An Anatomic Study on the Upper Lip Elevator Muscles in Koreans for Application of Botulinum Toxin

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This certifies that the masters thesis of

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감사의 글

이 논문이 완성되기까지 따뜻한 배려와 함께 세심한 지도와 격려를 아끼지 않으신 이기준 지도 교수님께 먼저 깊은 감사를 드립니다. 귀중한 시간을 내주시어 부족한 논문을 살펴주신 백형선 교수님, 김희진 교수님께 감사드리며 교정학을 공부할 수 있도록 기회를 주시고 제가 이 자리에 설 수 있도록 인도해주신 손병화 교수님, 박영철 교수님, 황충주 교수님, 유형석 교수님, 차정열 교수님, 김경호 교수님, 최광철 교수님, 정주령 선생님께도 감사드립니다.

바쁜 와중에도 연구 방법과 세부적인 사항에 대해 많은 도움과 조언을 해주신 허경석, 허미선 선생님을 비롯한 해부학 교실 선생님들께 감사의 말씀을 드립니다. 이 논문이 나오기까지 격려해주고 조언해주었던 동기들, 이태연, 조용민, 서승아, 이한아, 정시내, 조선미 선생과 의국 선배님과 후배님 모두에게 이 자리를 빌어 감사의 마음을 전합니다.

마지막으로 항상 변함없는 사랑으로 돌봐주시고 저를 이끌어주신 아버지와 어머니, 대구에서 힘들게 군복무 중인 동생, 그리고 옆에서 항상 힘이 되어준 레미에게 감사의 마음을 전하며 이 작은 결실을 드립니다.

2007년 7 월 저자 씀

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Abstract

An Anatomic Study on the Upper Lip Elevator Muscles in Koreans for Application of Botulinum Toxin

The purpose of this study was to investigate the distribution, morphological characteristics, and direction of muscle fibers of the levator labii superioris alaeque nasi muscle(LLSAN), levator labii superioris muscle(LLS), zygomaticus minor muscle(ZMi), and zygomaticus major muscle(ZMj) in Koreans, and when injecting botulinum toxin(BTX) to weaken the LLSAN, LLS, and ZMi in gummy smile patients, to propose an easy and reproducible injection point through simple surface landmarks.

50 hemi-faces from 25 Korean adult cadavers (male 13, female 12, average age 71(47~88)) were used for the study. The topographic relations, direction of muscle fibers, and injection point for BTX were measured using specific surface landmarks. The following conclusions were drawn from the study.

1. The insertion of the LLS was partially covered by the LLSAN and ZMi in 31 hemi-faces (62.0%) and was entirely covered in 19 hemi-faces (38.0%).

2. The shapes of the LLS were various; fan, rectangular, and trapezoidal shapes were observed. The rectangular shape was the most common showing a prevalence of 72.0% (36 hemi-faces) and the fan and trapezoidal shapes were seen in 16.0%(8 hemi-faces) and 12.0% (6 hemi-faces), respectively.

3. The mean angle between the facial midline and each muscle vector was 25.8±4.8° for the LLS, 55.7±6.4° for the ZMi, and 3 1.7±4.9° for the ZMj. There was a statistically significant difference between the three muscles. No significant differences in angular measurements could be found between the male and female subjects or left and right sides.

4. Symmetric distribution was found in 22 subjects(88%) for the LLS. 21 subjects(84%) had symmetric distribution of the ZMi, and the ZMj was symmetric in 24 subjects(96%).

5. The area the LLSAN, LLS, and ZMi passes through was identified as the triangular region formed by three points, the ala, midpoint of nasolabial fold between ala and commissure, and maxillary point located on cheek one quarter distance between ala and temporomandibular joint. The center of this triangle would be the appropriate injection point for botulinum toxin.

Key words: levator labii superioris, levator labii superioris alaeque nasi, zygomaticus minor, zygomaticus major, botulinum toxin, gummy smile

An Anatomic Study on the Upper Lip Elevator Muscles in Koreans for Application of Botulinum Toxin

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(Directed by Prof. Kee-Joon Lee)

1. Introduction

The smile is a unique human gesture which is usually expressed when a person senses happiness, pleasure, humor or greetings. It is the result of a complicated interaction between various facial muscles of expression and components of the oral cavity. People are usually concerned with their smile because a pleasing and attractive smile enriches not only the one who smiles, but also those who view it.

Garber and Salama[1] have suggested that the relationships between 3 primary components- the teeth, the lip framework, and the gingival scaffold- determine the esthetic appearance of a smile. The appearance of this lip framework is determined by the activity of the various facial muscles. Among these muscles, the major lip elevator muscles: the levator labii superioris muscle(LLS), levator labii superioris alaeque nasi muscle(LLSAN), zygomaticus minor muscle(ZMi) and the zygomaticus major muscle(ZMj) are crucial in determining the shape of the smile line. The LLS originates from the orbital rim of the maxilla and inserts in the upper lip while the LLSAN originates from the frontal process of the maxilla and inserts in the upper lip and skin tissue of the ala of the nose. The ZMi and ZMj originate from the zygomatic bone and insert in the skin tissue of the upper lip and the angle of the mouth, respectively. The primary function of the LLS, LLSAN, ZMi is to raise the upper lip during smiling while the ZMj elevates the angle of the upper lip and pulls it laterally.[2] Many variations exist in the morphology, distribution, and activity of the facial muscles of expression and this is considered to contribute to the variations in facial expression.[3]

The excessive display of gingival tissue on smiling is usually referred to as a “gummy smile,” and is a condition which is fairly common. A gummy smile is usually considered to be esthetically displeasing in most cultures and some people are actually psychologically affected by this condition. Several etiologic factors have been proposed in the literature such as skeletal, gingival, muscular factors or a combination of these. Most reports in the literature present cases in which the gummy smile is due to vertical maxillary excess or gingival problems from delayed passive eruption. However, hyperactive lip elevator muscles can also cause excessive gingival display.

