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Facial Nerve Anatomy in Eyelids and Periorbit

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Purpose: To clarify anatomically the facial nerve branches in the eyelids and periorbit.

Methods: The facial nerve branches of the left periorbits from 31 Japanese cadavers were dissected under a surgical microscope.

Results: The temporal, zygomatic, and deep buccal branches assembled posterior to the orbicularis oculi from its temporal or inferior side, and formed a dense plexus. The superficial buccal branches coursed, unlike the others, around the inferior nasal margin of the orbicularis oculi with some variations. The branches always passed across the "triangular window" that was outlined by the orbicularis oculi, the zygomaticus minor, and the levator labii superioris alaeque nasi. Then the branches crossed over the medial palpebral ligament, reaching both the procerus and corrugator supercilii in 94% of the specimens. The branches ramified the lower part of the orbicularis oculi in 65% and the upper part in 42% of the specimens.

Conclusions: The superficial buccal branches are the main supplier to the muscles in the nasal periorbit. This anatomical finding may be important information for accurate procedures in facial nerve surgery. **Jpn J Ophthalmol 2001; 45:445–452**

Key Words: Anatomy, blepharospasm, facial nerve, nerve block, orbital surgery.

Introduction

The branches of the facial nerve spread through the parotid gland, supplying the muscles of facial expression, and join with the terminal branches of the trigeminal nerve, making a precise neuroanatomical knowledge of them important for neurosurgery and nerve blocks. The branches in the intraparotid and extraparotid regions have been well documented in reports based on large series or detailed investigations with microscopy,[1–4] whereas, anatomical research on the eyelids and around the orbital opening (the periorbital region) has remained somewhat obscure.[5–10] The branches in this region are classified into three groups. However, the terminology varies in different anatomical textbooks. According to Berry et al[5] and Dutton,[6] the superior group of the branches crossing over the zygomatic arch are defined as the temporal branches; the middle group running on the zygomatic bone, as the zygomatic branches; and the lower group passing below the orbit, as the buccal branches, which are subdivided into superficial and deep branches. The temporal branches supply the frontalis, orbicularis oculi, and corrugator supercilii, and join with the supraorbital and lacrimal nerves. The zygomatic branches supply the orbicularis oculi and combine with the zygomaticofacial nerve. In the buccal branches, the superficial branches pass to the procerus and join with the infratrochlear nerve. The deep branches supply the buccolabial muscles and form an infraorbital plexus with the infraorbital nerve. However, in our previous research, a part of the deep buccal branches was found to course to the orbicularis oculi and form a dense plexus with the temporal and zygomatic branches.[10] Moreover, the course of the superficial buccal branches and the muscles they supply are still unclear. For example, two textbooks disagree on the

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supplier of the preocerus. Berry et al[5] claim that the superficial buccal branches supply the procerus, whereas Bron et al[7] argue that the temporal branches (they call them "upper zygomatic") are the supplier. This obscurity may prevent us from approaching clinical problems involving blepharospasm neurectomy and facial nerve blocks.

Thus, we revisited the anatomy of the facial nerve in the periorbital region, focusing in detail on the superficial buccal branches.

Material and Methods

The specimens were 31 left cervicofacial halves from formalin—preserved Japanese adult cadavers, 19 male and 12 female: all were voluntarily contributed to the Department of Anatomy, Teikyo University School of Medicine for research and education.

In 12 of the 31 specimens, all the branches of the facial nerve in the periorbital region were identified under a surgical microscope. We turned over the block of muscles and on the reverse sides the branches were marked with colored sutures. We removed the connective tissue from the posterior surface of the block, paying special attention to keeping the facial and trigeminal nerves intact. The terminal rami were followed up to the point of muscle insertion.

For quantitative analysis of the superficial buccal branches, we investigated all 31 specimens to examine the location of the nerves and ramification to the muscles on the frontal plane.

