이끌어 주시고 많은 가르침과 격려를 통해 지도 편달해 주신 김희진 지도교수님께 깊은 존경과 감사를 드립니다. 논문의 작성과 심사에 아낌없이 조언과 도움을 주신 허경석 교수님, 정한성 교수님, 황충주 교수님, 김홍중 교수님께도 깊은 감사를 드립니다.

바쁜 임상 과정 중에도 제가 논문을 쓰는데 정신적, 시간적으로 도움을 준 고운미소 김성현, 강호성, 박재한, 서정일 원장님과 스태프들, 실험과 정리에 많은 도움을 주신 최유진, 최다예 선생님, 그리고 해부 파트 모든 조교선생님께도 다시 한번 감사의 마음을 드립니다.

끝으로 제가 이 자리에 올 때까지 항상 같은 마음으로 희생해주신 감사하는 아버님, 어머님, 늘 사랑으로 보살펴주시는 장인, 장모님, 저의 인생 동반자로서 제가 하는 일을 항상 믿고 끝없는 내조로 제가 이 길을 정진할 수 있도록 도와주는 나의 사랑하는 아내 백수미와 똑같이 사랑하는 아들 선우에게 기쁨과 감사의 마음을 전합니다.

2013년 12월

저자 씀

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Abstract

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toxin injection

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The zygomaticus minor muscle (Zmi) is involved with the formation of negative expressions; it raise the corner of the mouth and upper lip, then helps to curl the upper lip when showing contempt, smugness, and disdain. It also helps to deepen the nasolabial sulcus when showing sadness. Drooping of the mouth corner caused by hyperactivity of the depressor anguli oris (DAO) can also generate a sad, tired, or almost angry look in some patients. However, The details of the Zmi insertion pattern and morphology are not well described even in general anatomy textbooks and illustrations. In addition, it is difficult to inject botulinum toxin type A (BoNT) into the DAO because its medial border overlaps with the depressor labii inferioris, and its lateral border is adjacent to the risorius, zygomaticus major, and platysma muscles. The aim of this study was to clarify the morphology and insertion pattern of the Zmi, and to provide critical information for determining the safest and most effective

BoNT injection site of the DAO.

Fifty-four embalmed adult hemifaces (48 bilateral and 6 unilateral; 31 males, 23 females; age range, 45 - 48 years; mean age, 67.4 years) from 30 cadavers were used in Zmi study and forty-two hemifaces from Korean (20 hemifaces, 9 left and 11 right; mean age, 69.1 years) and Thai (22 hemifaces, 11 left and 11 right; mean age, 78.4 years) adult cadavers (in total, 20 left and 22 right; mean age, 73.9 years) were dissected for DAO study.

The Zmi was classified into three types. Type A, in which the Zmi attached only to the upper lip, was observed in 63.0% (34/54) and was subdivided into two types: straight (A-1; 31.5%, 17/54) and curved (A-2; 31.5%, 17/54). Type B, in which the Zmi was attached to both the upper lip and the lateral alar region, occurred in 27.8% (15/54). In type C, there was either no or only undeveloped Zmi fibers (9.2%, 5/54).

The location of the modiolus was  $11.0 \pm 2.6$ mm laterally and  $8.9 \pm 2.8$ mm inferiorly to the cheilion. The angle formed by the sagittal line passing through the modiolus ( $L_V$ ) and the line connecting the modiolus and P2 (the point which meet the lateral border of the DAO and the mandibular border) was  $44.7 \pm 13.7^\circ$ . The angle formed by  $L_V$  and the line connecting the modiolus and the most concave point of the medial border of the DAO ( $L_{P3}$ ) was  $31.8 \pm 8.5^\circ$ .

The present finding of Zmi fibers being attached to the alar region in many cases (27.8%) suggests that this muscle is involved in elevation of both the nose ala and upper lip. The fan-shaped area bounded by  $L_{P2}$ ,  $L_{P3}$ , and the mandibular border is the safest and most effective injection site for DAO.

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Key words : Alar region, Botulinum toxin type A, Depressor anguli oris, Injection site, Zygomaticus minor muscle

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## I . INTRODUCTION

One of the many features that contribute to the negative appearance of facial expression is raising and drooping of the mouth corner. Acting together, the levator labii superioris muscle, levator labii superioris alaque nasi (LLSAN), and zygomaticus minor muscle (Zmi) raise the corner of the mouth and upper lip and hyperactivity of the depressor anguli oris (DAO) can lead to a drooping of the mouth corner.

The Zmi arises from the lateral surface of the zygomatic bone immediately behind the zygomaticomaxillary suture, and passes downward and medially into

the muscular substance of the upper lip. While the DAO arises from the oblique line of the mandible, inserts into the modiolus, and interlaces with the adjacent muscles. This muscle dilates the mouth and depresses the labial commissures bilaterally.

