Anatomy of the Corrugator Supercilii Muscle

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Objective: To define the anatomy of the corrugator supercilii muscle (CSM).

Design: Cadaver dissections following a preset approach.

Setting: Anatomy laboratory at a medical school.

Method: Sixteen sides of 8 preserved cadaver heads were dissected. Inferiorly based trapdoor-type flaps were developed in the subgaleal plane. The bone origins of the CSM were first identified. The muscles were then followed to their insertions. The origin and outline of the muscles were plotted on the face of the cadaver. Following the measurements, we transferred the configuration of the CSM to the image of a computer-manipulated face of a model.

Results: The origin of the CSM has a wide base, spanning across 0.6 cm from the midline and the supraorbital notch/foramen. The area of the muscle origin measured 0.98 × 2.52 cm on the right side and 1.04 × 2.35 cm on the left side. The lateral extent of the CSM insertion measured 4.27 and 4.50 cm from the midline on the right and left sides, respectively.

Conclusions: The CSM originates as 3 or 4 thin, rectangular, panelike muscle groups occupying a wide area across 0.6 cm from the midline and the supraorbital notch/foramen. The muscle groups travel parallel to one another in an oblique course without distinguishable oblique or transverse components.

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INTRODUCTION OF the endoscopic forehead lift procedure has heightened interest in the anatomy of the corrugator supercilii muscle (CSM). Unlike the coronal or pretrichial approach, the exposure of the muscle is compromised in the endoscopic approach. The lack of satisfactory improvement of glabellar frowning following the endoscopic procedure has been attributed to inadequate resection of the CSM. The recent use of botulinum toxin type A to treat frowning also demands a better understanding of the anatomy of the CSM.

Descriptions of the CSM in textbooks and in the literature are scant, incomplete, and often incorrect. Hollinshead1 described the CSM as “a small, deeply situated muscle arising from the frontal bone above the rim of the orbit close to the nasofrontal suture and extending laterally and upward to insert into the skin of the medial half of the eyebrow.” In the present study, we describe the anatomy of the CSM based on cadaver dissections. The CSM was found to have a larger mass, a broader bone origin, and an insertion on the middle and the lateral third of the eyebrow. These findings contrast with all previous attempts to describe the CSM.

METHODS

Cadaver dissections were carried out at the anatomy laboratory of the Northwest Center for Medical Education, Indiana University School of Medicine, Munster. First, 4 cadavers were dissected during August through October 2000. Then, 4 more cadavers were dissected during August through November 2001. The CSMs were dissected on 8 cadavers, totaling 16 sides. There were 4 male and 4 female cadavers. Reference points were identified and marked on the cadaver faces to indicate the locations of the medial canthus, the supraorbital notch/foramen, and the lateral canthus. Vertical lines were drawn through the midline, the medial canthus, supraorbital notch/foramen, and the lateral canthus bilaterally. Next, horizontal lines were drawn through the midline, the medial canthus, supraorbital notch/foramen, and 2 and 3 cm above the supraorbital notch/foramen. These last lines were arbitrarily chosen after the pilot dissection to contain the upper fibers of the CSM (Figure 1 and Figure 2). An inferiorly based trapdoor-type flap was then developed through the horizontal 3-cm
line, the vertical midline, and the vertical line crossing the lateral canthus (Figure 3). The flap was elevated from the periosteum. As the dissection approached the supraorbital rim, the bone origin of the CSM became visible. The dissection then progressed superficially, following the fibers of the CSM up to where the muscle ended in the subcutaneous tissue or interdigitated with the frontalis muscle. The pattern of interdigitation with the orbicularis oculi muscle was not actively sought via this approach. Through this approach, the CSM should be removed prior to exposure of the orbicularis oculi muscle.

In an attempt to determine the pattern of interdigitation between the CSM and the orbicularis oculi muscle, without violating the anatomy of the CSM, we elevated the skin and the subcutaneous tissues. The interdigitation pattern was not as clearly defined as that of the frontalis and corrugator muscles. The difficulty encountered was caused by the presence of dense fibrofatty tissue under the eyebrows, which compromised clean dissection in the area of the interdigitation between the CSM and the orbicularis oculi muscle.

Once the CSM was fully dissected but prior to skin elevation, needles were inserted through the skin to mark the boundary of the CSM on the surface of the face (Figure 4). The needle penetration points were then marked with a marking pen. Next, these points were connected to draw the boundary of the CSM on the forehead and eyebrow (Figure 5). The location of the 4 corners of the CSM were measured as distances from the reference points and lines. A photograph of a model face was obtained and altered by computer manipulation to match the averaged face proportions of the cadavers. The outline of the CSM based on the measurements and the 3-dimensional configuration of the CSM was then applied to the altered model face by computer reconstruction (Figure 2).

**RESULTS**

The average distance between the medial canthal horizontal line and the supraorbital horizontal line was 1.55 cm. From the midline to the medial canthal vertical line the distance was 1.82 cm on both sides. The distance between the midline and the supraorbital vertical line was 2.92 cm on the right and 2.95 cm on the left.

The CSM arises from the supraorbital ridge of the frontal bone. The origin has a wide base, spanning across 0.6 cm from the midline and the supraorbital notch/foramen. The average width of the base of the muscle origin in our cadavers measured 2.52 cm on the right side and 2.35 cm on the left. The vertical height of the base measured 0.98 cm on the right side and 1.04 cm on the left side.