Results

The muscles supplied by the facial nerve branches and the communications between the nerve branches in the 12 specimens are shown in Tables 1 and 2. The temporal, zygomatic, and deep buccal branches assembled posterior to the orbicularis oculi and integrated with each other and the terminal branches of the trigeminal nerve (Table 1). The rami of the plexus supplied the corrugator supercilii and orbicularis oculi. These findings are similar to our previous description.[10] However, these two muscles also received the superficial buccal branches and the course was different from the other branches. The insertion of the nerves into the muscles took different directions to each muscle; the orbicular oculi and zygomatic muscles from the posterior surface; the frontalis, procerus, and levator labii superioris alaeque nasi from the posterior surface and/or temporal margin; the corrugator supercilii from both the temporal and inferior margins; and the levator labii superioris from the anterior surface (Table 2).

The findings in one specimen are demonstrated in Figures 1, 2, and 3. Figure 1 shows the roots of the branches around the temporal side of the periorbit. The temporal branches, which are present on the superficial musculoaponeurotic system, reach the temporal side of the orbicularis oculi. The zygomatic branches are also on the system, reaching the temporal inferior side of the orbicularis oculi. The buccal branches course deeper than the other branches.

Table 1. Dense Communications of Facial Nerve Branches in Periorbital Region (N=12)

Communications	Specimens
Among Branches Posterior to Orbicularis Oculi	
Temporal – Zygomatic	8
Zygomatic – Deep Buccal	9
Deep Buccal – Superficial Buccal	5
To Terminal Branches of Trigeminal Nerve	
Upper Part of Plexus	
– Supraorbicularis	12
– Supratrochlearis	12
– Lacrimalis	3
Lower Part of Plexus	
– Zygomaticofacialis	7
– Infraorbicularis	12
Superficial Buccal	
– Infratrochlearis	7

Table 2. Muscle Complexes Supplied and Insertion Points of Facial Nerve Branches (N=12)

Branches	Plexus	Muscle and Insertion Point	Specimens
Temporal	Upper part	Frontalis temporal margin	7
		Corrugator Supercilii temporal margin	12
		inferior margin	12
Zygomatic		Orbicularis Oculi posterior surface	12
		nasal margin	8
	Lower part	Zygomaticus Major posterior surface	12
Buccal	Deep	Zygomaticus Minor posterior surface	12
	Superficial	Levator Labii Superioris anterior surface	12
		Levator Labii Superioris Alaeque Nasi temporal margin	12
		posterior surface	6
		Procerus temporal margin	9
		posterior surface	6

Figure 1. Facial nerve branches around temporal side of left periorbit (left) and in diagrammatic form (right). Temporal branches (TBr) and zygomatic branches (ZBr) run anterior to superficial musculoaponeurotic system (SMAS). To show the course of buccal branches (red marks) and parotid duct (PD), SMAS below zygomatic arch is removed and zygomaticus major is amputated and is turned over with forceps.

They cross over the masseter, run along the parotid duct, then run behind the superficial musculoaponeurotic system and the zygomatic muscles. Figure 2 shows nerves on the posterior surface of the muscles. The most superior branch of the temporal branches leaves a ramus of the frontalis by the margin of the orbicularis oculi. The zygomatic branches supply only the orbicularis oculi in this specimen. The buccal branches, the largest in size of the three facial nerve branches, ramify the zygomatic muscles from their posterior surface. They communicate with the infraorbital nerve that spreads on the posterior surface of the levator labii superioris. Finally, the deep buccal branches turn upward and reach the inferior