The Zmi is involved with the formation of negative expressions; it helps to curl the upper lip when showing contempt, smugness, and disdain. It also helps to deepen the nasolabial sulcus when showing sadness (Borley et al., 2008; Moore and Dalley, 1999). Drooping of the mouth corner caused by hyperactivity of the DAO can also generate a sad, tired, or almost angry look in some patients (Perkins, 2007). A common complaint when patients present for facial rejuvenation is an expression of sadness or discontent, which is made evident by raising and drooping of the mouth corner (Goldman and Wollina, 2010).

The Zmi is involved in the expression of many different facial emotions, only poor descriptions of it are available. The details of its insertion pattern and morphology are not well described even in anatomy textbooks and illustrations. The Zmi is described as inserting into the LLSAN , blending with the orbicularis oris muscle just lateral to the alar of the nose, or being nonexistent. There is thus some confusion in the literature as to the actual anatomy of the Zmi (Wolf-Heidegger G and Köpf-Maier P, 2000; Sobotta et al., 2006; Agur et al., 2005).

Some articles provide diverse descriptions of the morphology and insertion pattern of Zmi. Youn et al. (2012) reported a detailed description of the Zmi that differed from those in anatomy textbooks with regard to its origin. They reported that the Zmi and zygomaticus major muscle (Zmj) look very similar, and could not be distinguished in 34.4% (21/61). The prevalence of the Zmi was reported to be only 36% (18/50) (Pessa et al., 1998).

One of the minimally invasive methods for improving a droopy appearance

of the mouth corner is botulinum toxin type A (BoNT) injection. Although this process requires re-administration of the toxin after a given period for maintenance of its effect, it does not present the risks inherent in any surgical intervention. This procedure offers predictable and replicable outcomes with few risks and little discomfort (Goldman and Wollina, 2010).

BoNT is an established safe method for chemoimmobilization of the facial musculature. However, undesired outcomes are possible if the toxin is not used appropriately in the correct location and with the correct dosage. Inappropriate BoNT injection can easily result in dysfunction of the perioral musculature, affecting facial expression, muscle movement, and articulation. Toxin injection within the DAO is particularly effective, but also risky due to the proximity of the orbicularis oris and depressor labii inferioris muscles at this level. For safety purposes, injections should be carried out very superficially, more externally, and lower to avoid any effect on the depressor labii inferioris muscle (Raspaldo et al., 2011). Thus, physicians should have a detailed understanding of the facial muscle anatomy before performing BoNT injections.

The aim of this study was to clarify the morphology of the Zmi and DAO, thereby providing the critical anatomic information required to elucidate the functional aspects and clinical information for determining the safest and most effective the DAO injection site for BoNT.

## II. MATERIALS & METHODS

### 1. Materials

Fifty-four embalmed adult hemifaces (48 bilateral and 6 unilateral; 31 males, 23 females; age range, 45 - 48 years; mean age, 67.4 years) from 30 cadavers were used in Zmi study and forty-two hemifaces from Korean (20 hemifaces, 9 left and 11 right; mean age, 69.1 years) and Thai (22 hemifaces, 11 left and 11 right; mean age, 78.4 years) adult cadavers (in total, 20 left and 22 right; mean age, 73.9 years) were dissected for DAO study. Specimens with an impaired face were excluded. In all specimens, the skin and subcutaneous tissues of the face were removed to expose the facial expression muscles, focusing on Zmi and the modiolar region.

### 2. Methods

#### **Insertion site of the Zmi**

The skin and subcutaneous tissues of the face were removed. A detailed dissection was performed on all specimens, with extreme care being taken not to damage the underlying muscles. Special attention was paid to the precise site of insertion and the course of the Zmi. The dissection was performed with the aid of a surgical microscope (OPMI pico, Carl Zeiss Co, Oberkochen, Germany).

After dissection, the insertion region of the Zmi was measured and analyzed with regard to the nose ala (point A in Fig. 1) and the Zmj to clarify the location of its insertion point(s). First, the point where the two muscles join was checked, the medial margin of the Zmj and the orbicularis oris muscle

(point B in Fig. 1) and the distance between points A and B was measured. The insertion area of the Zmi on this line was then examined. Second, the insertion area of the Zmi was examined with the reference to point A, and finally the width of the Zmi was measured.

### **Morphology and insertion pattern of the Zmi**

The Zmi was classified according to its morphology and course. All photographs and diagrams in this article are of structures viewed from the left side of the face.

### **Direction and angular measurements of the Zmi**

The vector that represented the center of the Zmi fiber was defined on the photograph on the basis of its origin and insertion. The angle between the muscle vector of each Zmi and the facial midline was measured with image-analysis software (Image-Pro Plus version 4.0, Media Cybernetics Co, Bethesda, MD, USA).

