Kinesiology of the Head and Spine

UNIT 4: MUSCULOSKELETAL FUNCTIONS WITHIN THE HEAD
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The preceding three units examine the structure, function, and dysfunction of the upper extremity, which is part of the appendicular skeleton. Since the function of the remaining appendicular skeleton, the lower extremities, is so intimately related to the spine, it is necessary first to investigate the spine, which is part of the axioskeleton. The axioskeleton includes the head and spine, and this text begins its examination of the axioskeleton at the head and proceeds in a rostral direction. The current unit examines the function and dysfunction of the musculoskeletal components of the head. These structures work in concert with each other in diverse functions including facial expression, vocalization, chewing, and swallowing. This unit is divided rather artificially by function, and the structures most associated with each function are described within the context of that function. However, the reader must recognize that many anatomical components participate in multiple functions. For example, the lips participate in facial expressions, chewing, and speech, and the tongue is equally important in swallowing and speech.

The first three chapters of this unit deviate slightly from the organization used in other parts of this textbook because they focus on the overall functions of facial expression, vocalization, and swallowing. The structure of bones and joints plays a smaller role in the understanding of these functions, so the chapters present a less detailed review of the relevant anatomical structures. Although plastic surgeons require a detailed knowledge of the structures within the face, and otolaryngologists and speech and language specialists need a more detailed understanding of the larynx and pharynx, conservative management of functional deficits is typically based on more-global assessments of impairments in these activities, and few individuals are able to isolate single muscles throughout the face, mouth, and throat. Therefore, each of the next three chapters presents a discussion of the role of the muscles participating in the specified function. The purposes of the first three chapters are to

- Examine the muscles that move the face and eyes (Chapter 20)
- Describe the intrinsic muscles of the larynx and discuss the mechanics of voice production (Chapter 21)
- Review the muscles of the mouth and pharynx and discuss the sequence of movements that constitute the swallow (Chapter 22)

Chapters 23 through 25 in this unit focus on the temporomandibular joint, in which a more detailed understanding of the skeletal, articular, and muscular components is necessary to understand the function and dysfunction of the joint. Consequently,
these chapters return to the organization used in most of this text. The purposes of the last three chapters of this unit are to

- Present the bony and articular structures of the temporomandibular joint and describe the motions that occur (Chapter 23)
- Review the muscles of mastication and their contribution to chewing (Chapter 24)
- Review the forces sustained by the temporomandibular joints under various conditions (Chapter 25)
The muscles of the face are small and superficial, attaching at least in part to the skin of the face. The resulting skin movement is an essential part of human communication, allowing a face to express love, rage, sadness, fear, and a multitude of other human emotions [14,19,20].

Human expression is enhanced by movements of the eyes, such as when an individual rolls the eyes in disgust. Appropriate and coordinated eye movement also is critical to clear and accurate vision. This chapter presents the muscles that produce facial and ocular movements and discusses the dysfunctions resulting from pathology affecting these muscles.

The specific purposes of this chapter are to

- Present the muscles of facial expression
- Discuss the movement dysfunctions that result from weakness in these muscles
- Describe the muscles that move the eyes
- Discuss the coordination of the eye muscles that produces smooth eye movements essential for proper vision

**DISTRIBUTION OF THE FACIAL NERVE**

The muscles of facial expression are innervated by the motor branch of the seventh cranial nerve, known as the facial nerve (Fig. 20.1). As it emerges from the stylomastoid foramen of the temporal bone, the facial nerve gives off a branch, the posterior auricular nerve, to the occipitalis and the posterior auricularis muscle. The terminal portion of the facial nerve, lying within the parotid gland, divides into several branches that go on to supply the rest of the muscles of facial expression:

- The temporal branch supplies the anterior and superior auricular muscles and the frontalis, orbicularis oculi, and corrugator muscles.
- The zygomatic branch supplies the lateral portions of the orbicularis oculi.
The buccal branch innervates the muscles of the nose and the zygomaticus, levator labii superioris, levator anguli oris, orbicularis oris, and buccinator.

• The mandibular branch supplies the muscles of the lower lip and the mentalis.
• The cervical branch supplies the platysma.