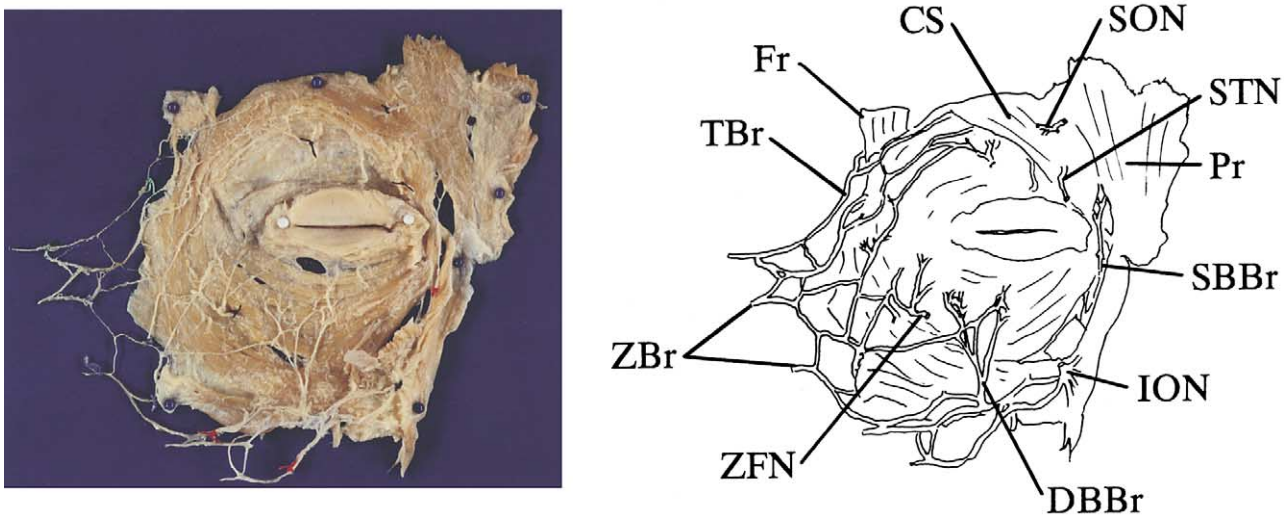

Figure 2. Left periorbital nerves on posterior surface of muscles (left) and in diagrammatic form (right). Facial nerves depicted are temporal branches (TBr), zygomatic branches (ZBr), deep buccal branches (DBBr), and superficial buccal branches (SBBr). Terminal branches of trigeminal nerve are supratrochlearis nerve (STN), supraorbicularis nerve (SON), infraorbital nerve (ION), and zygomaticofacialis nerve (ZFN). Muscles are procerus (Pr), corrugator supercilii (CS), and a portion of frontalis (Fr).