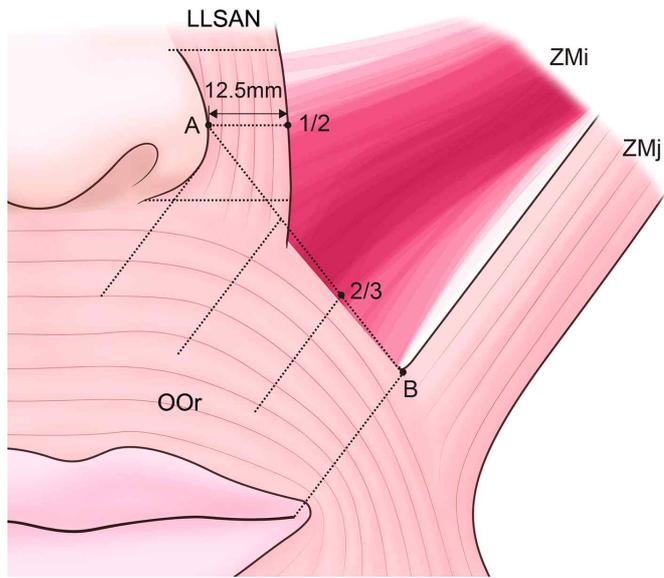


Fig. 1. Insertion site of the Zmi. The insertion regions of the Zmi were marked and overlapped. Zmi: zygomaticus minor muscle, Zmj: zygomaticus major muscle, LLSAN: levator labii superioris alaeque nasi muscle, OOr: orbicularis oris muscle, A: nose ala. B: the point where the medial margin of the Zmj joins the OOr, C: the point where the Zmi joins the LLSAN.

### **Measurements of the DAO using reference points and lines**

The relationship between the modiolus, medial and lateral borders of the DAO, and the most concave point of medial border of the DAO were noted. Reference points and lines were established prior to making the following measurements (Fig 2):

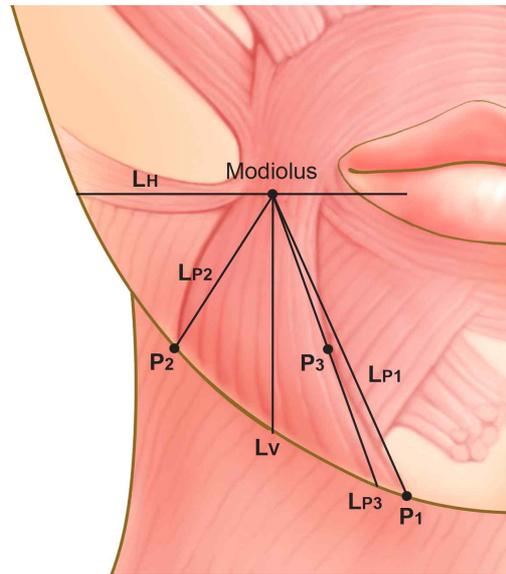


Fig. 2. Reference points and lines centered from the modiolus. P1: the point at which the medial border of the depressor anguli oris (DAO) and the mandibular border meet, P2: the point at which the lateral border of the DAO and the mandibular border meet, P3: the most concave point of the medial border of the DAO, L<sub>H</sub>: the horizontal line passing through the modiolus, L<sub>V</sub>: the vertical line passing through the modiolus, L<sub>P1</sub>: the line connecting the modiolus and P1, L<sub>P2</sub>: the line connecting the modiolus and P2, L<sub>P3</sub>: the line from the modiolus to the point of the mandibular border passing P3.

The following dimensions were also measured using a protractor and digital caliper (CD-15CP, Mitutoyo, Kawasaki Co, Japan):

1. The location of the modiolus (the horizontal distance between the cheilion and the modiolus/the vertical distance from the intercheilion line to the modiolus).
2. A<sub>HP1</sub>: the angle formed by L<sub>H</sub> and L<sub>P1</sub>.
3. A<sub>HP2</sub>: the angle formed by L<sub>H</sub> and L<sub>P2</sub>.

4.  $A_{VP3}$ : the angle formed by  $L_V$  and  $L_{P3}$ .
5.  $A_{VP2}$ : the angle formed by  $L_V$  and  $L_{P2}$ .

### III. RESULTS

#### **Insertion site of the Zmi**

The distance between the nose ala and the point where the medial margin of the Zmj join the orbicularis oris muscle (line A - B in Fig. 1) was  $35.3\pm 3.9\text{mm}$ . The distance between the nose ala and the point where the Zmi join the LLSAN (line A - C in Fig. 1) was  $12.6\pm 3.0\text{mm}$ .

In order to clarify the location of Zmi, the insertion area of Zmi was marked and overlapped. In most cases the Zmi was inserted between point C ( $12.6\text{mm}$  from the nose) and the lateral two-thirds of line A - B (Fig. 1). The width of the Zmi was  $11.9\pm 4.4\text{mm}$ .

#### **Morphology and insertion pattern of the Zmi**

The Zmi was classified into three types according to its insertion area. In type A, the Zmi was attached only to the upper lip (63.0%, 34/54). This type could be further subdivided into two subtypes: straight, A-1 (31.5%, 17/54), and curved, A-2 (31.5%, 17/54). The muscle fibers of the Zmi passed straight from the origin site to the upper lip in type A-1, and the muscle fibers of the Zmi curved while passing downward and medially to the upper lip in type A-2 (Fig. 3).