An understanding of the organization of the facial nerve helps the clinician recognize and evaluate the clinical manifestations of facial nerve palsies.

MUSCLES INNERVATED BY THE FACIAL NERVE

Most of the muscles innervated by the facial nerve are muscles of facial expression, unique because they cross no joints and attach to aponeuroses and, directly or indirectly, to the skin of the face, producing movement of the facial skin [34,43,44]. There are approximately 21 pairs of muscles in the face. However, asymmetry in movements produced by individual muscles within a pair is common among healthy individuals [13,31]. Consequently, clinicians must be cautious when determining the clinical significance of asymmetrical facial excursion. For example, many individuals can raise one eyebrow but not the other [13]. The inability to raise an eyebrow may reflect a common lack of motor control or may be the manifestation of muscle weakness. The clinician requires additional evidence before determining that a muscle is weak. Such corroborating evidence includes the function of surrounding muscles, the resting posture of the face, and the condition of the facial skin.

CLINICAL RELEVANCE: FACIAL CREASES

As noted in Chapter 17, most normal skin creases are formed by the pull of underlying muscles that lie perpendicular to the creases. Most facial creases are the consequence of activity of the facial muscles that lie just underneath the skin. Because facial creases are the superficial manifestations of muscle activity under the skin, the absence of facial creases in an adult may indicate weakness in underlying facial muscles. The clinician must be cautious to avoid interpreting the smooth, unlined skin of an elder patient as the consequence of a lifetime of good skin care when it may actually indicate muscular weakness. Careful observation of the wrinkles of both sides of the face allows the clinician to recognize asymmetrical wrinkle patterns that may indicate asymmetrical muscle performance and possible pathology. Since individual palpation of single muscles is impossible, inspection of these facial wrinkles is an important component of an assessment of the facial muscles.

The muscles of facial expression surround the orifices of the face, regulating their apertures, and pull on the skin, thereby modifying facial expressions. The functions of the muscles of facial expression are less well studied than that of the muscles in the limbs and spine. The classic understanding of these muscle actions is reported in standard anatomy texts, which are cited in the discussions that follow [34,44]. However, there is a growing body of literature describing the activity of facial muscles by using electromyography (EMG) to examine the participation of these muscles in facial movements, and these studies also are cited in the following discussions.

Many of the muscles of the face attach to each other and, therefore, participate together in facial movements. Few people can voluntarily contract all of the muscles of the face individually [4]. Therefore, this text groups the muscles together according to the region of the face affected by their contractions. The discussion includes the actions performed by the muscles and the emotional expressions typically associated with the muscle activity. Weakness of these muscles affects facial expressions and facial wrinkles and also has an impact on functional activities such as chewing and speech. The clinical manifestations of weakness are discussed with each muscle.

Muscles of the Scalp and Ears

The muscles of the scalp and ears include the frontalis, occipitalis, and the auricularis anterior, posterior and superior
Fig. 20.2). Only the frontalis has a visible and reliable contribution to emotional expression, yet all four muscles may be activated during looks of surprise [3].

FRONTALIS AND OCCIPITALIS

The frontalis and occipitalis actually are the anterior and posterior muscle bellies of a single muscle, the occipitofrontalis, although they are frequently listed separately and can function independently of one another [3,23] (Muscle Attachment Box 20.1). They are separated by the galea aponeurotica, which is a large fibrous sheet covering the cranium. The action of the frontalis portion of the muscle is more observable and is the portion typically evaluated clinically.

Actions

The reported action of the frontalis is to lift the eyebrows. By lifting the eyebrows, the frontalis contributes to a look of surprise [3,31,43]. It also pulls the galea aponeurotica forward, creating the horizontal wrinkles in the forehead. The reported action of the occipitalis is to pull the galea aponeurotica posteriorly and anchor it against the pull of the frontalis. The occipitalis also is active in smiling and yawning, although its functional significance is unclear [3].