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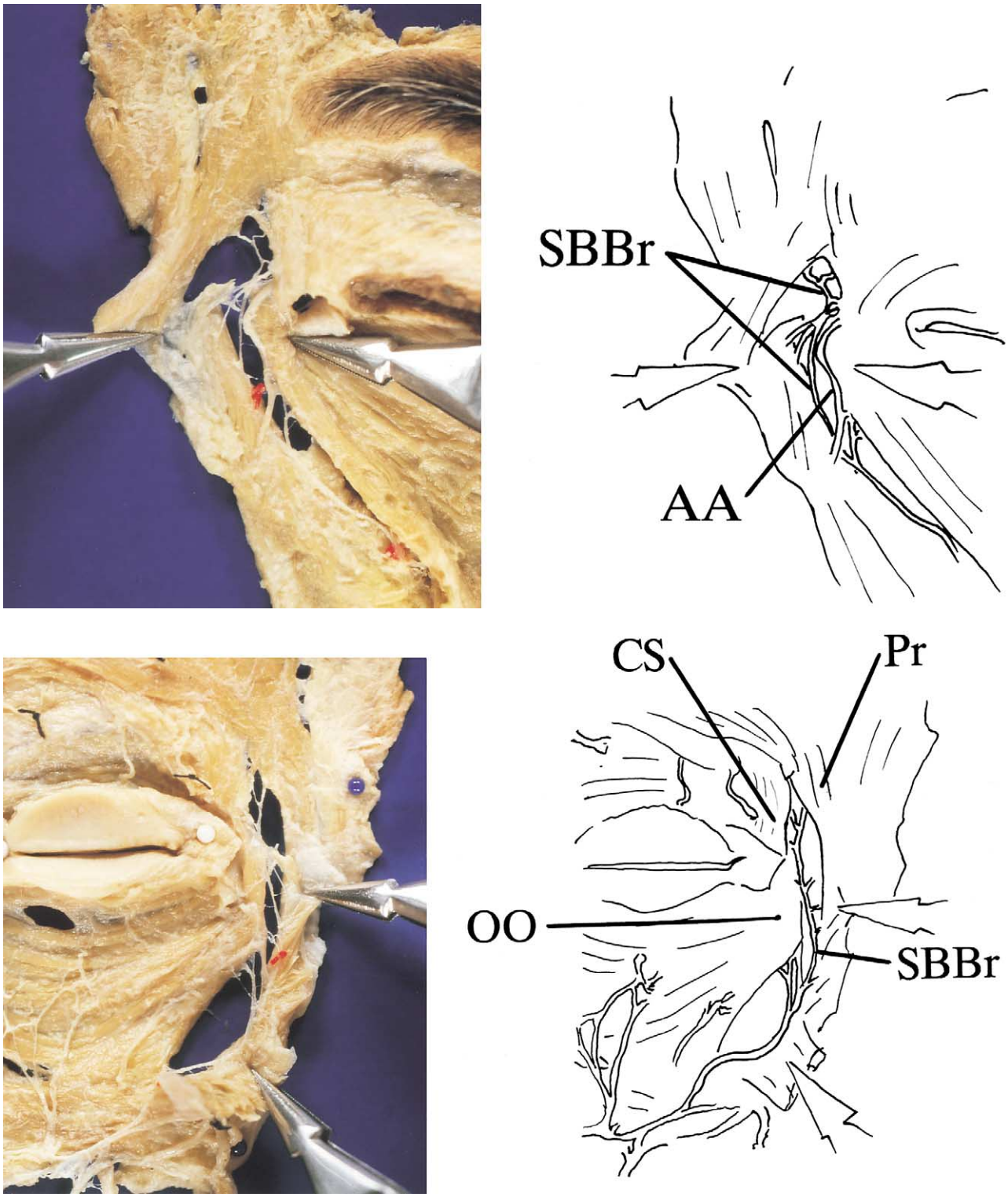

Figure 3. Left superficial buccal branches. (**A**) Anterior view (left) and in diagrammatic form (right). Superficial buccal branches (SBBr) spread into terminal rami to surrounding muscles. Also demonstrated is angular artery (AA). (**B**) Posterior view (left) and in diagrammatic form (right). Lower forceps turn over levator labii superioris, and upper forceps pull upper end of levator labii superioris alaeque nasi nasally, to show course of superficial buccal branches (SBBr). Terminal rami supply procerus (Pr), corrugator supercilii (CS) and orbicularis oculi (OO).