The origin of the CSM is compartmentalized into 3 or 4 vertically oriented, long, narrow, rectangular areas. The muscle groups arise from each compartment as a thin, rectangular, panelike sheet of muscle and then travel parallel to each other in a lateral and superior oblique course (Figure 6). In our cadavers, there were no distinguishable transverse and oblique components of the CSM.

Beyond the supraorbital notch/foramen, each muscle group inserts into the skin. The more medial groups attach first followed by the lateral groups, with insertions progressing laterally thereafter. At the insertion area, the muscle fibers blend into each other and lose their compartmental characteristics. The boundary of the CSM is defined in terms of distances from the reference points and lines, the vertical midline, and the vertical line crossing the lateral canthus (Figure 3). The flap was elevated from the periosteum. As the dissection approached the supraorbital rim, the bone origin of the CSM became visible. The dissection then progressed superficially, following the fibers of the CSM up to where the muscle ended in the subcutaneous tissue or interdigitated with the frontalis muscle. The pattern of interdigitation with the orbicularis oculi muscle was not actively sought via this approach. Through this approach, the CSM should be removed prior to exposure of the orbicularis oculi muscle.

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lines, as summarized in Table 1 and Table 2. The average lateral extent of the CSM measured from the midline was 4.27 cm on the right side and 4.55 cm on the left.

Superiorly and laterally, the CSM fibers interdigitated with the fibers of the frontalis muscle. Interdigitation with the orbicularis oculi muscle was not clearly demonstrated. Although the CSM is distinctively under the frontalis muscle, medial to the supraorbital notch/foramen, the CSM shares the same plane as the frontalis and the orbicularis muscle at its lateral skin insertion.

**COMMENT**

Hollinshead describes the CSM as a small muscle arising from the frontal bone close to the nasofrontal suture. The illustrations found in other publications also depict the bone origin as being confined to a small area. Contrary to these publications, we found that the bone origin occupies a large area of approximately $1 \times 2.5$ cm spanning almost the entire area from the midline to the supraorbital notch/foramen. And instead of the area being circular in shape, the CSM is rectangular in shape.

We were unable to find any previous descriptions of the compartmentalization of the CSM muscle groups at the site of origin. These panellike muscle groups travel in parallel in an oblique course with a distinctive loose areolar space between each group of muscle. Previously described oblique and transverse patterns of the CSM were not found. The deep galeal plane covering the inner aspect of the frontalis muscle appears to become investing fascia for the CSM.

The supraorbital neurovascular bundle runs posterior to the CSM as noted in previous documentation. However, 1 fiber always penetrates the CSM about 1 to 2 cm.
above the supraorbital notch/foramen. The lateralmost group of the CSM origin is located just medial to the supraorbital notch/foramen.

We found the supraorbital notch/foramen to be 27 to 33 mm from the midline, comparable with previous studies.\textsuperscript{4,5} Beyond the supraorbital notch/foramen, the CSM groups begin to merge gradually before their insertion into the subcutaneous tissue. Interdigitation with the frontalis muscle occurs among the uppermost fibers. The interdigitations appear to be a gradual union of 2 muscle fibers that transition from the oblique direction of the CSM to the vertical one of the frontalis muscle rather than a true interwoven pattern.

Lateral extensions of the CSM are somewhat poorly defined owing to this gradual union of 2 muscles. However, distinctive fibers of the CSM extend laterally up to 4.55 cm from the midline, in contrast to previous descriptions of the CSM being confined to the medial third of the eyebrow.\textsuperscript{1,6} Our dissection revealed that the CSM extends even to the lateral third of the eyebrow. An explanation for this discrepancy might be that, in previous dissections, the lateral portion of the CSM was considered to be part of the frontalis muscle or orbicularis oculi muscle. This confusion may have occurred because the earlier dissections were performed from the surface, unlike our deep-to-surface dissection during which the CSM was clearly defined first, and then the muscle was followed laterally and superficially without a loss of fiber orientation.

A similar example may be found in the dissection of the peripheral branch of the nerve, which we found to be significantly easier and more complete when the nerve was dissected from the main trunk to the periphery as opposed to attempting nerve exploration at the distal fine nerve fiber first. When the dissection is approached from the surface, the delicate muscle fibers with similar fiber orientation can be mistaken as a part of another muscle (ie, the CSM as a part of the orbicularis oculi muscle). To clarify the interdigitation pattern between the CSM and the orbicularis oculi muscle, we performed the dissection from the skin by peeling off the skin from the area of the orbicularis oculi muscle. The orbicularis oculi muscle has a distinctive circular pattern, as expected, and was located inferior to the CSM. However, the interdigitation pattern was not clearly demonstrated on our dissections.

Four main conclusions may be drawn from our study: (1) The CSM originates as 3 or 4 thin, rectangular, panellike muscle groups. (2) Its bone origin has a wide base spanning across 0.6 cm from the midline and supraorbital notch/foramen. (3) The muscle groups travel an oblique parallel course; there is no distinguishable oblique or transverse component. And (4) the CSM has a larger mass and a wider base than previously described.

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### REFERENCES