MUSCLE ATTACHMENT BOX 20.1

ATTACHMENTS AND INNERVATION OF THE OCCIPITOFRONTALIS

Bony/fascial attachment:
- Occipitalis: Lateral two thirds of superior nuchal line on the occiput, the mastoid process of the temporal bone, and the epicranial (galea) aponeurosis
- Frontalis: Epicranial (galea) aponeurosis

Soft tissue attachment: Skin of the occipital and frontal regions

Innervation:
- Occipital: Posterior auricular branch of facial nerve
- Frontal: Temporal branches of facial nerve (7th cranial nerve)

Weakness

Weakness of the occipitofrontalis is manifested in weakness of the frontalis portion, which limits or prevents the ability to raise the eyebrows. Consequently, the eyebrows are somewhat drooped, stretching the skin of the forehead and reducing or eliminating the forehead wrinkles. When weakness of the frontalis is suspected, careful inspection of the forehead for the presence or absence of wrinkles helps the clinician determine the muscle’s integrity.

Weakness of the frontalis is an important clinical finding that helps clinicians distinguish between upper and lower motor neuron lesions [5]. Most muscles are innervated by nerves that are supplied by the contralateral motor cortex of the brain [27]. The frontalis and part of the orbicularis oculi, however, receive input from the motor cortex of both the contralateral and ipsilateral hemispheres via the temporal branch of the facial nerve [5,44,45] (Fig. 20.3). As a result, a central nervous system disorder such as a cerebral vascular accident (CVA) that affects the motor cortex of one hemisphere may produce weakness of all of the muscles of facial expression except the frontalis, which is only mildly affected since it still receives input from the ipsilateral hemisphere. In contrast, a lower motor neuron lesion to the facial nerve produces weakness in all of the facial muscles including the frontalis, since the facial nerve is the final common pathway to the muscles of facial expression (Fig. 20.4). Facial weakness with sparing of the frontalis suggests an upper motor neuron lesion, while facial weakness including the frontalis suggests a lower motor neuron lesion.
AURICULARES ANTERIOR, SUPERIOR, AND POSTERIOR

The auriculares muscles are much less developed in humans than in animals who rotate their ears to localize the sounds of prey or predators (Muscle Attachment Box 20.2).

**Action**

The theoretical action of the auriculares muscles is to wiggle the ears. In a study of 442 university students, approximately 20% exhibited the ability to move either ear, and slightly less than 20% could move both ears simultaneously [13]. Evaluation of the auriculares muscles is not clinically relevant.

**Muscle Attachment Box 20.2**

**Attachments and Innervation of the Auriculares**

**Bony/fascial attachment:**
- Anterior: Temporal fascia and epicranial aponeurosis
- Superior: Epicranial aponeurosis and temporal fascia
- Posterior: Surface of the mastoid process of the temporal bone

**Soft tissue attachment:**
- Anterior: Cartilage of the ear
- Superior: Cartilage of the ear
- Posterior: Cartilage of the ear

**Innervation:** Posterior auricular and temporal branches of facial nerve (7th cranial nerve)
Facial Muscles Surrounding the Eyes

The facial muscles affecting the eyes are the orbicularis oculi, levator palpebrae superioris, and corrugator (Fig. 20.5). Contraction of these three muscles manifests a variety of emotions such as anger, confusion, and worry. In addition, the orbicularis oculi plays a critical role in maintaining the health of the eye.

**ORBICULARIS OCULI**

The orbicularis oculi is a complex muscle that is arranged circumferentially around the eye and is attached to the medial and lateral borders of the orbit (Muscle Attachment Box 20.3). Its fibers vary in size and length and are primarily type II fibers with rapid contraction velocities [18,24].

**Action**

The reported actions of the orbicularis oculi are to

- Close the eye
- Draw the eyebrow medially

The orbicularis oculi is one of the most important muscles of facial expression [17]. By closing the eye in spontaneous blinks, the orbicularis oculi lubricates the eye, spreading the tears excreted by the lacrimal gland. **Spontaneous blinks** occur at a rate of approximately 12 or 13 blinks per minute (up to 750 blinks per hour) [18,22]. **Reflex blinks** are critical to protecting the eye from foreign objects. The muscle’s high density of type II muscle fibers is consistent with the need to perform rapid, fleeting contractions. In contrast, the orbicularis oculi, like other muscles of facial expression, is unable to tolerate sustained contractions of several seconds duration without fatigue [6,18].