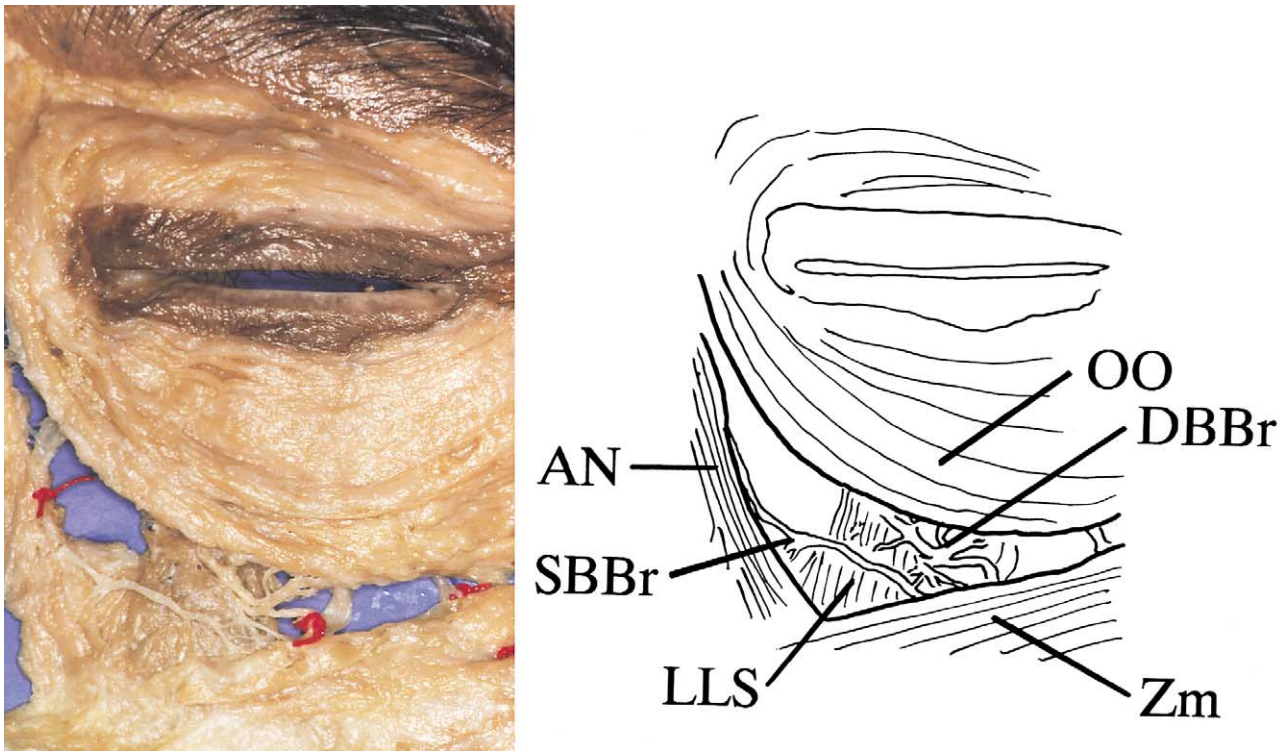

Figure 4. "Triangular window" in left infraorbit (left) and in diagrammatic form (right). "Triangular window" is outlined by inferior margin of orbicularis oculi (OO), nasal margin of zygomaticus minor (Zm), and temporal margin of levator labii superioris alaeque nasi (AN). Also demonstrated is levator labii superioris (LLS). Posterior to "triangular window," superficial buccal branches (SBBr) pass horizontally and deep buccal branches (DBBr) run upward to orbicularis oculi.

side of the orbicularis oculi. On the posterior surface of the orbicularis oculi, the temporal, zygomatic, deep buccal branches and the terminal branches of the trigeminal nerve form a plexus. The terminal rami from the plexus in the upper eyelid run nasally to the corrugator supercilii. The branches in the lower eyelid form a mesh-like plexus and divide the rami into the orbicularis oculi. In contrast, the plexus is not prominent on the posterior surface of both the corrugator supercilii and the procerus. The supraorbital and supratrochlear nerves penetrate the corrugator supercilii and join with the facial nerve branches in a layer between the corrugator supercilii and the orbicularis oculi. Figure 3 shows the superficial buccal branches in this specimen. They divide from the common trunk of the buccal branches just posterior to the zygomaticus minor. They pass anterior to the levator labii superioris, run upward between the lower part of the orbicularis oculi and the levator labii superioris alaeque nasi, supplying thin fibers to all these muscles. Then they cross over the medial palpebral ligament with the angular artery. Finally, they spread into the terminal rami to the muscles, including the upper part of the orbicularis oculi, procerus, and corrugator supercilii.

