Mimic muscles are arranged in four layers regarding their origins, and these four layers should be considered when muscle tissue is added or lifted. All mimic muscles are built up by parallel fibers. Mean values of length, width, and thickness of the three lip elevators have been determined. These data might be of importance when dealing with this muscle system, which appears rather different from all other muscles in the human. The individual muscles receive their innervating facial nerve branches from their deeper surface when they belong to the superficial (first, second, or third) layer and from outside when they lie in the deepest (fourth) layer. Nerve branches communicate at least four times before innervating their respective muscles.

In reconstructive as well as aesthetic surgery of the face, we constantly have to consider the surgical anatomy of this particular region. Increasing attention has to be paid to the exactness of preparation regarding the different layers of the mimic muscle system irrespective of optimal vascularization when repairing a defect with a well-vascularized myocutaneous, fasciocutaneous, or isolated flap, as well as in correcting an aging face (SMAS and sub-SMAS).1

Reconstructive surgery by free-muscle transplantation in irreversible facial palsy has evoked new interest in the detailed anatomy of the mimic muscle system. We still do not know which donor muscle is optimal, what quality and architecture this muscle should have, how long and how thick it should be, and how it should be attached to achieve optimal function. Perhaps an examination of some of the anatomic aspects of the mimic muscle system can help us better understand these 20 paired muscles.

The level of preparation is important in order to preserve the facial nerve. Normal anatomy of the facial nerve has been well described by Fujita,2 Davis et al.,3 Pernkopf,4 and Dingman and Grabb.5 Other papers have shown the exact arrangement of this muscle system.6-8 To our knowledge, Proctor9 is the only one who combines these two structures, giving some information about how and where the facial nerve branches enter the individual muscles.

The aim of the present study was to describe in detail the widely spaced network of the facial nerve branches and their topographic relationship to the mimic muscles, as well as the three-dimensional arrangement of the mimic muscles themselves.

MATERIALS AND METHODS

Twelve human cadaver heads (62 to 94 years old) were fixed in a solution of formaldehyde and phenol. Three to six months later, skin and subcutaneous fat tissue were removed and the mimic muscles were dissected. Great care was taken in order to differentiate the muscles according to different layers. In another group of 10 fixed specimens the elaborate network of facial nerve branches was prepared. Special attention was paid to the relationship between this nerve plexus and the mimic muscles. The dissection and description were restricted to the face region from the orbicularis oculi muscle to the elevators and depressors of the lips.

RESULTS AND DISCUSSION

Mimic Muscles

This brief anatomic review is particularly focused on the arrangement of the lip elevators.
We paid attention to the exact site of origin, course, and attachment of these muscles. Anatomic textbooks usually do not show the three-dimensional arrangement and therefore do not consider the four layers of mimic muscle origins, an aspect that is probably of great importance. Figure 1 shows the facial muscles in a schematic drawing.

The first (superficial) layer includes three muscles: the depressor anguli oris, the superficial part of the zygomaticus minor, and the orbicularis oculi. The second layer consists of the platysma, the risorius, the zygomaticus major, the deeper portion of the zygomaticus minor, and the levator labii superioris alaeque nasi. The third layer is represented by the levator labii superioris and the orbicularis oris; the fourth layer, by the levator anguli oris, the mentalis, and the buccinator. The main lip-lifting muscles are the zygomaticus major, the levator labii superioris, and the levator anguli oris.

The zygomaticus major (Fig. 1, no. 7) originates from the zygomatic bone in front of the zygomaticotemporal suture. In the upper and lateral parts it is covered by the orbicularis oculi and the superficial portion of the zygomaticus minor. The major zygomatic muscle runs to the angle of the mouth, where its superficial fibers form the so-called modiolus together with the insertions of the depressor anguli oris, the risorius, the orbicularis oris, the buccinator, and the levator anguli oris. In the modiolus, all these muscles interdigitate. This structure is particularly evident during contraction of the participating muscles. The cranial and deeper insertion of the zygomaticus major reflects upward and fuses with the levator anguli oris, whereas the medial fibers lie on the buccinator. The caudal fibers continue into the depressor anguli oris.

The second important lip elevator is the levator labii superioris (Fig. 1, no. 10). This muscle arises from the lower margin of the orbit above the infraorbital foramen. Its medial and upper insertion forms the sulcus nasobuccalis. The lateral fibers descend to the orbicularis oris lying superficially to it. Only the deepest fibers interdigitate, forming part of the modiolus. The third muscle elevating the lip is the levator anguli oris (Fig. 1, no. 12). This muscle originates from the corpus maxillae below the infraorbital foramen, fills the fossa canina, and runs vertically. Its insertion again participates in the formation of the modiolus. Table 1 shows a statistical survey concerning the length of muscles; mean values for the zygomaticus major and levator anguli oris and the lateral length of the levator labii superioris. The table also contains the width at the origin and thickness of the muscles. To determine the point of origin (intermediate point of origin for the zygomaticus major and levator anguli oris and lateral point of origin for the levator labii superioris), the face was divided into vertical fifths in accordance with the approach of Powell and Humphreys10 (Fig. 2). These vertical lines run through the lateral and medial corners of the eye and the helix. The vertical line through the lateral corner of the eye represents the ordinate (y axis). A horizontal line connects the lowest points of the bony orbits and stands for the abscissa (x axis). The mean values show that there are no significant differences between male and female in terms of the size and arrangement of the facial muscles.