Several surgical procedures have been reported in the literature to treat gummy smiles due to hyperfunctional muscles.[4-7] However surgical procedures showed frequent relapse and a number of side effects were reported.

A minimally invasive and reversible treatment method for excessive gingival display

caused by hyperfunctional muscles would be much more advantageous than the previously stated surgical procedures, and thus botulinum toxin(BTX) is recently being considered. There are seven serologically distinct types of botulinum neurotoxin, and among these, type A seems to be the most potent and is most commonly used clinically. The toxin acts by cleaving the SNAP-25(synaptosomal-associated protein) and inhibiting the release of acetylcholine, thus preventing muscle contraction. Clinically, muscle weakness is seen approximately 2-4 days following injection, with full paralysis or maximal weakness complete at 7-10 days. However, peripheral sprouts begin to form over time and SNAP-25 proteins eventually regenerate in the original nerve muscle complex, making the effects of BTX, which last for only a period of 3-6 months, reversible.[8]

Recently, use of BTX in the dental field is also increasing. Other than for hypertrophic masseter muscles or orofacial pain, it has also been used for treatment of gummy smile. Polo[9] reported the use of BTX in gummy smile patients with hyperfunctional lip elevator muscles and found a significant decrease in gingival display in his patients. However, data regarding the distribution of the lip elevator muscles in Koreans and clinical data regarding the use of BTX for treatment of gummy smile is insufficient. Moreover, the injection technique of BTX in the midface and the target muscles differed according to the investigator.

Therefore the purpose of this study was to investigate the distribution, morphological characteristics, and direction of muscle fibers of the major lip elevator muscles (LLSAN, LLS, ZMi, and ZMj) in Koreans and when injecting BTX to weaken the LLSAN, LLS, and ZMi in gummy smile patients, to propose an easy and reproducible injection point for BTX through simple surface landmarks.

2. Materials and Methods

50 hemi-faces from 25 Korean adult cadavers(male 13, female 12, average age 71(47~88)) surveyed at Yonsei University College of Dentistry were used in this study. After an incision following the midline, the facial muscles were carefully exposed. The levator labii superioris alaeque nasi(LLSAN), levator labii superioris(LLS), zygomaticus minor(ZMi), zygomaticus major(ZMj) were carefully dissected so the direction of the muscle fibers could be clearly seen. Photographs were taken for each dissected specimen with a FinePix S3 Pro® camera(Fujifilm Co., Japan) and 105mm macro lens(Nikon Co., Japan). The topographic relations and morphological variations of the lip elevating muscles were observed and vectors of the upper lip elevators were drawn on the photograph (Fig.1) based on the muscle origin, insertion, and major direction of the muscle fibers. The facial midline was also drawn, passing through the glabella, subnasale, and soft tissue pogonion. Measurements were made using the ImagePro® computer software (MediaCybernetics, Des Moines, Iowa).

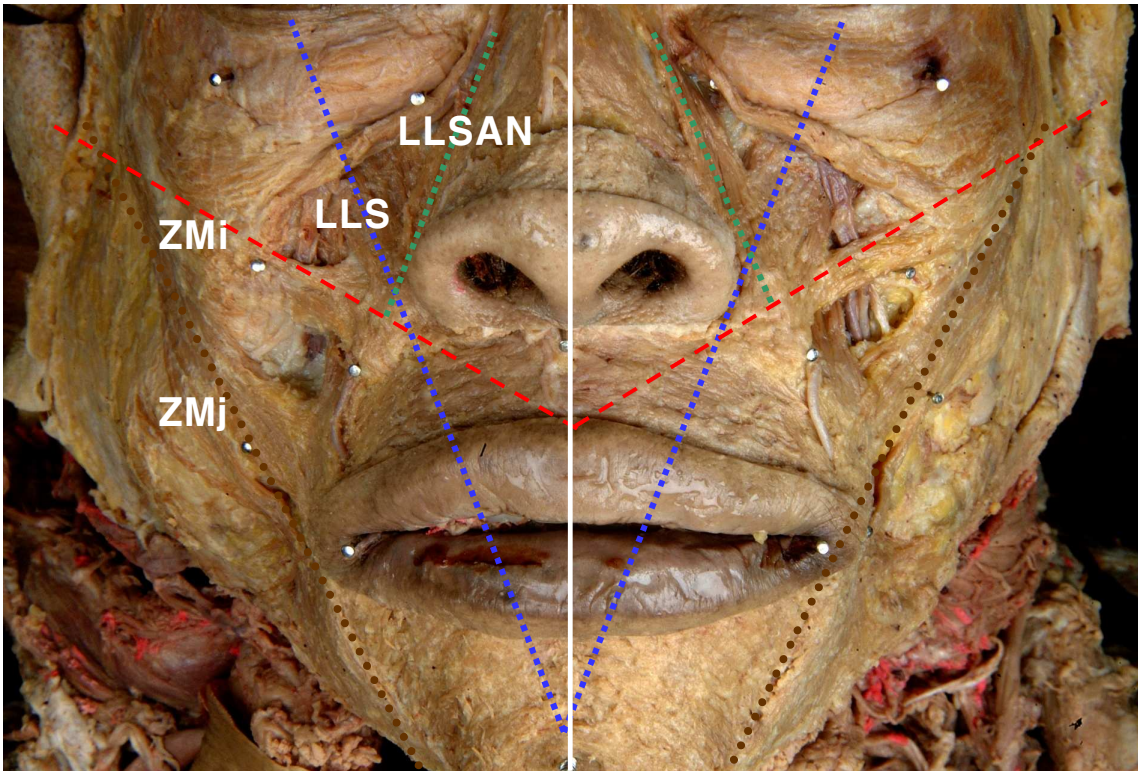


Fig. 1 Photograph of dissected specimen with vectors showing direction of muscle fibers.