Type B, in which the Zmi was attached to both the upper lip and the alar portion, occurred in 27.8% (15/54). The Zmi fibers could be traced to their attachment at the nose ala, but could not be separated from those of the orbicularis oculi (OOc). In addition, the muscle fibers of the Zmi blended with the inner lower part of the OOc. In type C, there was either no or only undeveloped Zmi fibers (9.3%, 5/54) (Fig. 3).

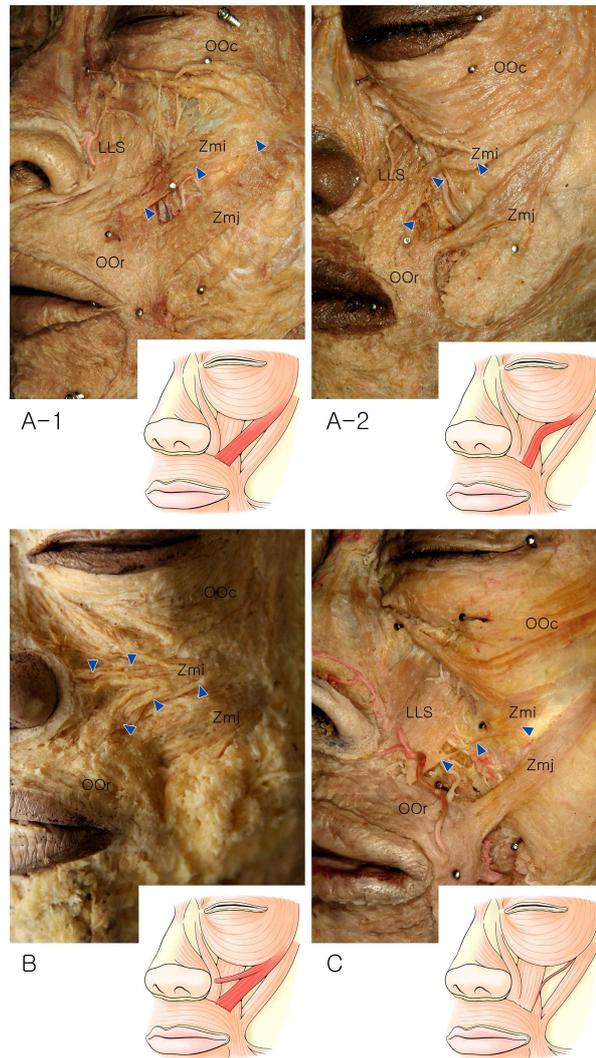


Fig. 3. Classification of the Zmi into three types. The Zmi was attached only to the upper lip in type A. Type A was subdivided into two subtypes: straight (A-1) and curved (A-2). The Zmi attached to both the upper lip and the alar portion of the nose in type B. There was either no or only undeveloped Zmi fibers in type C. Zmi: zygomaticus minor muscle, Zmj: zygomaticus major muscle, OOr: orbicularis oris muscle, OOc: orbicularis oculi muscle, LLS: levator labii superioris muscle.

### Direction and angular measurements of the Zmi

The angles between the facial midline and the Zmi vector were  $58.4 \pm 8.5^\circ$ ,  $35.5 \pm 12.3^\circ$ , and  $45.3 \pm 10.7^\circ$  for types A-1, A-2, and B, respectively (Table 1). In type B it looked as if the muscle fibers were attached to the upper lip.

The symmetry of the Zmi with respect to its morphology and vector was examined. The symmetry was accepted when the difference between the vectors of both sides of the face was less than  $5^\circ$ . Specimens with an impaired midface or type C were excluded from this analysis. Of the 18 specimens, the bilateral Zmi fibers were symmetrical in 33.3% (6/18) and asymmetrical 66.6% (12/18).

Table 1. The angle between the facial midline and the zygomaticus minor muscle (Zmi) vector in three subtypes of Zmi.

	Minimum	Maximum	Mean	SD
A-1	38	70	58.4	8.5
A-2	18	56	35.5	12.3
B	27	59	45.3	10.7

Values are expressed in degrees.

### Location of the depressor anguli oris with reference to the modiolus

The modiolus in Asians (Koreans and Thais) was located  $11.0\pm 2.6$ mm laterally and  $8.9\pm 2.8$ mm inferiorly to the cheilion. There was no statistically significant difference in the location of the modiolus between the left and right sides ( $p>0.05$ ).

P1 was located  $23.5\pm 6.4$ mm laterally and  $30.9\pm 6.1$ mm inferiorly to the modiolus. P2 was positioned  $-22.6\pm 8.6$ mm laterally and  $20.8\pm 8.3$ mm inferiorly, and P3 was  $10.6\pm 3.6$ mm laterally and  $17.9\pm 5.1$ mm inferiorly to the modiolus (Table 2). There were no significant differences in the locations of P1, P2, and P3 between the right and left sides ( $p>0.05$ ).