The superficial buccal branches in another specimen are shown in Figure 4. In the infraorbit, the branches run across horizontally anterior to the levator labii superioris and posterior to a "triangular window" that is outlined by the inferior margin of the orbicularis oculi, the nasal margin of the zygomaticus minor, and the temporal margin of the levator labii superioris alaeque nasi.

The course and ramifications of the superficial buccal branches in all 31 specimens are demonstrated in Table 3 and Figure 5. All of the specimens showed the branches running across the "triangular window" and anterior to the levator labii superioris. After leaving the window, the branches coursed with some variations (Figure 5): in the first, the branches ran upward between the two muscles (type I) as shown in Figure 3. In the second, the proximal part of the branches ran upward posterior to the levator labii superioris alaeque nasi, then emerged between this muscle and the orbicularis oculi near the medial palpebral ligament (type II). In the last, the course of the branches did not run along the nasal margin of the orbicularis oculi: in the majority of the group, the branches ran upward posterior to the levator labii

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Table 3. Superficial Buccal Branch Courses and Ramifications

Type	I	II	IIIa	IIIb	Total
Specimens	9	10	10	2	31
Course					
Across Posterior to "Triangular Window" *	9	10	10	2	31
Anterior to Levator Labii Superioris	9	10	10	2	31
Anterior to Medial Palpebral Ligament	9	10	10	0	29
Ramifications					
Levator Labii Superioris	9 (100)	9 (90)	7 (70)	2	27 (87)
Levator Labii Superioris Alaeque Nasi	9 (100)	10 (100)	10 (100)	2	31 (100)
Orbicularis Oculi					
Lower Part	8 (89)	6 (60)	6 (60)	0	20 (65)
Upper Part	7 (78)	4 (40)	2 (20)	0	13 (42)
Procerus	9 (100)	10 (100)	10 (100)	0	29 (94)
Coruggator Supercilii	9 (100)	10 (100)	10 (100)	0	29 (94)

* outlined by orbicularis oculi, zygomaticus minor and levator labii superioris alaque nasi

( ) %

superioris alaeque nasi and the procerus (type IIIa). The rest of the branches are too fine to be traced in the levator labii superioris alaeque nasi (type IIIb). All branches that reached the medial palpebral ligament in the 29 specimens took the course that crossed over the ligament anteriorly. The branches supplied the surrounding muscles in the nasal part of the periorbital region in most specimens; not only the procerus, but also the levator labii superioris, the levator labii superioris alaeque nasi, and the corrugator supercilii. The frequency of ramification to the orbicularis oculi varied among the course types: type I showed the highest frequency.

Discussion

This study demonstrated the microsurgical anatomy of the branches of the facial nerve in the periorbital region. The findings of the temporal, zygomatic, and deep buccal branches were similar to the findings of our previous study.[10] Moreover, in this study, the superficial buccal branches were clarified anatomically as the main supplier of the nasal part in the periorbit for the first time. the superficial buccal branches took a unique course: they always passed across a closed area, anterior to the levator labii superioris and posterior to the "triangular window" that was outlined by the orbicularis oculi, the zygomaticus minor, and the levator labii superioris alaeque nasi. The branches