2.1. Measurement of the direction of the lip elevator muscles

The angle between the vector of each lip elevator muscle and the facial midline was measured using the ImagePro® program. (MediaCybernetics, Des Moines, Iowa) (Fig. 2) The angle of the LLSAN was not measured since the muscle fibers follow the lateral borders of the nasal bridge.

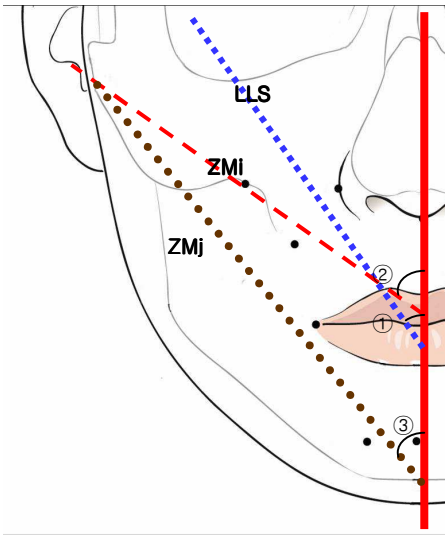
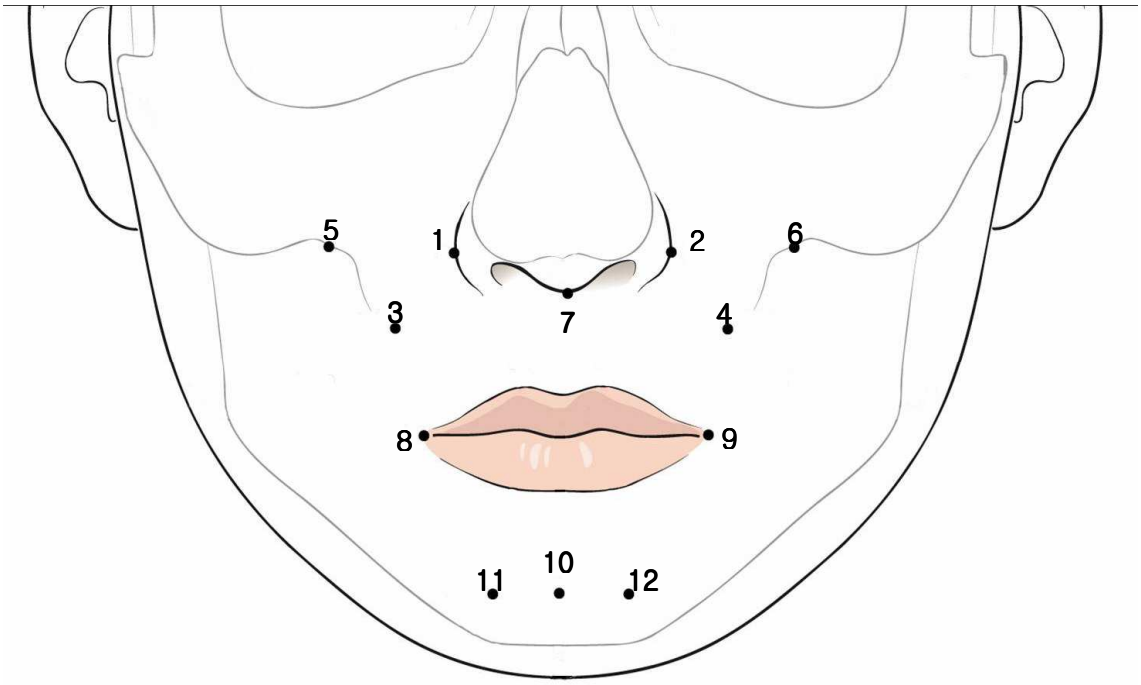


Fig. 2 Angular measurements between facial midline and each muscle vector
① Angle between vector of LLS and facial midline
② Angle between vector of ZMi and facial midline
③ Angle between vector of ZMj and facial midline

2.2 Determining a reliable point of injection for botulinum toxin

After dissection, pins were placed at the predetermined surface landmarks. (Fig. 3) The area which the vector of the LLSAN, LLS, ZMi passes through was investigated, and it was assumed that by injecting botulinum toxin at that point all three muscles would be effected. The effective range of botulinum toxin was set in this study to 2cm, according to Garcia and Fulton's study[10]. By drawing a circle with a radius of 1cm for several points and investigating the frequency the muscle vectors passed through, the proper injection point could be determined.

Fig. 3 Surface landmarks used in this study



1(2): ala

3(4): midpoint of nasolabial fold between ala and commissure

5(6): maxillary point located on cheek one quarter distance between ala and temporomandibular joint

7: subnasale

8, 9: commissure(right & left)

10: pogonion

11, 12: lateral chin point located 2cm lateral to pogonion (right & left)

2.2.1 Measurement of injection point

After the proper point of injection was determined, the horizontal distance from the ala of the nose and the vertical distance from the line connecting the lip commissures(lip line) were measured.

2.3 Statistical analysis

Means, standard deviations, minimum and maximum values were obtained for the angular measurements of the muscle vectors and measurements of the injection point. 1-way ANOVA was performed to assess differences in the angles of the three muscle groups (LLS, ZMi, and ZMj). Independent t-tests were performed to assess differences between male and female subjects and left and right side measurements. The level of significance used was $P < 0.05$.