Table 2. Distances from the modiolus to P1, P2, and P3

	P1		P2		P3	
	$x_1$	y	$x_2$	y	$x_1$	y
Left side	$23.7\pm 6.0$	$31.4\pm 6.7$	$-22.6\pm 8.8$	$20.4\pm 8.9$	$9.7\pm 3.6$	$17.6\pm 4.5$
Right side	$23.3\pm 6.9$	$30.4\pm 5.7$	$-22.6\pm 8.6$	$21.1\pm 7.8$	$11.5\pm 3.4$	$18.1\pm 5.7$
Overall	$23.5\pm 6.4$	$30.9\pm 6.1$	$-22.6\pm 8.6$	$20.8\pm 8.3$	$10.6\pm 3.6$	$17.9\pm 5.1$

Values are presented as mean $\pm$ SD and expressed in millimeters.

Positive values mean that the position is medial ( $x_1$ ) or inferior (y) to the modiolus.

Negative values mean that the position is lateral to the modiolus ( $x_2$ ).

### Angles of the depressor anguli oris

Angles of  $A_{HP1}$  and  $A_{HP2}$  relative to the horizontal line passing through the modiolus were  $51.5 \pm 9.8^\circ$  and  $45.2 \pm 13.7^\circ$ , respectively; the corresponding values of  $A_{VP3}$  and  $A_{VP2}$  were  $31.8 \pm 8.5^\circ$  and  $44.7 \pm 13.7^\circ$ , respectively (Table 3).  $A_{HP1}$ ,  $A_{HP2}$ ,  $A_{VP2}$ , and  $A_{VP3}$  did not differ significantly between the left and right sides ( $p > 0.05$ ).

Table 3. Angles of  $A_{HP1}$ ,  $A_{HP2}$ ,  $A_{VP2}$ , and  $A_{VP3}$

	$A_{HP1}$	$A_{HP2}$	$A_{VP3}$	$A_{VP2}$
Left side	$52.7 \pm 8.2$	$44.2 \pm 15.1$	$28.9 \pm 9.0$	$45.7 \pm 15.1$
Right side	$50.5 \pm 11.0$	$46.0 \pm 12.8$	$35.1 \pm 6.8$	$43.9 \pm 12.8$
Overall	$51.5 \pm 9.8$	$45.2 \pm 13.7$	$31.8 \pm 8.5$	$44.7 \pm 13.7$

Values are expressed in degrees.

## IV. DISCUSSION

Facial expression muscles have been studied from various perspectives due to their unique characteristics. The organization of the facial expression muscles differs from that of muscles in other regions of the body because there is no associated deep membranous fascia beneath the skin of the face. Instead, many small slips of muscle attached to the facial skeleton insert directly into the skin (Borley et al., 2008), which allows the facial muscles (especially the Zmi) to move the facial skin so as to reflect emotions.

It is well known that the Zmi raises the upper lip; this muscle is also partly responsible for expressions such as contempt, smugness, and disdain. However, since only simple explanations exist regarding the origin and insertion of the Zmi in textbooks, it has been difficult to elucidate its action—there has been no detailed description of how these expressions are made.

In the present study, the course of the Zmi was classified into three types: A (including A-1 and A-2), B, and C. The most commonly encountered was type A, in which the Zmi was attached only to the upper lip (63.0%, 34/54). The straight (A-1) and curved (A-2) types were equally common (31.5%, 17/54). It is anticipated that each type of Zmi plays a different role in raising the upper lip, since each has a different vector.

Five specimens had either no or only undeveloped Zmi fibers (9.3%, 5/54). In agreement with this finding, in some articles it is noted that the Zmi does not exert great influence on function because it is usually a very poorly developed muscle (Brand and Isselhard, 1990).

The angle between the facial midline and the Zmi muscle vector was measured. The mean angle was smallest in type A-1 and largest in type A-2. Both faces had similar vectors (i.e., the difference was less than 5°) and were

thus symmetrical in 33.3% (6/18). Asymmetry was found in 66.6% (12/18). This is one of the causes of an asymmetric smile.

According to the present findings, Zmi fibers attached to the nose ala were observed in 27.8% (15/54). Most textbooks and research articles have made no mention of this structure. In such cases, the Zmi might be involved with elevation of both the alar of the nose and the upper lip.

The Zmi arises from bone and blends with the lateral belly of the orbital part of the OOc (Youn et al., 2012). In the present study, most of the muscle fibers of the Zmi that blended with OOc passed downward and medially into the upper lip. The muscle fibers of the Zmi originate from the bone and attach to the alar of the nose (Fig. 4). Based on the present detailed dissection of the insertion of the Zmi, the insertion into the nose ala could play a role in the formation of a small protrusion next to it (Fig. 5). Clinically, this small protrusion can be attenuated by injection of BoNT.

