Morphological Evaluation of the Human Facial Muscles

By

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Summary: The facial muscles are composed of striated muscle fibers, as well as other skeletal muscles, and can produce more delicate and complex expressions. We studied 12 facial muscles of 10 Japanese cadavers (8 males and 2 females, average 74.7 years old) by histological techniques. We measured the cross-sectional area of the muscle belly (mm\(^2\)), number of muscle fibers per mm\(^2\), total number of muscle fibers, and muscle fiber size (µm\(^2\)). The depressor anguli oris m. was predominant for the cross-sectional area and the total number of muscle fibers than other facial muscles. For the muscle fiber size, muscles inserted to the angle of the mouth were larger than those inserted to the lip. The orbicularis oculi and orbicularis oris muscles were the smallest facial muscles. The muscle fiber sizes in the facial muscles were less than other skeletal muscles.

Human expressions are delicate and more complex than those of animals, and facial muscles form those various expressions. The facial or mimetic muscles arise from the bones of the skull or fascia and are inserted into the overlying skin in the face. Their contraction causes the skin of the face to move and wrinkle in a wide variety of ways and form various emotional expressions\(^1\). These expression levels vary according to the individual. The individual variations and racial differences of the facial muscles were reported by macroscopic observation\(^2\). Histochemical examinations revealed that the fiber-type composition of the facial muscles varied dramatically from muscle to muscle\(^3\)–\(^6\). The organization of facial expression muscles differs from that of skeletal muscles in most other regions of the body\(^7\). The purpose of this study was to present fundamental data on the muscle fiber constitution of Japanese facial muscles, and to examine the functional features of the facial muscles compared with the other muscles.

Materials and Methods

Muscle samples were obtained from 10 Japanese cadavers (8 males and 2 females) for anatomical dissection. The average age was 74.7 years (60–86 years). The causes of death did not indicate the presence of neuro-muscular diseases. The following facial muscles were examined: m. frontalis; m. orbicularis oculi; m. orbicularis oris; m. levator labii superioris; m. zygomaticus minor; m. zygomaticus major; m. levator anguli oris; m. risorius; m. depressor anguli oris; m. depressor labii inferioris; m. buccinator; and platysma. For comparison, m. masseter, m. temporalis, m. biceps brachii and m. tibialis anterior were examined. The number of specimens is shown in Table 1. Muscle slices were embedded in celloidin (Shiojirin, Showa Ether Co., Japan) and 20 µm-thick sections were stained with haematoxylin and eosin (HE) (Fig. 1). We measured the cross-sectional area of the muscle belly (CSA; mm\(^2\)), the number of muscle fibers per square millimeter, and the muscle fiber size. The total number of muscle fibers in each section was

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calculated by multiplying the cross-sectional area by the number of muscle fibers per square millimeter. Fiber size (cross-sectional area of the individual fibers; \( \mu m^2 \)) was measured by NIH image program using about 200 muscle fibers in each section.

### Results

The microphotograph of transverse sections and the morphometorical data of the facial muscles are shown in Figure 1 and Table 1.

#### Cross-sectional area of the muscle belly (Fig. 2)

It was not possible to measure the CSA for m. orbicularis oculi, m. frontalis, m. orbicularis oris, m. buccinator and platysma. The CSA of the 7 facial muscles examined varied between 4.7 and 7.6 mm\(^2\). The smallest CSA was observed in m. zygomaticus minor and the largest in m. depressor anguli oris.

#### Number of muscle fibers per square millimeter (Fig. 3)

The number of muscle fibers per mm\(^2\) varied between 1060 (platysma) and 2210 (m. orbicularis oculi). Most facial muscles, except m. orbicularis oculi and m. orbicularis oris ranked between 1000 and 1400, and were equal to m. masseter, m. biceps brachii and m. tibialis anterior.

#### Total number of muscle fibers of the muscle belly (Fig. 4)

The total number of muscle fibers varied between 5400 (m. zygomaticus minor) and 9630 (m. depressor anguli oris).