3. Results

3.1 Topographic relations of the lip elevator muscles

The ZMi and LLSAN were located in the superficial layer (Freilinger et al. 1987)[11] and covered the medial and lateral margins of the LLS. The insertion of the LLS was partially covered by the LLSAN and ZMi (Fig. 4) in 31 hemi-faces (62.0%) and was entirely covered in 19 hemi-faces (38.0%).(Fig. 5)

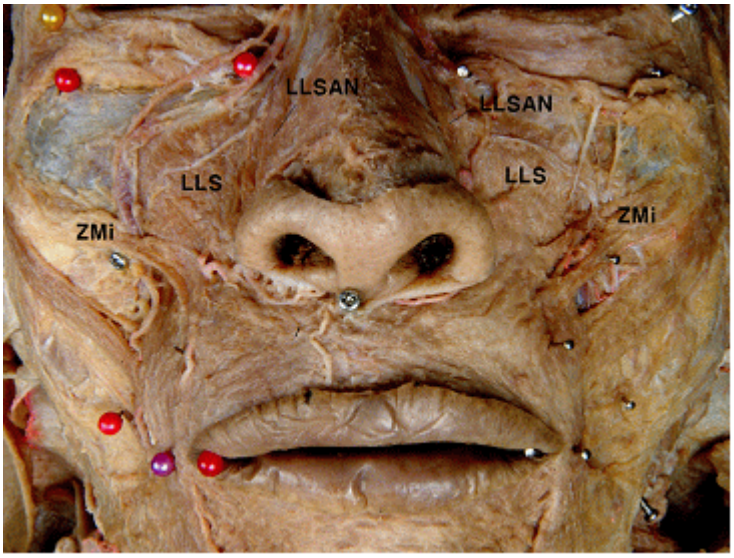


Fig. 4 Insertion of the LLS partially covered by the LLSAN and ZMi

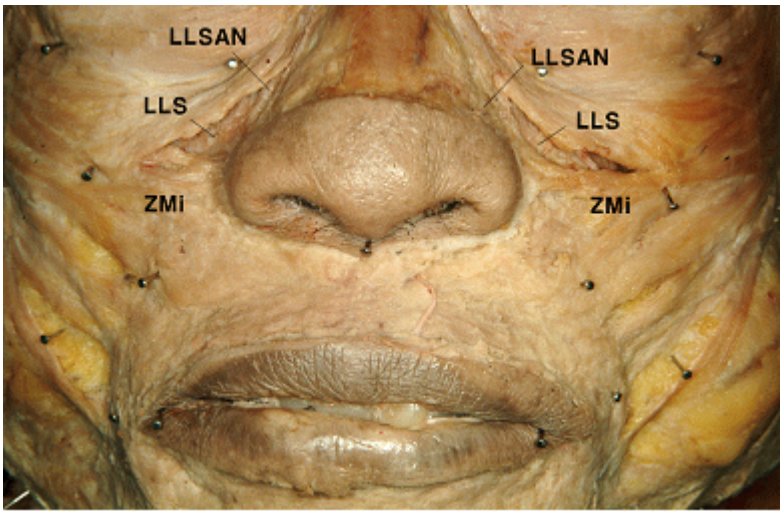


Fig. 5 Insertion of LLS entirely covered by the LLSAN and ZMi

3.2 Morphological variation of the LLS

The shapes of the LLS were various; fan, rectangular, and trapezoidal shapes were observed in this study. (Fig. 6) The rectangular shape was the most common showing a prevalence of 72.0% (36 hemi-faces) and the fan and trapezoidal shapes were seen in 16.0%(8 hemi-faces) and 12.0% (6 hemi-faces), respectively.

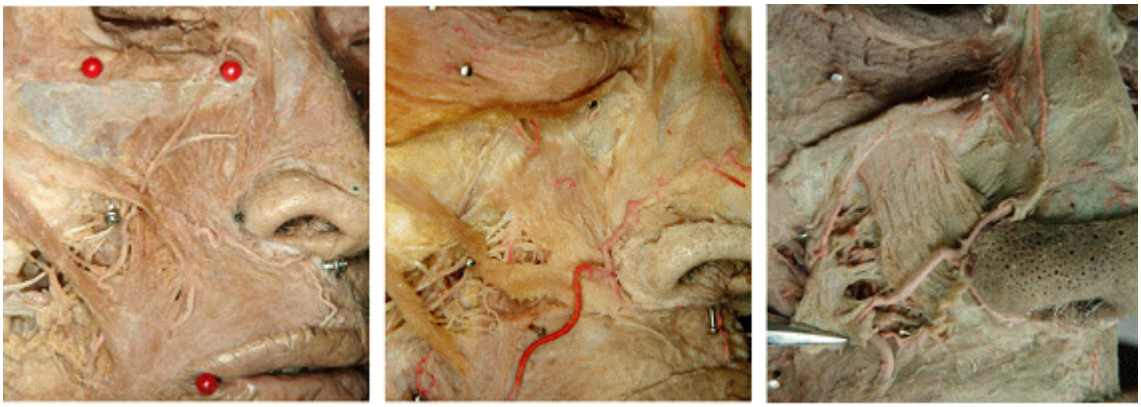
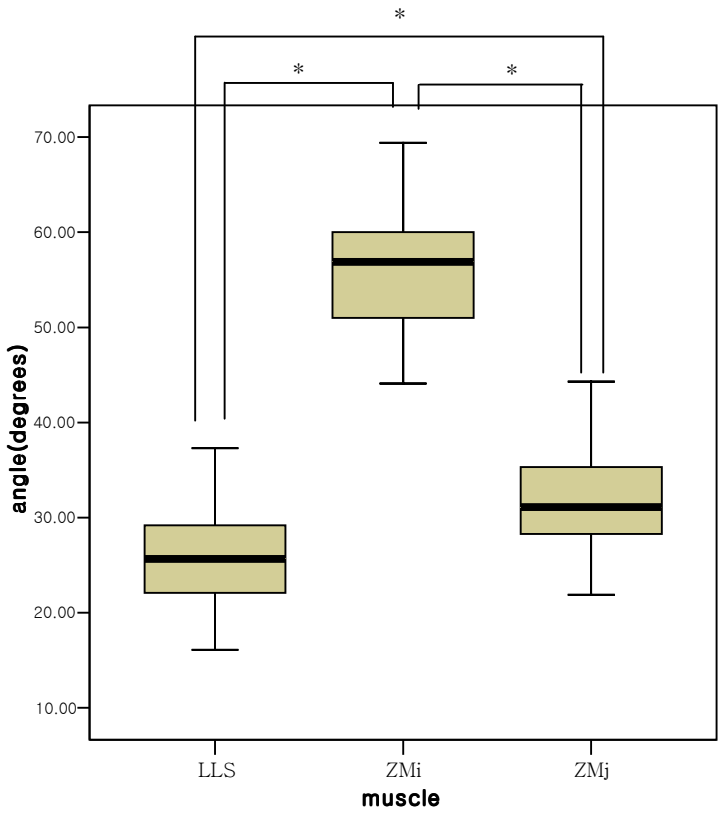