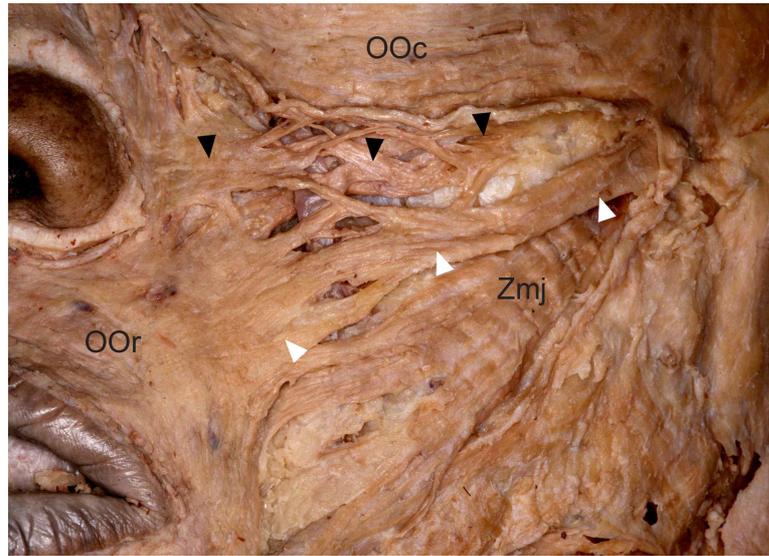


Fig. 4. Zmi fibers inserting into the nose ala. Most of the muscle fibers of the Zmi that blended with OOc passed downward and medially into the upper lip (white arrowheads). The Zmi fibers originated from the bone and attached to the nose ala (black arrowheads). Zmi: zygomaticus minor muscle, Zmj: zygomaticus major muscle, OOr: orbicularis oris muscle, OOc: orbicularis oculi muscle.

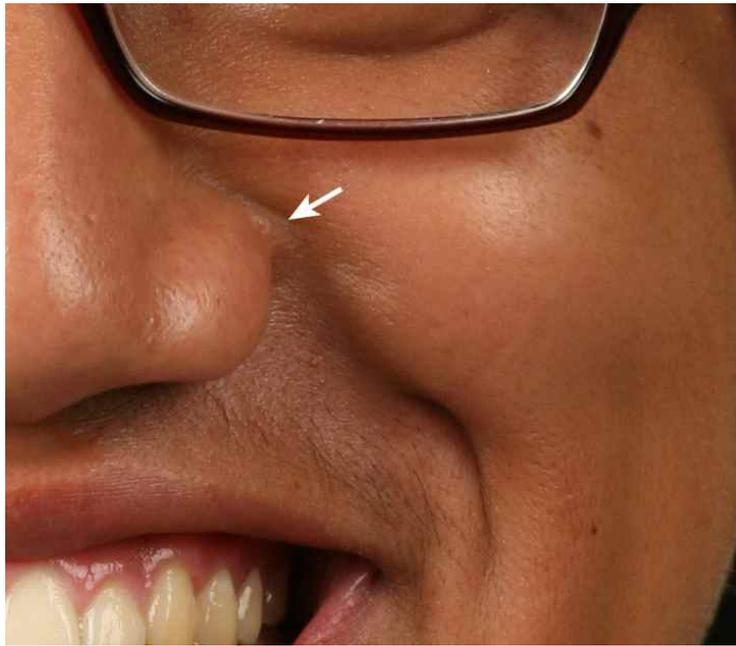


Fig. 5. Small protrusion next to the nose ala. Insertion of zygomaticus minor muscle fibers into the nose ala could play a role in the formation this small protrusion (white arrow).

The continuation of the DAO forms an oblique line below and lateral to the depressor labii inferioris muscle, and it converges into a narrow fasciculus that blends at the modiolus with the orbicularis oris and risorius muscles (Le Louarn et al., 2006). The modiolus is the mobile muscular mass located at the lateral border of mouth corner, and is formed by a convergence of the muscle fibers from the DAO, Zmj, orbicularis oris muscle, risorius, buccinators, and levator anguli oris muscles (Yu et al., 2013). The location of the modiolus varies between individuals and races. Contrary to the case in Africans and Caucasians, and in Asians (including Koreans and Japanese) the modiolus is located below the intercheilion line in 58.4% and 45.1%, respectively (Shimada and Gasser, 2005; Greyling and Meiring, 1992; Hu et al., 2005). This means that the modiolus generally lies lower in Asian populations than in Caucasian and Africans populations.

The modiolus is directly involved in all of the forces acting on the mouth corner. Therefore, hyperactivity of the DAO can pull down the modiolar position, leading to drooping of the mouth corner, which can manifest in a depressed and gloomy expression. Application of BoNT to the DAO, causing its inactivation, may lead to elevation of the mouth corner by its antagonists, such as the levator anguli oris and Zmj, which insert into the modiolus.

If BoNT is injected at a point lateral or medial to the DAO, the Zmj, risorius, and platysma or the orbicularis oris and depressor labii inferioris muscles can be influenced. In such cases BoNT injection can result in unwanted changes or difficulties related to facial expression.

The target of BoNT injection in a muscle may be determined based on its individual morphology, topographic relationships with adjacent muscles, and corresponding facial wrinkles or folds. Hur et al. (2008) provided critical information for the safest and most effective site for BoNT injection into the DAO based on the relationships between this muscle and the mental foramen.

However, they did not present clinical and surface anatomic information targeting the DAO. Therefore, it is very important to understand the surface anatomy and topography of the DAO for identifying accurate location of DAO.