The medial and superior muscle fibers of the orbicularis oculi assist in drawing the eyebrows medially, and the muscle is active during the expression of emotions such as anger and contentment [19,43,44]. The wrinkles formed by the contraction of the orbicularis oculi lie perpendicular to the muscle’s fibers and radiate from the corners of the eye in the characteristic “crow’s feet” pattern [44].

**Weakness**

Weakness of the orbicularis oculi results in the inability to close the eye (Fig. 20.6). A patient with weakness of the orbicularis oculi often exhibits a perpetual look of surprise because the affected eye is maintained in a wide-open position.
CLINICAL RELEVANCE: WEAKNESS OF THE ORBICULARIS OCULI
Weakness of the orbicularis oculi is the most serious consequence of facial weakness because it impairs the lubricating mechanism of the eye. If the eye is unable to close at regular and frequent intervals to spread tears over the surface of the eye, the cornea dries, which can lead to ulceration and impaired vision [17]. In addition, foreign objects may enter the eye without the protection of the reflex blink. Consequently, the patient with facial weakness must obtain immediate consultation with an ophthalmology specialist who can prescribe the appropriate intervention to maintain the necessary lubrication and protection of the eye. The patient may wear a protective eye patch to prevent drying of or trauma to the eye.

LEVATOR PALPEBRAE SUPERIORIS
The levator palpebrae superioris is technically an extrinsic muscle of the eye and, unlike the muscles of facial expression, is innervated by the third cranial nerve, the oculomotor nerve (Muscle Attachment Box 20.4). It is discussed here because the levator palpebrae superioris is the antagonist to the orbicularis oculi.

Action
The reported action of the levator palpebrae superioris is to elevate the upper eyelid. It is because the levator palpebrae is not innervated by the facial nerve that a patient with a facial nerve palsy affecting the orbicularis oculi maintains a wide-eyed expression. In the patient with facial weakness, the levator palpebrae pulls without the normal balance of its antagonist, the orbicularis oculi, and the eye remains wide open. In a healthy awake individual, the levator palpebrae superioris maintains a low level of activity to keep the eye open, but activity decreases as the orbicularis oculi closes the eye. Increased activity occurs when the eye opens wide in a look of surprise or excitement [44].

Weakness
Weakness of the levator palpebrae superioris leads to drooping of the upper eyelid, known as ptosis. Ptosis interferes with vision, since the eyelid droops over the eye, obscuring the view. Surgical intervention can be useful in mechanically lifting the eyelid to improve vision.

CORRUGATOR
The corrugator lies deep to the frontalis (Muscle Attachment Box 20.5). Unlike the orbicularis oculi, it is composed of...
approximately equal proportions of type I and type II muscle fibers and, consequently, is more fatigue resistant [18].

Action

The reported action of the corrugator is to pull the eyebrows medially and down. The corrugator contracts with the orbicularis oculi to pull the eyebrows down (Fig. 20.7). It is active when an individual squints to protect the eyes from bright lights. Its activity also is a characteristic part of a frown and is associated with emotions such as anger and confusion [15,19,43,44]. Contraction of the corrugator produces vertical creases at the superior aspect of the nose.

Weakness

There is no known functional deficit associated with weakness of the corrugator muscle, but weakness leads to flattening of the skin at the medial aspect of the eyebrow.

Muscles of the Nose

There are four primary facial muscles of the nose: the procerus, the nasalis with its transverse and alar portions, the dilator naris, and the depressor septi [9,10,12] (Fig. 20.8). The procerus appears to function primarily in facial expressions [9,10]. The other muscles of this group also move or stabilize the nose and are active during respiration [9,10,12]. The functional importance of these muscles is not well studied and, consequently, the functional significance of weakness in these muscles is unknown, although weakness does contribute to facial asymmetry. Only the actions of these muscles are discussed below.

PROCERUS

The procerus lies close to the orbicularis oculi and the corrugator (Muscle Attachment Box 20.6).