Fig. 6 Morphological classification of the LLS

(a) fan shape (b) rectangular shape (c) trapezoidal shape

3.3 Direction of muscle fibers for the lip elevator muscles

The results of the angular measurements for the LLS, ZMi, and ZMj are shown in Fig.7 and Tables 1~3. The mean angle between the facial midline and each muscle vector was 25.8±4.8° for the LLS, 55.7±6.4° for the ZMi, and 31.7±4.9° for the ZMj. There was a statistically significant difference between the three muscles according to the 1-way ANOVA results. No significant differences in angular measurements could be found between the male and female subjects or left and right sides.



(* p< .05)

Fig 7. Comparison of the mean angles of the LLS, ZMi, and ZMj

Table 1. Angular measurements for the LLS, ZMi, and ZMj

			Mean	SD	minimum	maximum
LLS	**Male**	**Lt.**	24.5	3.5	16.1	29.5
		Rt.	25.1	3.9	19.3	31
	Female	**Lt.**	27.7	5.4	20.9	37.3
		Rt.	25.8	4	20.7	33.4
ZMi	**Male**	**Lt.**	56.4	7	44.1	69.4
		Rt.	56.3	6.1	47.6	66.4
	Female	**Lt.**	55.8	6.4	44.2	65.7
		Rt.	54.7	5.3	46.8	65.7
ZMj	**Male**	**Lt.**	31.9	6.1	21.9	41.2
		Rt.	31.7	4.3	24.3	39.1
	Female	**Lt.**	32.1	4.8	26.2	44.3
		Rt.	31.8	4.7	24.2	40.4

(unit: degrees)

Table 2. Comparison of the angular measurements of the three muscles according to sex

	Male(n=13)		Female(n=12)		Sig.
	Mean	**SD**	**Mean**	**SD**	
LLS	24.8	3.7	27	4.9	*NS*
ZMi	56.1	7.1	55.2	5.7	*NS*
ZMj	31.8	5.1	31.9	4.6	*NS*

NS: not significant *(unit: degrees)*

Table 3. Comparison of the left and right side angular measurements of the three muscles

	Left(n=25)		Right(n=25)		
	Mean	**SD**	**Mean**	**SD**	**Sig.**
LLS	26.2	4.7	25.4	4	*NS*
ZMi	55.9	7.3	55.5	5.7	*NS*
ZMj	32	5.4	31.7	4.4	*NS*

NS: not significant *(unit: degrees)*

3.3.1 Symmetry

The symmetric distribution of the facial muscles was investigated for each subject. More than a 5 degree difference between the left and right sides was considered to be asymmetric. The LLS, ZMi, and ZMj were investigated.

For the LLS, 22 subjects(88%) showed a symmetric distribution. 21 subjects(84%) had symmetric distribution of the ZMi, and the ZMj was symmetric in 24 subjects(96%).

3.4 Determination of injection point for botulinum toxin

The area which the vector of the LLSAN, LLS, ZMi passes through was investigated, and as shown in Fig. 8 they pass through a triangular area formed by the points, 1(2), 3(4), and 5(6). Assuming that botulinum toxin would be most effective within a 1cm radius, a circle with a 1cm radius(2 cm diameter) was drawn for four points, the three points of the triangle and the center of the triangle. (Fig. 9) The frequency the vectors passed through was investigated.