#### Muscle fiber size (Fig. 5)

The muscle fiber size of the 12 facial muscles varied between 230.6 \( \mu m^2 \) (m. orbicularis oculi) and 610.2 \( \mu m^2 \) (platysma). The fiber sizes in facial muscles were less than in m. temporalis, and m. biceps brachii. Based on their muscle fiber sizes, three groups of facial muscles may be divided:

- **Large muscles with more than 500 \( \mu m^2 \) of fiber size** were platysma, m. levator anguli oris, and m. risorius. These muscles were equal to m. masseter and m. tibialis anterior.
- **Intermediate muscles** (between 500 and 400 \( \mu m^2 \) of fiber size): m. zygomaticus major, m. depressor anguli oris, m. buccinator, m. zygomaticus minor, m. depressor labii inferior, and m. levator labii superioris.
- **Small muscles** (less than 400 \( \mu m^2 \)): m. frontalis, m. orbicularis oris, and m. orbicularis oculi. M. orbicularis oris and m. orbicularis oculi had a particularly small fiber size.

### Discussion

The facial muscles lie in the subcutaneous tissue of the face and most arise from the bones of the skull and are inserted into the skin. They represent

### Table 1. Morphometry of human facial muscles

<table>
<thead>
<tr>
<th>Muscle sample</th>
<th>Number of specimen</th>
<th>Cross-sectional area (mm(^2))</th>
<th>Number of m.f. per mm(^2)</th>
<th>Total number of m.f.</th>
<th>Size of m.f. (( \mu m^2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontalis</td>
<td>7</td>
<td>*</td>
<td>1345.7</td>
<td>*</td>
<td>319.2</td>
</tr>
<tr>
<td>Orbicularis oculi</td>
<td>9</td>
<td>*</td>
<td>2210.3</td>
<td>*</td>
<td>230.6</td>
</tr>
<tr>
<td>Orbicularis oris</td>
<td>10</td>
<td>*</td>
<td>1649.7</td>
<td>*</td>
<td>296.3</td>
</tr>
<tr>
<td>Levator labii superioris</td>
<td>9</td>
<td>5.4</td>
<td>1390.2</td>
<td>7763.1</td>
<td>426.1</td>
</tr>
<tr>
<td>Zygomaticus minor</td>
<td>8</td>
<td>4.7</td>
<td>1236.6</td>
<td>5404.6</td>
<td>440.8</td>
</tr>
<tr>
<td>Zygomaticus major</td>
<td>9</td>
<td>5.5</td>
<td>1258.4</td>
<td>6777.0</td>
<td>471.9</td>
</tr>
<tr>
<td>Levator anguli oris</td>
<td>4</td>
<td>5.9</td>
<td>1388.5</td>
<td>6403.2</td>
<td>605.7</td>
</tr>
<tr>
<td>Risorius</td>
<td>4</td>
<td>4.8</td>
<td>1138.5</td>
<td>5494.4</td>
<td>543.5</td>
</tr>
<tr>
<td>Depressor anguli oris</td>
<td>10</td>
<td>7.6</td>
<td>1232.4</td>
<td>9630.4</td>
<td>466.6</td>
</tr>
<tr>
<td>Depressor labii inferioris</td>
<td>10</td>
<td>5.5</td>
<td>1330.4</td>
<td>7547.6</td>
<td>430.9</td>
</tr>
<tr>
<td>Buccinator</td>
<td>10</td>
<td>*</td>
<td>1124.4</td>
<td>*</td>
<td>449.5</td>
</tr>
<tr>
<td>Platysma</td>
<td>9</td>
<td>*</td>
<td>1060.5</td>
<td>*</td>
<td>610.2</td>
</tr>
<tr>
<td>Masseter</td>
<td>10</td>
<td>*</td>
<td>1209.4</td>
<td>*</td>
<td>580.6</td>
</tr>
<tr>
<td>Temporalis</td>
<td>7</td>
<td>*</td>
<td>885.1</td>
<td>*</td>
<td>697.2</td>
</tr>
<tr>
<td>Biceps brachii</td>
<td>7</td>
<td>341.8</td>
<td>1111.6</td>
<td>33147.3</td>
<td>722.9</td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>7</td>
<td>257.5</td>
<td>1158.9</td>
<td>290608.3</td>
<td>599.6</td>
</tr>
</tbody>
</table>

* We were not able to measure it.

m.f.: muscle fibers.
flat and thin muscle sheets and are distinct from other skeletal muscles from a morphological aspect.