**Muscle Attachment Box 20.6**

<table>
<thead>
<tr>
<th>ATTACHMENTS AND INNERVATION OF THE PROCERUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bony attachment: Fascia covering the lower parts of the nasal bone and upper part of the lateral nasal cartilage</td>
</tr>
<tr>
<td>Soft tissue attachment: Skin over the lower part of the forehead and between the eyebrows</td>
</tr>
<tr>
<td>Innervation: Superior buccal branches of facial nerve (7th cranial nerve)</td>
</tr>
</tbody>
</table>
Action

The reported actions of the procerus are to
- Pull the nose cranially, creating horizontal wrinkles across the bridge of the nose
- Pull the eyebrows inferiorly

Contraction of the procerus contributes to the characteristic look of distaste, as an individual wrinkles the nose at an unpleasant smell, flavor, or idea [2,44] (Fig. 20.9). The muscle participates with the orbicularis oculi and corrugator in a frown [43,44].

NASALIS

The nasalis consists of two components, the transverse and alar segments [9,10,12,34] (Muscle Attachment Box 20.7).

Actions

The reported actions of the transverse segment of the nasalis are to
- Compress the lateral wall of the nose
- Stabilize the lateral wall of the nose

EMG data support the role of the transverse portion of the nasalis muscle in compressing or flattening the nose [12]. Such movement is associated with a look of haughtiness. The movement also is important functionally in closing off the nasal airway during speech when making vocal sounds such as “b” and “p.”

Studies report activity in the transverse portion of the nasalis during inspiration [9,10]. These studies suggest that this activity stiffens the outer walls of the nose to prevent collapse as the pressure within the nose decreases during inspiration. Additional studies are needed to verify or refute this explanation.

The reported actions of the alar portion of the nasalis are to
- Dilate, or flare, the nostrils
- Draw the nostrils down and posteriorly

Flaring the nostrils elicits EMG activity in the alar portion of the nasalis [12]. Although the ability to flare the nostrils seems unimportant to most humans, studies demonstrate activity in this muscle during inspiration, particularly during increased respiration following exercise [9,10,12,42]. The activity of the alar portion of the nasalis appears to stabilize the nostrils during inspiration while the pressure within the nose is low, tending to collapse the nostrils.

DILATOR NARIS

The dilator naris is described by some as a part of the nasalis [44] but is described separately in this text because recent studies analyze and describe it separately [9,10,12] (Muscle Attachment Box 20.8).

Actions

Like the alar portion of the nasalis, the reported action of dilator naris is to dilate the nostrils. The dilator naris appears to function with the alar portion of the nasalis to maintain the shape of the nose during inspiration [9,10,12].
DEPRESSOR SEPTI

The depressor septi is a small muscle lying at the base of the nose (Muscle Attachment Box 20.9).

Action

The reported action of the depressor septi is to

- Pull the nose down
- Elevate the upper lip

EMG activity is reported in the depressor septi when subjects attempt to flatten the nose or to “look down the nose” in a snobbish manner [9,12]. The muscle also is active during inspiration with the other muscles of the nose, presumably to stabilize the nose.

Muscles of the Mouth

The muscles of the mouth serve several purposes:

- Control the aperture of the mouth
- Stabilize the oral chamber and alter its volume
- Change the position of the mouth and surrounding skin to produce varied verbal sounds and convey a wide spectrum of emotions from elation to abject sorrow

The muscles that attach to the lips and act as constrictors of the mouth consist of the orbicularis oris and the mentalis (Fig. 20.10). The dilators of the mouth are the zygomaticus, risorius, levator labii superioris, levator labii superioris alaeque nasi, levator anguli oris, depressor labii inferioris, depressor anguli oris, and platysma (Fig. 20.11). Control of the oral aperture maintains food and liquid within the oral cavity. The size and shape of the mouth also are critical in speech, contributing to the variety of vowel and consonant sounds in oral speech [2,26]. The volume regulators are the buccinator muscles.

Although each muscle applies a unique pull on the lips or cheeks, studies consistently demonstrate that muscles of the mouth participate together during eating and speech [2,4,11,26,46]. It is virtually impossible to activate these muscles individually through voluntary contraction and almost as difficult to isolate them with electrical stimulation [4]. Consequently, evaluation requires the assessment of the coordinated movements of the mouth in activities such as smiling, eating, and speaking. Weakness is most apparent in the asymmetrical and sometimes grotesque facial movements that result from a loss of balance among these muscles. With weakness of the muscles of the mouth on one side of the face, the unaffected muscles pull the mouth toward the intact side, since there is no counteracting force from the opposite side. It is important for the clinician to recognize that this imbalance produces a mouth...
that looks smooth and “normal” on the weakened side but contracted and contorted on the unaffected side. Care is needed to correctly distinguish the weak from the unaffected side.