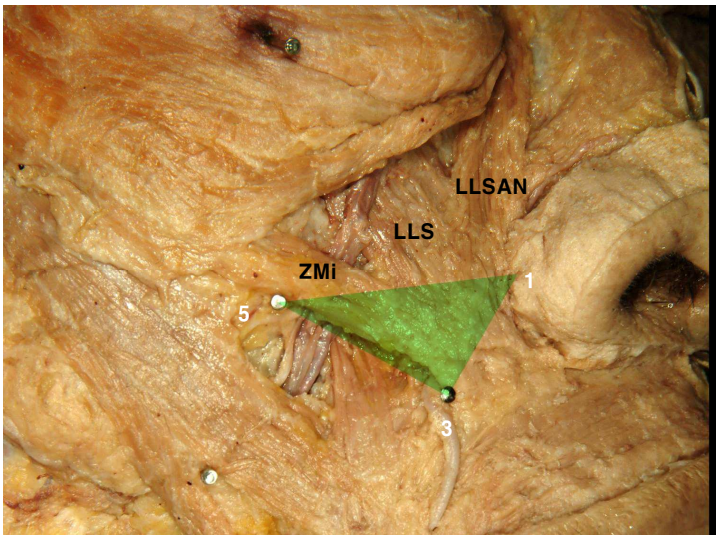


Fig. 8 Convergence of the LLSAN, LLS, and ZMi

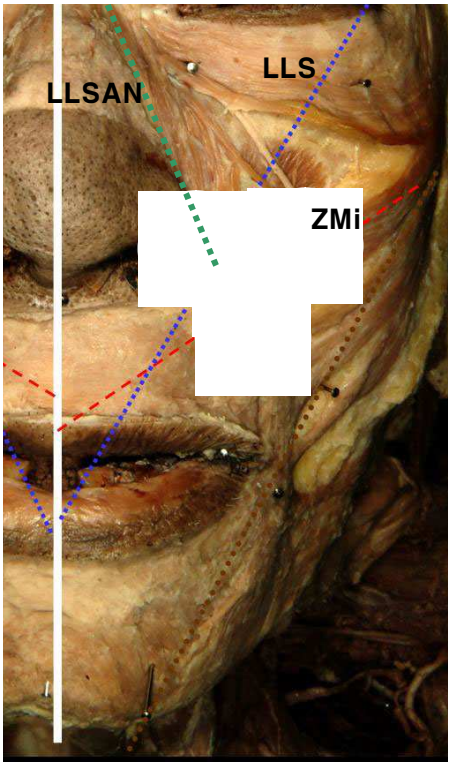


Fig. 9 Circles with a 1cm radius(2cm diameter) drawn on each photograph representing the effective range of botulinum toxin.

3.4.1 Injection point for botulinum toxin

In Table 4, the frequency of the muscle vectors (LLS, LLSAN, and ZMi) passing through each circle is presented. The number of hemi-faces in which all three muscle vectors passed through was the largest when the injection point was the center of the triangle, and this was statistically significant.(Chi-square test, $p<0.05$) Thus, it was concluded that the center of the triangle would be the most appropriate injection point.

Table 4. Frequency of the muscle vectors passing through the circle of each injection point

		Number of muscles		
		3	**2**	**1**
Point	**1(2)**	17(34.0%)	33(66%)	0
	3(4)	14(28%)	32(64%)	4(8%)
	5(6)	0	4(8%)	46(92%)
	Center of triangle	44(88%)	6(12%)	0

3.4.2 Measurement of the injection point

The distance of the center of the triangle from the alar and the lip line (the line connecting both commissures) was measured.

The mean horizontal distance from the alar was 10.4±2.1mm in males and 10.3±2.1mm in females. The mean vertical distance from the lip line was 32.3±4.2mm in males and 31.5±3.3mm in females.

4. Discussion

In the past, the anatomy of the perioral musculature usually has been neglected by many dental professionals, their main interest being the appearance of the teeth and periodontal tissue. However, the appearance of the soft tissue is recently being more a concern not only to orthodontists, but also to the general public. Knowing the anatomy of the perioral musculature is essential, and knowledge of the midfacial muscles(lip elevator muscles) would be valuable to the dentist evaluating the esthetics of a patient's smile.

In the present study the morphological characteristics and the direction of muscle fibers of the major lip elevator muscles were investigated. Previous studies regarding the midfacial muscles were relatively uncommon and there were no reports stating the direction of muscle fibers. The most extensive study regarding the midfacial muscles was the study by Pessa[12](1998), which described the variability of 5 midfacial muscles, the LLS, LLSAN, ZMi, ZMj and the risorius with 50 hemifacial cadaver dissections. The frequency of the midfacial muscles, the width of each individual muscle, and the correlation between the facial muscle pattern and the nasolabial crease were investigated in the study. Seven distinct patterns of the facial muscles were observed and the most common pattern was the combination of the LLSAN, LLS, and single ZMj. These three muscles were present in 100 percent of all specimens while the ZMi and risorius were present in 36% and 6%, respectively. This is in contrast with the present study, which shows a 100% frequency of all the major lip elevator muscles. Pessa stated that the consistent finding of the lip elevator muscles suggests a superior vector may be a significant component of the smile mechanism. Whether the high frequency of the four muscles in Koreans contributes to a different smile pattern compared to Caucasians is a topic for future research.

The topographic relationships described in this study show that the LLS was covered by the LLSAN and ZMi in all the specimens. This finding was in accordance

with the study of Freilinger(1987)[11], in which the 4 separate layers of the mimic muscles were defined. According to his study, the first three layers constituted the superficial layer and the fourth layer, the deeper layer. The first layer includes the depressor anguli oris, the superficial part of the ZMi, and the orbicularis oculi. The second layer includes the platysma, the risorius, the ZMj, the deeper part of the ZMi, and the LLSAN. The third layer consists of the LLS and orbicularis oris; the fourth layer(deeper layer), the levator anguli oris, the mentalis, and the buccinator. The location of the infraorbital nerve plexus was also investigated in the present study, and was found underneath the deeper layer of the LLS; similar to the study of Freilinger and Fujita.