**Facial Nerve Ramification**

According to textbooks of anatomy, the branches of the facial nerve are differentiated
### TABLE I
Attachments and Dimensions of Lip-Lifting Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Length (mm)</th>
<th>Width (Origin) (mm)</th>
<th>Thickness (mm)</th>
<th>Intermediate Origin Point (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>M. zyg. major</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>70.67</td>
<td>6.52</td>
<td>9.00</td>
<td>1.68</td>
</tr>
<tr>
<td>Female</td>
<td>69.50</td>
<td>6.58</td>
<td>7.33</td>
<td>1.02</td>
</tr>
<tr>
<td>M. lev. ang. oris</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37.83</td>
<td>4.58</td>
<td>14.63</td>
<td>2.57</td>
</tr>
<tr>
<td>Female</td>
<td>38.33</td>
<td>8.02</td>
<td>14.17</td>
<td>2.33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Maximal Length (mm)</th>
<th>Width (Origin) (mm)</th>
<th>Thickness</th>
<th>Intermediate Origin Point (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>M. lev. lab. sup.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>53.67</td>
<td>4.13</td>
<td>25.00</td>
<td>4.46</td>
</tr>
<tr>
<td>Female</td>
<td>55.50</td>
<td>6.69</td>
<td>25.50</td>
<td>2.67</td>
</tr>
</tbody>
</table>

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Topographically, the temporal branches are lying in a most superficial layer. In craniocaudal sequence, the temporal, zygomatic, buccal, and marginal ramifications are consecutively arranged in deeper layers. For instance, the branches of the rami buccales are partly overlapped by the ramification of the rami zygomatici.

Usually, three to four rami temporales are observed. The two lower ones communicate with each other and innervate the superior part of the orbicularis oculi. They enter the muscle from its deeper surface about 3 to 4 mm medial to the free edge of this muscle. Connecting branches lead over to the rami zygomatici. Generally, there are two rami zygomatici. The superior branch is much thinner than the one below. It crosses the outside of the major zygomatic muscle in its upper third to reach the inside of the inferior part of the orbicularis oculi. The second ramus zygomaticus is the thickest extraparotid nerve stem, with again two thick branches. The very fine ramification of the superior one reaches into rami temporales, a rami zygomatici, a rami buccales, and a ramus marginalis and mandibulae reaching the face at the margin of the parotid gland. Figure 3 shows the branches of the facial nerve and their way of entering the individual

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Fig. 2. Site of mimic muscles, projected to ordinate and abscissa.
the inside of the major zygomatic muscle in its lower third. The lower branch partly runs underneath the major zygomatic muscle to reach the levator labii superioris, which again is innervated from its deeper surface. The branches of the infraorbital plexus of the facial nerve anastomosing with those of the infraorbital nerve of the nervus trigeminus are situated between the deeper surface of the levator labii superioris and the superficial surface of the levator anguli oris. This fact has already been described by Fujita. The lower zygomatic branch also participates in the innervation of the buccinator. Since this is a muscle of the fourth layer, it is innervated from outside. The same zygomatic branch further supplies innervation for the levator anguli oris, also belonging to the deepest layer. Like the muscle mentioned before, its innervation comes from the outside.

The two rami buccales cross the masseter and communicate with one another, but also with the rami zygomatici and the ramus marginalis mandibulae. The superior branch innervates the buccinator. The lower branch, together with the ramus marginalis mandibulae, innervates the depressor anguli oris from its inside.

The ramus marginalis mandibulae leaves the parotid gland about 1 cm below the angulus mandibulae, crosses the edge of the mandible halfway between the mandibular angle and the mental protuberance, runs beneath the muscle fibers of the platysma, and reaches the depressor anguli oris and the depressor labii inferioris from their inside. The mentalis is supplied by the marginal branch from its outside. In some preparations, two marginal rami were observed with only one detectable connection to each other. In these cases, the cranial branch innervates all three muscles mentioned, whereas the caudal nerve just supplies the depressor anguli oris. This situation has been described by Correia and Zani.

All the groups of facial nerves intermingle after emerging from the parotid gland at least four times until they reach their corresponding muscles. The first branches are almost as thick as the nerve branches themselves and can be compared to a tree with a short central trunk, two major secondary trunks, and a variable number of tertiary limbs which communicate through multiple interconnections in the periphery. In our daily operative practice we have realized that a loss of the more peripheral branches is tolerated with very little or no long-term deficiency.
In face-lift operations, where SMAS and sub-SMAS preparation has become more and more popular, we urgently need the exact anatomic data in order to avoid damage to facial nerve branches. However, in reconstructive facial surgery, including that for facial palsy, detailed knowledge of facial nerve anatomy as presented in this study might be very useful.

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REFERENCES
11. Lightoller, G. H. S. Facial muscles, the modiolus, and muscles surrounding the rima oris with some remarks about the panniculus adiposus. J. Anat. 60: 1, 1925.