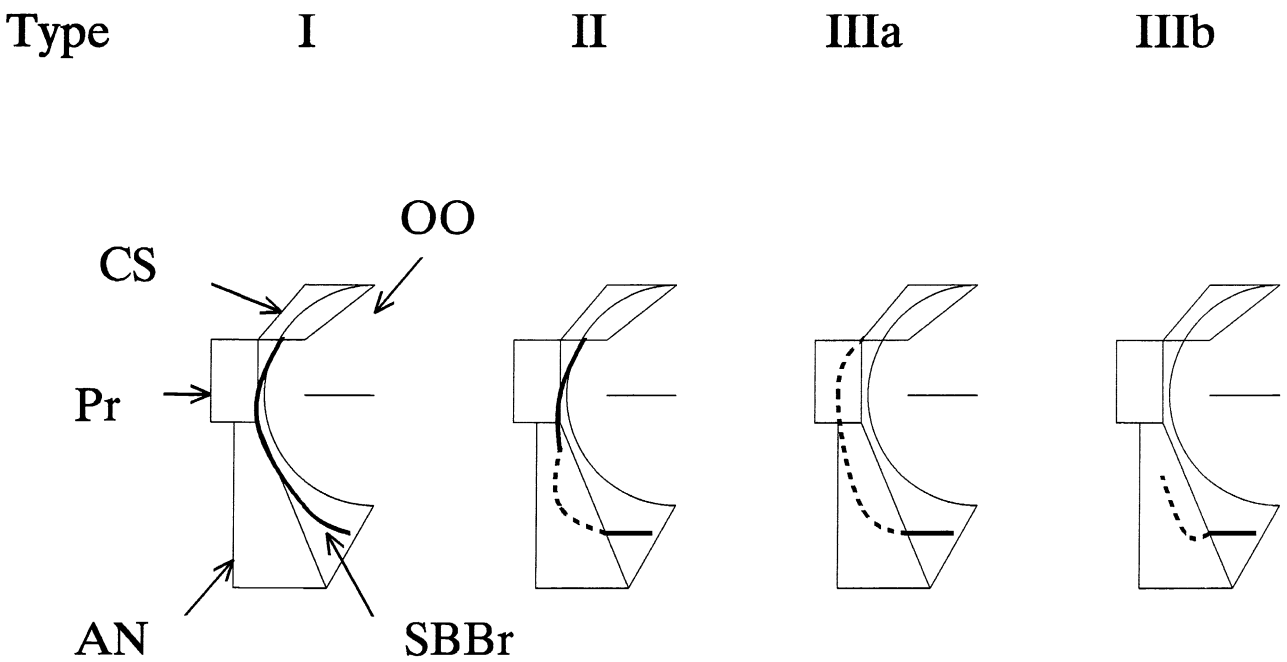

Figure 5. Superficial buccal branch courses. Relationships between superficial buccal branches and surrounding muscles vary in nasal periorbit. See text (Results) and Table 3 for detailed explanation.

ran upward on the posterior or temporal side of the levator labii superioris alaeque nasi, and supplied the muscles in the nasal part of the periorbit in most specimens. This finding will lead us to develop solutions to the clinical problems of blepharospasm neurosurgery or facial nerve blocks such as the following.

Severe blepharospasm, as Meige characterized "spasme facial median,"[11] most seriously involves the muscles in the nasal part of the periorbit. Previous reports pointed out that the buccal branches might play an important role on the basis of the postsurgical findings.[12–14] Small described that almost all the buccal branches had to be removed to denervate the muscle.[12] McCabe stressed the importance of resecting the upper lip branches.[13] Finally, in our experience, a neurectomy including the buccal branches at the margin of the orbicularis oculi eliminated spasms in not only the eyelids, but also in the eyebrow.[14] In this study, the superficial buccal branches were confirmed to run throughout the nasal periorbit and ramify the muscles, including the corrugator supercilii and orbicularis oculi. Above all, the superficial buccal branches are the most likely to carry abnormal impulses from the central nervous system to the muscles, and denervation of these branches is the key to success in blepharospasm neurosurgery.

Freilinger et al classified the lower facial muscles into four layers of anatomical origin.[15] They described the muscles of the superficial three layers, including the levator labii superioris, as being innervated from their posterior surfaces. In our study, almost all the lower facial muscles were also found to be supplied from their posterior surfaces; however, the levator labii superioris was supplied not from the posterior, but from the anterior surface by the buccal branches. This muscle originates above the infraorbital foramen and covers the trunk of the infraorbital nerve. We think that an approach through the "triangular window" to the levator labii superioris is appropriate to denervate the buccal branches during blepharospasm neurosurgery without postsurgical dysesthesia. Surgeons can find the nerve branches using the levator labii superioris as a guide: the superficial buccal branches exist anteriorly to the muscle, the deep buccal branches temporally, and the infraorbital nerve posteriorly.