CLINICAL RELEVANCE: BELL’S PALSY
Acute idiopathic facial nerve palsy is known as Bell’s palsy and is characterized by weakness of the muscles innervated by the facial nerve (7th cranial nerve) (Fig. 20.12). It typically is unilateral and usually temporary, although the time course of recovery varies from days to years [8,32]. Exercise and biofeedback have been shown to enhance recovery in patients with facial nerve palsies [7,8]. Clinicians must be able to evaluate the integrity of the muscles of facial expression to establish goals, implement treatment, and monitor progress. It is essential that clinicians be able to identify weakness even when unable to apply a specific muscle assessment to each individual muscle.

ORBICULARIS ORIS

The orbicularis oris is one of the most important muscles of facial expression because it is the primary constrictor muscle of the mouth (Muscle Attachment Box 20.10). Although it usually is described as a single muscle [34], its superior and inferior portions found in the upper and lower lips, respectively, can function independently [2,37,44,47].

Actions
The reported action of the orbicularis oris is lip closure. The orbicularis oris is the sphincter for the mouth and is active whenever mouth closure is needed. It is active in chewing, to retain the food within the mouth [38,39,46]. It
is used to help slide food from a utensil such as a fork or spoon, and it is essential during sucking through a straw or blowing on a clarinet [29,30,34,44]. It participates in speech to make sounds such as “p” and “b” and assists in the expression of love or friendship, since it is the muscle used to kiss [35,46].

The orbicularis oris has a relatively large cross-sectional area and, consequently, is capable of forceful contractions. Studies report compression forces between the two lips up to 2–4 N (approximately 0.5–1.0 lb) [16,38].

Weakness

Weakness of the orbicularis oris diminishes the ability to close the mouth firmly, producing oral incontinence. A patient with weakness of the orbicularis oris muscle reports a tendency to drool or an inability to hold liquid in the mouth. Attempts to whistle are futile, with the air leaking out through the weakened side of the mouth. The patient may also exhibit altered speech, with particular difficulty in pronouncing words that include the sounds of letters such as “p,” “b,” and “w.”

A patient with weakness of the orbicularis oris exhibits flattening of the lips on the affected side. When the muscle contracts, the lips are pulled toward the unaffected side, producing a distorted posture of the mouth, particularly pronounced on the sound side (Fig. 20.13).

MENTALIS

Although the mentalis has no direct connection to the lips, it is the only other muscle that can assist the orbicularis oris in closing the mouth (Muscle Attachment Box 20.11).

### MUSCLE ATTACHMENT BOX 20.11

**ATTACHMENTS AND INNERRVATION OF THE MENTALIS**

- **Bony attachment:** Incisive fossa of the mandible
- **Soft tissue attachment:** Skin of the chin
- **Innervation:** Mandibular branch of facial nerve (7th cranial nerve)

**Actions**

The reported actions of the mentalis are to

- Raise and protrude the lower lip
- Raise and wrinkle the skin of the chin

The mentalis helps the orbicularis oris in sucking actions by pulling the lower lip up and forward, and the muscle is active in such actions as sucking on or blowing through a straw [1,2,37,40,44]. Protrusion of the lower lip also is characteristic of a pouting expression (Fig. 20.14).

**Weakness**

Weakness of the mentalis limits the ability to protrude the lower lip. The weakness contributes to the asymmetrical posture of the mouth during sucking actions, with the lower lip on the affected side appearing flat while the lip on the unaffected side appears distorted as it protrudes alone.
The zygomaticus is one of the muscles that dilate the orifice of the mouth, although its primary functional significance is to express emotion (Muscle Attachment Box 20.12).