The detailed facial animations at the lower face, including those reflecting determination, satisfaction, smiling, purposeful action, and sadness, is made possible by muscles that terminate at the modiolus. The modiolus can be palpated effectively in the patient by using the opposing thumb and index finger to compress the mucosa and skin simultaneously. Therefore, the modiolus is a very important clinical and surface anatomic reference of beauty and esthetics of the lower face.

The DAO formed a fan shape and was located at less than 45° laterally and less than 30° medially to the modiolus. The platysma and risorius muscles are located on the lateral side of the DAO, and the depressor labii inferioris is located on its medial side.

It is difficult to predict the position of the medial border of the DAO because it formed curved pattern, and blended with the depressor labii inferioris. Therefore, L<sub>P3</sub> can be used as a guide line when injecting BoNT into the medial side of the DAO. The DAO and depressor labii inferioris muscle coexist in the area bounded by L<sub>P1</sub> and L<sub>P3</sub>. Thus, if BoNT was injected into this area, it could influence both muscles and cause asymmetry of the lower face. The physician must therefore avoid this area when performing BoNT injection to the DAO (Fig. 6).

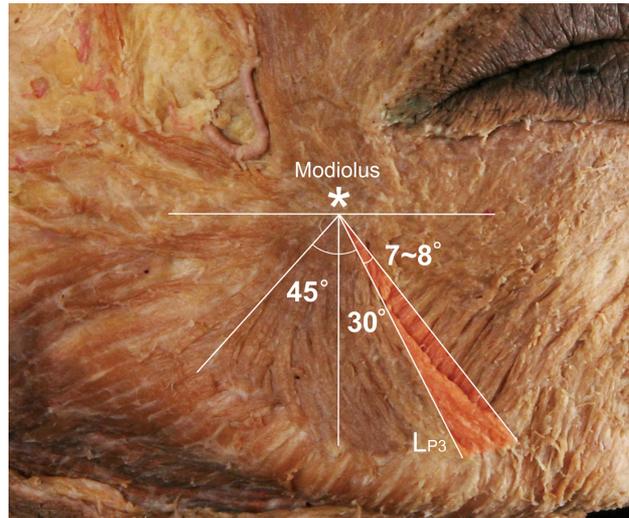


Fig 6. The location relationship between the reference lines and perioral muscles. The medial and lateral borders of the depressor anguli oris (DAO) are sometimes difficult to determine since they can be close to the lateral border of the depressor labii inferioris, and platysma and risorius muscles, respectively. The present findings suggest that the fan-shaped area located at less than 45° laterally and less than 30° medially to the modiolus is only part of the DAO. If LP<sub>3</sub> leans more medially at an angle of 7~8°, the medial border of the DAO overlaps with the depressor labii inferioris in the 'shaded area.' Therefore, the physician must avoid that 'shaded area' when performing BoNT injection into the DAO.

The present findings suggest that the following steps should be followed for BoNT injection into the DAO:

1. Identify and check the location of the modiolus by palpating the cheek.
2. Draw a sagittal line passing through the modiolus (i.e., L<sub>V</sub> ).
3. Draw an oblique line with an angle of 30° on the medial side of the modiolus (i.e., LP<sub>3</sub>).

4. Draw an oblique line with an angle of  $45^\circ$  on the lateral side of the modiolus (i.e.,  $L_{P2}$ ).

The fan-shaped area bounded by  $L_{P2}$ ,  $L_{P3}$ , and the inferior margin of the mandible, and represents the safest and most effective site for BoNT injection into the DAO (Fig. 7).

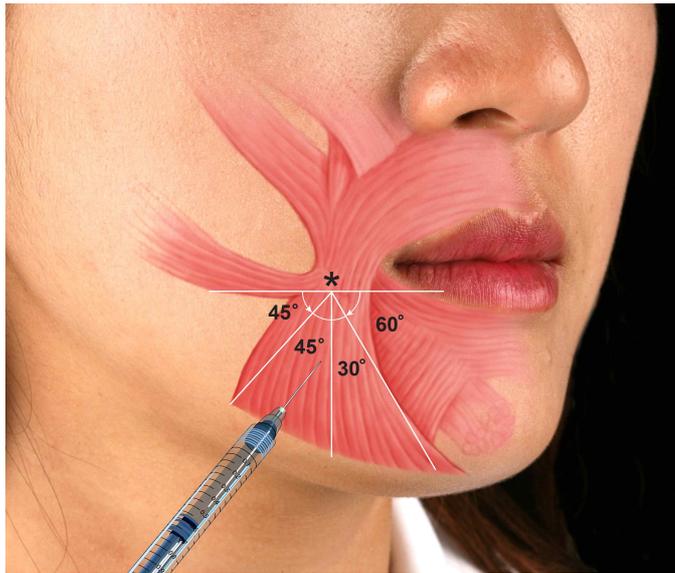


Fig 7. The modiolus can be palpated using the fingers and may be used as a clinical landmark of the inferior face. It is very difficult to establish a singular, definitive location of the modiolus as a specific point in cadavers. However, it is possible to estimate the location of the modiolus in humans. Therefore, the modiolus may be a very important surface anatomic landmark for botulinum toxin type A (BoNT) injection into the depressor anguli oris (DAO) in the clinical setting. If the modiolus can be identified in patients, the BoNT injection site in the DAO should be located less than  $45^\circ$  lateral and less than  $30^\circ$  medial to the modiolus.