The morphologic variation in the LLS was investigated in this study and there turned out to be 3 distinct types: rectangular, fan, and trapezoid. The most common was the rectangular shape, showing a prevalence of 72.0%. (36 hemi-faces) In most anatomy textbooks, the LLS is illustrated as a fan shape muscle and the insertion is stated to be the skin tissue of the upper lip. However, one third of the muscle fibers of the rectangular shaped LLS inserted into the alar of the nose along with the LLSAN. The frequently reported bifid zygomaticus major muscle is thought to contribute to the formation of a facial dimple[13] during smiling. Whether this morphologic variation of the LLS contributes to another anatomic variation during function is yet to be studied.

In the present study, the distribution of each muscle was investigated by using the vector lines representing the lip elevator muscles. By measuring the angle these vector lines form with the facial midline, the distribution area of each lip elevator muscle could be estimated when the face is seen from a frontal view. This method does have limitations since the vector lines do not reflect the actual origin, insertion, and lateral margins of each muscle.

The mean angle for the LLS, ZMi, and ZMj muscles were 25.8±4.8°, 55.7±6.4°, and 31.7±4.9°, respectively. The differences in the angles of these three muscles were statistically significant. ($p<0.05$) However, no significant differences could be found

between left and right sides or male and female subjects for the angular measurements. Previously, Tjan, Miller and The[14] performed a study on smile-line variations and reported a sex difference in smile-line frequency: low smile lines were predominantly a male characteristic, 2.5 to 1, and high smile lines were predominantly a female characteristic, 2 to 1. The results of the present study suggest that the muscle fiber directions of the lip elevator muscles may have no association with the amount of lip elevation. Since gummy smiles occur due to various factors such as the amount of incisor display at rest, skeletal dysplasias(vertical excess of the maxilla), and gingival problems, the cause of the previously stated sex difference still remains indeterminable. However, it would have been better if the skeletal pattern, gingival status, and amount of incisor exposure of each cadaver were investigated.

The appearance of the smile can be influenced by the components of the oral region, which are the teeth and gingiva, and the perioral musculature. Previously, perceptions of dental esthetics by the public and dental professionals were related primarily to the alterations of the teeth; however emphasis on the other two factors, the gingival and perioral musculature is increasing recently.

The smiling mechanism was first described in terms of muscle action by Rubin(1960)[15] in his study of 1000 humans. According to his study, the smile was categorized into three distinct types. The first type, the so called “Mona Lisa” smile, was dominated by the ZMj and was characterized by sharply elevated corners of the mouth. This type of smile was most common and was found in 67% of the population. The second type, the canine smile, was dominated by the LLS, showing exposure of the canine initially before the rest of the lip was elevated. This type of smile was found in 35%. The third type was the full denture smile, which exhibits a simultaneous contraction of all lip elevators and depressors resulting in the exposure of all maxillary and mandibular teeth during smiling. This type of smile was relatively rare, showing a prevalence of 2%.

The excessive display of gingiva during smiling is commonly called a “gummy smile.”

This type of smile is usually associated with the “canine smile,” proposed by Rubin. It is not only displeasing to the patient but also provokes interest and concern among orthodontists and plastic surgeons. Several causes of this condition have been stated in the literature, such as vertical excess of the maxilla, altered passive eruption, muscle hyperactivity of the lip elevating muscles or a combination of these. Most reports in the literature present cases in which the gummy smile is due to vertical maxillary excess or gingival problems from delayed passive eruption. However, hyperactive lip elevator muscles can also be a causative factor of excessive gingival display. According to Peck[16], in his study comparing gingival smile patients with non-gingival smile patients, patients with a gummy smile had a facial muscular capacity to raise the upper lip on smiling nearly 20% more.

The treatment of excessive gingival display must be based on a prudent diagnosis. Evaluation of lateral cephalograms, upper incisor exposure at rest, and gingival tissue are necessary to differentiate between the etiologic factors of gummy smile. Ezquerra et al[6]. proposed that when analysis of the maxilla shows normal cephalometric dimensions and 2mm of tooth is visible with the lips in repose but gingival display is excessive on smiling, the gummy smile may be the result of hyperfunction of the lip elevating muscles.

Many surgical procedures for correction of the gummy smile with hyperactive musculature have been proposed in the literature for many years.[4-7] However, relapse after surgery has been frequently reported, and other side effects related to the surgical procedures also exist.

Botulinum toxin(BTX) is recently being considered in treatment of the gummy smile due to several advantages. It is minimally invasive, reversible and cost effective compared to the previous surgical procedures. Although the use of botulinum toxin is increasing in the dental field, such as in treatment of orofacial pain and hypertrophic masseter muscles, clinical reports regarding treatment of gummy smile patients are relatively rare. Recently, Polo[9] performed a clinical trial of the use of BTX in gummy

smile patients with hyperfunctional lip elevator muscles and found a significant decrease in gingival display in his patients.

The injection site or injection dose has been stated in a number of reports but differs among investigators. In Polo's clinical study, injections were made intramuscularly under electromyographic guidance[17]. 1.25 U were injected per side in the LLSAN, LLS, and the overlap areas of the LLS and ZMi. Additional injections of 1.25U or 0.625U were made according to the postoperative evaluation. Ahn[18] made injections using electromyographic guidance in the LLSAN, LLS, and the ZMi. The injection dose was 2.5U per muscle. Kane[19] treated patients with excessive gingival display through improvement of the nasolabial fold. The LLSAN was targeted and 5U per side were injected. The LLSAN was easily located by palpating the piriform aperture. Carruthers[8] also advocated the injection of BTX in the LLSAN. The injection site was determined by placing a fingertip on the pyriform aperture just inferior to the nasomaxillary groove. The injection dose was 1U initially, and after 2-3 weeks follow up, the subsequent dose was determined according to the clinical response.