**Actions**

The reported action of the zygomaticus is to pull the angles of the mouth superiorly and laterally. The zygomaticus is the smile muscle, contributing to the characteristic broad full smile that brings the corners of the mouth toward the eyes [2,28,36] (Fig. 20.15). It is important, however, to recognize that several muscles are active in this sort of smile. The zygomaticus does not contract alone [21].

**Weakness**

Weakness of the zygomaticus alters the form of an attempted smile. As the patient smiles, the unaffected muscle pulls the mouth vigorously toward the sound side, producing a rather grotesque image [21] (Fig. 20.16).

**CLINICAL RELEVANCE: PSYCHOLOGICAL CHALLENGES FOR A PATIENT WITH FACIAL PALSY**

Weakness of the facial muscles, particularly around the mouth, produces significant social challenges to the patient. Weakness of the orbicularis oris may make eating difficult and embarrassing, as the patient is unable to avoid leakage of the food or liquid from the mouth. In addition, facial expressions that are the natural manifestations of emotions such as joy or sorrow are no longer the familiar smiles or frowns but rather grotesque caricatures of such expressions. As a result, many patients are reluctant to leave the privacy of their own homes [41].

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The risorius is another dilator of the mouth and functions with the zygomaticus (Muscle Attachment Box 20.13).

**Actions**

The reported action of the risorius is to pull the angles of the mouth laterally. Although the risorius typically contracts with
the zygomaticus, when its activity is primary, the risorius produces a grimace that can convey feelings of disgust, dislike, frustration, or other emotions (Fig. 20.17).

Weakness

Weakness of the risorius, like the zygomaticus, results in a distorted smile with the mouth pulled toward the unaffected side.

LEVATOR LABII SUPERIORIS AND LEVATOR LABII SUPERIORIS ALAEQUE NASI

The two levator labii superioris muscles lie between the nose and the mouth, contributing to the characteristic furrow between the side of the nose and the corners of the mouth (Muscle Attachment Box 20.14).

Actions

The reported actions of both levator labii superioris muscles are to lift the upper lip off the teeth and to turn the lip outward. The action of the two levator labii superioris muscles produces the common look of disgust or revulsion and typically coincides with contraction of the procerus [10]. These muscles also contribute to retraction of the lips during a large smile [2,36]. The levator labii superioris alaeque nasi also contributes to the dilation of the nostrils with the alar portion of the nasalis and the dilator naris [44].

Weakness

Weakness of the two levator labii superioris muscles contributes to a flattening of the lips in a smile. The patient also may report a tendency to bite the upper lip, particularly while eating. Weakness of these muscles tends to flatten the furrow between nose and mouth. Since this furrow deepens with age normally, weakness of the levator labii superioris muscles tends to make an older individual appear younger.

LEVATOR ANGULI ORIS (ALSO KNOWN AS CANINUS)

The levator anguli oris also contributes to the furrow between the nose and upper lip (Muscle Attachment Box 20.15).

Actions

The reported action of the levator anguli oris is to lift the lateral aspect of the upper lip off the teeth. By lifting the lateral aspect of the lip, the levator anguli oris exposes the canine tooth, which gives the muscle its other name, caninus. Although many individuals are unable to isolate this muscle, its action is associated with a sneering expression (Fig. 20.18). Like the other dilator muscles, the levator anguli oris participates in a broad smile [36].
Weakness

Weakness of the levator anguli oris contributes to a distorted smile.

DEPRESSOR LABII INFERIORIS

Depressor labii inferioris is a dilator of the mouth, affecting the lower lip (Muscle Attachment Box 20.16).

Actions

The reported action of the depressor labii inferioris is to lower the lower lip and turn it outward, thereby exposing the lower teeth. The action of the depressor labii inferioris is generally associated with the emotions of sadness or anger manifested by a frown. However, the muscle also appears to be active in large smiles in which the lips are pulled back from both rows of teeth [33,36].

Weakness

Like all of the muscles that attach to the lips described so far, weakness of the depressor labii inferioris contributes to distortions of the mouth when the patient frowns or smiles, and the mouth is pulled toward the stronger side.

DEPRESSOR ANGULI ORIS

The last of the primary depressors of the lips, the depressor anguli oris, is active with the depressor labii inferioris (Muscle Attachment Box 20.17).