Schimek and Fahle[16] investigated the efficacy of the different techniques of facial nerve block. They demonstrated that periorbital blocks such as those advocated by Atkinson and van Lint have no effect clinically and showed in radiographs that the course of the buccal branches was free from contrast medium. We think that these procedures do not block the buccal branches because the buccal branches run deeper, behind both the superficial musculoaponeurotic system and zygomatic muscles. An auxiliary block into the "triangular window" just anterior to the infraorbital foramen may be effective in case of failure after the periorbital block procedure because both the deep and superficial buccal branches run across posterior to the "triangular window."

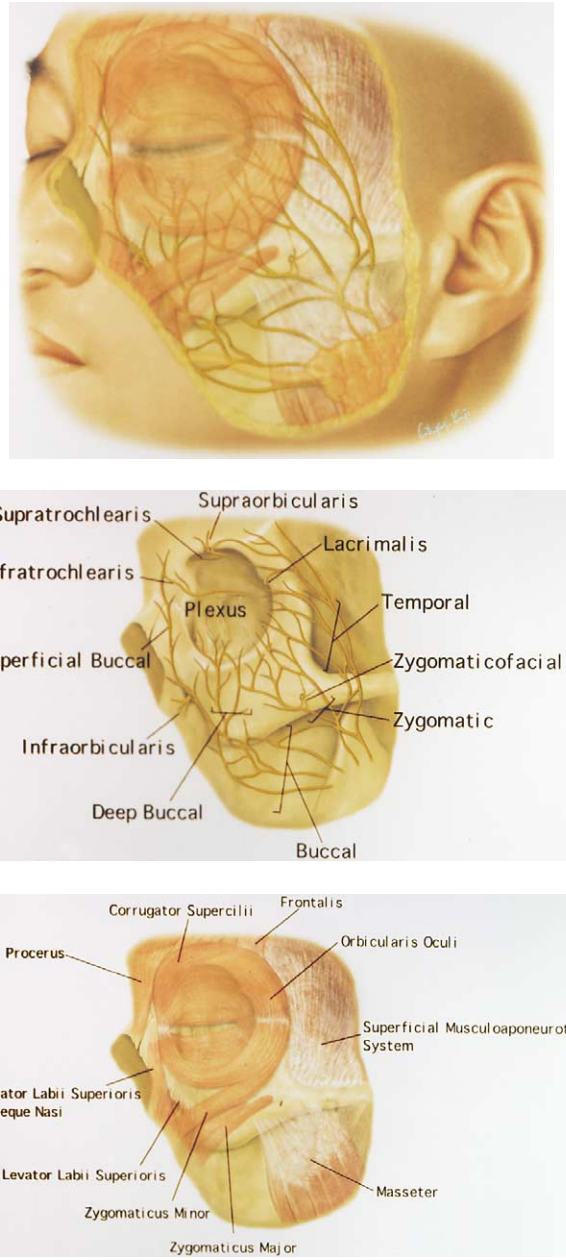

Figure 6. Anatomy of left periorbital region. (**A**) Relationships between nerves and muscles. Muscles over nerve are shown translucently. (**B**) Nerves. (**C**) Muscles.

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On the basis of both our last and the present study, we prepared Figure 6. There are two features in this figure. First, it illustrates the most frequent types of locations, ramifications, and communications of the facial nerve branches. Second, the muscles over the branches are drawn translucently. We believe that Figure 6 will be useful for not only blepharospasm neurosurgery and nerve blocks, but also for orbital surgical approaches, because it makes the anatomical relationships between the branches and these interrelated areas easy to understand.

We have shown the roots and ramifications of the facial nerve branches in the periorbital region, but the specimens were limited to the left side of Japanese subjects. Further equivalent neuroanatomical studies showing racial or individual variations, or both, would be welcome.

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