The facial muscles serve as a sphincter or dilator of the facial orifices (orbita, mouth, etc.) and modify the facial expressions. These movements are sensitive and do not demand force development.

Morphologically, facial muscles are not enveloped by definite fascia and typical muscle bellies are never observed. They vary considerably in their development among individuals and interlace. In this study, for some facial muscles, it was not possible to obtain specimens from each of the ten cadavers (Number of specimens in Table 1). The risorius muscle was lacking in four cadavers.

Several reports have examined the muscle fiber size and fiber-type composition of the facial muscles by histochemical techniques, and facial muscles could be classified into “phasic”, “intermediate” and “tonic” muscles. These results, however, do not always accord.

In this study by routine histological method using HE stain (Fig. 1), we could obtain morphometrical standard data for the facial muscles, as well as the trunk and limb muscles.

For the CSA and the total number of muscle fibers, it is obvious that the facial muscles are much smaller than other skeletal muscles from morphological aspects. Facial muscles, however, are equal to the lumbrical muscles of the hand and foot.

The muscle fibers in facial muscles were generally smaller than in the mastication or limb muscles. The muscle fibers in facial muscles were generally smaller than in the mastication or limb muscles. These results show that facial muscles do not need force development unlike limb muscles.

Based on the muscle fiber size, we divided the facial muscles into three groups: “large”, “intermediate”, and “small”. Large muscles built up to more than 500 \( \mu m^2 \): platysma, levator anguli oris, and risorius. These muscles act on the angle of the mouth. Intermediate muscles ranging from 500 \( \mu m^2 \) to 400 \( \mu m^2 \): zygomaticus major, depressor anguli oris, buccinator, zygomaticus minor, depressor labii inferior, and levator labii superior. In the intermediate group, the muscles inserted at the oral

Fig. 1. Transverse sections of the levator anguli oris (A), depressor anguli oris (B), depressor labii inferioris (C) and orbicularis oculi muscle (D). HE stain, bar = 100 \( \mu m \).
angle (zygomaticus major, depressor anguli oris, and buccinator) had larger fiber sizes than those inserting into the lips. Small muscles less than 400 μm²: frontalis, orbicularis oculi, and orbicularis oris. For the orbicularis oculi muscle, the muscular fiber size was the smallest of the investigated muscles\(^\text{13}\), and this fiber composition was predominant in phasic muscle fibers. This shows that blinking by reflective movement does not require power but

![Cross-sectional area of the muscular belly of human facial muscles (mm²).](image-url)
need speed.

These results reveal that muscles converging at the corner of the mouth are well developed compared to those, inserting into the upper and lower lips. It is possible for the corner of the mouth to make dynamic actions, and for the upper and lower lips to make fine actions. These actions reflect not only emotional expressions but also mastication, sucking and phonation.

In this study, we presented histological normal

![Histogram of muscle fibers per mm² of human facial muscles.](image)

**Fig. 3.** Number of muscle fibers per mm² of human facial muscles.
data of facial muscles and clarified the functional differences among muscles concerned with exercise of the corners of the mouth and lips. Furthermore, we can clarify the functional characteristics of facial muscles by identifying the fiber composition in other facial muscles and its relationship with the facial nerves.

Fig. 4. Total number of muscle fibers of the muscular belly of human facial muscles.
References


Fig. 5. Muscle fiber size of human facial muscles (μm²).