The method of determining the injection site in this study was based on the results of Garcia's study[10], which stated that the toxin can spread by diffusion to an area of 15~30mm. After drawing a circle of 20mm diameter for each candidate point and investigating the frequency of muscles passing through each point, the point which showed the highest frequency of all three muscles passing through was determined to be the appropriate injection point. Table 3. shows the result of this investigation, and it was concluded that the center of the triangle would be the appropriate injection point for BTX. The mean distance of this point was approximately 10mm from the ala of the nose and 30mm above the lip line.

The major limitation of the present study would be that the study was performed using cadavers, in which the smile conformation could not be confirmed. Further studies regarding the relationships between the muscle fiber direction and smile type would be beneficial, and comparisons between ethnical groups would also be

meaningful. The injection point for BTX suggested in this study may be a simple and reliable method of injection when targeting the LLSAN, LLS, and ZMi. Electromyographic guidance may be useful, but the equipment is relatively expensive, makes the procedure somewhat cumbersome, and requires 3 injections, 1 for each muscle. Nevertheless, further investigation is required to determine the clinical efficiency of the injection technique suggested in this study and to determine the appropriate injection dose.

5. Conclusion

50 hemi-faces from 25 Korean adult cadavers(male 13, female 12, average age 71(47~88)) at Yonsei University college of dentistry and Kun-Kook University school of medicine were used and the levator labii superioris alaeque nasi(LLSAN), levator labii superioris(LLS), zygomaticus minor(ZMi), zygomaticus major(ZMj) muscles were dissected. The topographic relations, direction of muscle fibers, and injection point for BTX were measured using specific surface landmarks. The following conclusions were drawn from the study.

1. The insertion of the LLS was partially covered by the LLSAN and ZMi in 31 hemi-faces (62.0%) and was entirely covered in 19 hemi-faces (38.0%).

2. The shapes of the LLS were various; fan, rectangular, and trapezoidal shapes were observed. The rectangular shape was the most common showing a prevalence of 72.0% (36 hemi-faces) and the fan and trapezoidal shapes were seen in 16.0% (8 hemi-faces) and 12.0% (6 hemi-faces), respectively.

3. The mean angle between the facial midline and each muscle vector was 25.8±4.8° for the LLS, 55.7±6.4° for the ZMi, and 3 1.7±4.9° for the ZMj. There was a statistically significant difference between the three muscles. No significant differences in angular measurements could be found between the male and female subjects or left and right sides.

4. Symmetric distribution was found in 22 subjects(88%) for the LLS. 21 subjects(84%) had symmetric distribution of the ZMi, and the ZMj was symmetric in 24 subjects(96%).

5. The area the LLSAN, LLS, and ZMi passes through was identified as the triangular region formed by three points, the alar, midpoint of nasolabial fold between ala and commissure, and maxillary point located on cheek one quarter distance between ala and temporomandibular joint. The center of this triangle would be the

appropriate injection point for botulinum toxin.

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국문 요약

Botulinum toxin 적용을 위한 한국인 윗입술 올림근육의 국소 해부

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황 우 상

<지도 교수: **이 기 준**>

본 연구에서는 미소시에 윗입술을 거상하는데에 관여하는 위입술올림근(LLS), 위입술콧방울올림근(LLSAN), 작은광대근(ZMi), 큰광대근(ZMj)의 해부학적인 분포 및 주행 방향을 알아봄으로써 한국인의 웃음과 관련된 해부학적인 특징을 확인하고자 하였으며, 입술 근육 과활성이 원인인 gummy smile의 치료를 위해 botulinum toxin(BTX)을 사용할 경우 여러 표지점을 통해 간단하면서도 안전한 주입점을 제안하고자 하였다.

해부학 실습으로 사용한 고정된 한국인 시신 25구(남자: 13 여자: 12 평균 연령: 71)의 얼굴 50쪽을 대상으로 하였다. 맨눈 해부를 통해 4가지 위입술올림근들을 노출시킨 뒤 형태학적인 관계, 분포, 주행 방향 등을 조사하여 다음과 같은 결과를 얻었다.

1. LLS의 닿는 곳이 LLSAN과 ZMi에 의해 부분적으로 덮인 경우가 31쪽(62.0%), 완전히 덮인 경우가 19쪽(38%)에서 관찰되었다.

2. LLS의 형태는 fan, rectangular, trapezoidal shape로 다양하게 관찰되었다. Rectangular shape이 72.0%(36쪽)에서 관찰되어 가장 흔한 형태였으며, fan과 trapezoidal shape는 각각 16.0%(8쪽), 12.0%(6쪽)에서 관찰되었다.

3. 근육의 주행 방향이 중심선과 이루는 평균 각도는 LLS는 25.8±4.8°, ZMi 는 55.7±6.4°, 그리고 ZMj는 31.7±4.9°였다. 이 세 근육 간의 차이는 통계학적으로 유의한 것으로 나타났다. 각도 계측치에서 좌우, 성별에 따른 통계학적으로 유의한 차이는 발견되지 않았다.

4. 근육의 주행 방향이 좌우 대칭 분포를 보이는 경우가 LLS는 22구(88%), ZMi는 21구(84%), 그리고 ZMj는 24구(96%)에서 관찰되었다.

5. LLSAN, LLS, ZMi 세 근육이 모두 지나가는 영역은 ala, midpoint of nasolabial fold between ala and commissure, maxillary point located on cheek one quarter distance between ala and temporomandibular joint의 세 지점에 의해 이루어지는 삼각형의 영역으로 나타났다. 이 삼각형의 중심이 BTX 주입을 위한 적절한 주입점이 될 것으로 사료된다.

Key words: 위입술올림근, 위입술콧방울올림근, 작은광대근, 큰 광대근, botulinum toxin, gummy smile