## V . CONCLUSION

The conclusions of this study are as follows.

1. It is anticipated that different courses of Zmi play a different role in facial expression, especially around mouth.

2. Asymmetry angle between the facial midline and the Zmi vector was one of causes of an asymmetric smile.

3. The various features of the morphology and insertion pattern of the Zmi presented herein are considered to represent critical anatomic information that will help to elucidate the mechanisms underlying the formation of smiles and other facial animations.

4. The modiolus may be a very important surface anatomic landmark for BoNT injection into the DAO in the clinical setting. The BoNT injection site in the DAO should be located less than 45° laterally and less than 30° medially to the modiolus.

5. The fan-shaped area with reference to the modiolus will be helpful for enabling physicians to perform safe and effective injection sites to the DAO.

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Abstract (in korean)

## 보툴리눔 독소 주사를 위한 작은광대근과 입꼬리내림근의 임상해부학적 연구

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김 정 석

심미적 욕구가 증가함에 따라 얼굴 표정과 주름에 대한 관심이 높아지고 있다. 이를 위한 임상적 술기의 발전과 환자의 만족감을 위해, 얼굴 표정에 관련한 해부학적 지식은 임상 의에게 매우 중요하다. 감정을 표현하는 표정의 변화는 특히 입 주위에서 두드러진다. 작은광대근과 입꼬리내림근은 각각 입술의 위, 아래에서 부정적인 표정을 짓는데 관여할 뿐만 아니라, 주름의 형성에도 관여한다. 따라서 두 근육의 닿는곳과 주변근육들과의 위치관계 등의 해부학적 자료는 심미교정, 성형, 재건 환자를 평가할 때 중요한 자료가 될 것이다. 따라서 본 연구의 목적은 미세해부를 통해 입주위부위 (perioral region)에서 작은광대근의 형태와 닿는곳의 위치를 파악하고, 입꼬리내림근에 대한 형태계측학적 분석을 시행하여 입꼬리내림근에 보툴리눔 독소 주사 시 안전하고 효과적인 주사점을 제시하는데 그 목적이 있다.

작은광대근의 연구에서는 한국인 성인 시신 머리 54쪽 (남자 31, 여자 23; 평균연령 67.4세)을 사용하였으며, 입꼬리내림근의 연구에서는 한국인과 태국인 성인 시신 머리 42쪽 (왼쪽 20, 오른쪽 22; 평균연령 73.9세)을 사용하였다. 얼굴의 피부와 피부밑조직 (subcutaneous tissue)을 제거한 후 수술용 현미경을 이용해 미세 해부 하였다.

작은광대근의 형태를 닿는곳에 따라 3가지 유형으로 분류하였다. 작은광대근이 위입술로만 닿는 경우가 34 쪽 (63%)으로 가장 많았으며, 이 중 17 쪽은 위입술을 향해 곧게 주행하였고, 나머지 17쪽은 안쪽으로 "ㄱ"자 모양의 형태로 꺾여 위입술로

주행하였다. 작은광대근이 위입술 뿐만 아니라, 콧방울 가쪽부위에 닿는 힘살을 갖고 있는 경우는 15 쪽 (27.8%)에서 관찰되었다. 그 외에 5 쪽 (9.2%)에서는 작은광대근의 힘살이 너무 작거나 얇게 퍼져 없어지는 양상을 보였다.

불굴대의 위치는 입꼬리점으로부터 가쪽으로 11.0 mm, 아래쪽으로 8.9 mm 떨어진 곳에 위치하였다. 불굴대를 지나는 수직선을 기준으로 안쪽으로 30°, 가쪽으로 45° 기울어진 두 직선과 아래턱뼈 모서리를 경계로 하는 부채꼴모양의 영역은 다른 근육과 겹치지 않는 순수한 입꼬리내림근만의 영역임을 확인하였다.

작은광대근은 위입술의 울림뿐만 아니라 콧방울의 움직임에도 관여할 것으로 여겨진다. 이러한 결과는 중간얼굴부위의 해부학적 특징과 얼굴에 나타나는 표정의 관계에 대한 이해를 도울 것이며, 주름을 개선하기 위한 심미 치료에도 유용한 자료를 제공할 것이다. 또한 불굴대를 중심으로 하는 부채꼴 모양의 영역은 입꼬리내림근만을 목표로 하는 보툴리눔 독소 주사점으로 제시할 수 있으며, 이러한 결과는 실제 임상 술식에서 유용한 표면해부학적 자료로 활용될 수 있을 것이라 기대한다.

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핵심되는 말 : 보툴리눔 독소, 입꼬리내림근, 작은광대근, 주사점, 콧방울 부위