Clinical anatomic considerations of the zygomaticus minor muscle based on the morphology and insertion pattern

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Introduction

The zygomaticus minor muscle (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. Acting together, the levator labii superioris muscle, levator labii superioris alaque nasi (LLSAN), and Zmi raise the corner of the mouth and upper lip, and expose the maxillary teeth when expressing a smile.

The Zmi is also 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.

While 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 general anatomy textbooks and illustrations. The Zmi is described as inserting into the LLSAN, blending with the orbicularis oris muscle (OOr) 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.

Some articles provide diverse descriptions of the morphology and insertion pattern of Zmi. Youn et al. reported a detailed description of the Zmi that differed from those in general 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% of cases. The prevalence of the Zmi was reported to be only 36% (Pessa et al.).

The aim of this study was to clarify the morphology and insertion pattern of the Zmi through a topographic examination followed by a detailed dissection. In addition, the anatomical variations in the insertion of the Zmi are described herein, thereby providing the critical anatomic information required to elucidate the functional aspects related to human facial animation.

Materials and Methods

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 this study. Specimens with an impaired midface were excluded. The study protocol was approved by the Ethics Committee of Yonsei Medical Center, Korea.

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, nerves, and blood vessels. Special att-
tention 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, 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 (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, Bethesda, MD, USA).

**Results**

**Insertion site of the Zmi**

The distance between the nose ala and the point where the medial margin of the Zmj joined the orbicularis oris (line A–B in Fig. 1) was 35.3±3.9 mm (mean±SD). The distance between the nose ala and the point where the Zmi joined the LLSAN (line A–C in Fig. 1) was 12.6±3.0 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 12.6 mm from the nose ala (point C) and the lateral two-thirds of line A–B. The width of the Zmi was 11.9±4.4 mm.

**Morphology and insertion pattern of the Zmi**

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

Type B, in which the Zmi was attached to both the upper lip and the alar portion, occurred in 27.8% of cases (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 (9.3% of cases, 5/54) there was either no or only undeveloped Zmi fibers (Fig. 2).

**Direction and angular measurements of the Zmi**

The angles between the facial midline and the Zmi vector were 58.4±8.5º, 35.5±12.3º, and 45.3±10.7º 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 insertion area was examined; symmetry was accepted when the difference between the vectors of both sides of the face was less than 5º. Specimens with an impaired midface or type C were excluded from this analysis. Of the 18 specimens, the bilateral Zmi fibers were symmetrical in 6 cases (33.3%) and asymmetrical in 12 (66.6%).

**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 most 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, 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 in smiling; 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 (representing 63.0% of cases) was type A, in which the Zmi was attached only to the upper lip. The straight (A-1) and curved (A-2) types were equally common (31.5%). 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 (9.3%) had either no or only undeveloped Zmi fibers. 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.

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. In 6 of 18 specimens (33.3%), both faces had similar vectors (i.e., the difference was less than 5º) and were thus symmetrical. Asymmetry was found in 12% of cases (66.6%); 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% of cases. 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. 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. 3).

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. 4). Clinically, this small protrusion can be attenuated by injection of botulinum toxin type A.

In summary, 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.

References

Fig. 1. Insertion site of the zygomaticus minor muscle (Zmi). The insertion regions of the Zmi were marked and overlapped. Zmi, zygomaticus minor muscle; Zmj, zygomaticus major muscle; LLSAN, levator labii superioris alaque nasi; OOr, orbicularis oris; A, nose ala; B, the point where the medial margin of the Zmj and the orbicularis oris (OOr) join; C, the point where the Zmi joins the levator labii superioris alaque nasi (LLSAN).
Fig. 2. Classification of the Zmi into three types. In type A the Zmi was attached only to the upper lip. Type A was subdivided into two subtypes: straight (A-1) and curved (A-2). In type B the Zmi attached to both the upper lip and the alar portion of the nose. In type C there was either no or only undeveloped Zmi fibers. Zmi, zygomaticus minor muscle; Zmj, zygomaticus major muscle; OOr, orbicularis oris; OOc, orbicularis oculi; LLS, levator labii superioris.

Fig. 3. 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 arrowhead). The Zmi fibers originated from the bone and attached to the nose ala (black arrowhead). Zmi, zygomaticus minor muscle; Zmj, zygomaticus major muscle; OOr, orbicularis oris; OOc, orbicularis oculi.

Fig. 4. Small protrusion next to the nose ala. Insertion of Zmi fibers into the nose ala could play a role in the formation this small protrusion (white arrow).