Actions

The reported action of the depressor anguli oris is to pull the angles of the mouth down and laterally. The action of the depressor anguli oris is associated with the emotion of sadness, since contraction contributes to the classic frown (Fig. 20.19).
Weakness

Weakness of the depressor anguli oris contributes, with the other muscles of the mouth, to the distortions of the mouth as it is pulled toward the unaffected side. Loss of the depressor anguli oris is particularly apparent when a patient, depressed or saddened by the effects of the facial weakness, begins to cry. The mouth is pulled down and laterally by the unaffected depressor anguli oris, causing the whole mouth to deviate toward the strong side (Fig. 20.20).

PLATYSMA

The platysma is a broad, thin sheet of muscle extending from the mouth to the upper thoracic region (Muscle Attachment Box 20.18). It is superficial, lying just below the skin in the cervical region.

Actions

The actions of the platysma are not well studied. The reported actions are to

- Pull the corners of the mouth and the lower lip down in a frown
- Assist in inspiration
- Support the skin of the cervical region

The attachments of the platysma are consistent with the actions listed above [2,44]. Contraction of the platysma often contributes to a look of horror (Fig. 20.21). Observation of an individual in respiratory distress typically reveals contraction of the platysma during inspiration, but the significance of such a contraction is unknown.

Weakness

The significance of platysma weakness is unknown.
The buccinator is the muscle of the cheek, with only an indirect attachment to the lips by way of the orbicularis oris (Muscle Attachment Box 20.19).

**Actions**

The reported action of the buccinator is to compress the cheeks. The buccinator muscle is an essential muscle in chewing. By compressing the cheeks, the buccinator keeps the bolus of food from getting caught in the buccal space, the space between the mandible and the cheek. The buccinator also controls the volume of the oral cavity and thereby controls the pressure within the cavity. This role is particularly important to musicians who play brass or woodwind instruments but is used by anyone who has blown out the candles on a birthday cake. The buccinator stiffens the cheeks so that the air can be expelled under pressure while contraction of the orbicularis oris muscles directs the air stream toward the target [30].

**Weakness**

Weakness of the buccinator produces several serious difficulties in chewing. Weakness of the muscle allows the food to become sequestered in the buccal space, so the patient cannot grind the food effectively between the teeth. Prolonged sequestering also can lead to skin breakdown and tooth decay. In addition, with little control of the cheek, a patient is prone to biting the inner wall of the cheek while chewing. Weakness of the buccinator also produces difficulty in blowing air out forcefully through pursed lips, so a patient has difficulty playing a brass or wind instrument.

**MUSCLES THAT MOVE THE EYES**

There are seven extrinsic muscles of the eye, including the levator palpebrae superioris, which is discussed earlier in this chapter. The remaining six muscles are responsible for moving the eye within the orbit and include the superior, inferior, medial, and lateral rectus muscles and the superior and inferior oblique muscles (Fig. 20.22). Evaluation and treatment of

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**ATTACHMENTS AND INNERVATION OF THE BUCCINATOR**

- **Bony attachment:** Outer surface of alveolar process of maxilla and mandible opposite the sockets of the molar teeth and the anterior border of the pterygomandibular raphe posteriorly
- **Soft tissue attachment:** The orbicularis oris and the lips and submucosa of the mouth
- **Innervation:** Lower buccal branches of facial nerve (7th cranial nerve)

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these muscles are the primary responsibility of ophthalmologists and neurologists. Rehabilitation specialists participate in the conservative management of patients with impairments of these muscles and require an understanding of the basic mechanisms that produce normal eye movements described in this text.

To understand the movements produced by these muscles, it is necessary to appreciate the axes of motion that form the reference frame for eye movement (Fig. 20.23). Movements of the eye are described with respect to the axes through the eye itself. **Elevation** and **depression** occur about the medial lateral axis; **medial** and **lateral rotation**, also known as **adduction** and **abduction**, occur about a vertical axis; and **intorsion** and **extorsion** occur about the anterior–posterior axis. Intorsion is defined as the motion that rotates the superior surface of the eye medially toward the nose. Extorsion is motion of the same point laterally toward the ear.

The orbit of the eye projects anteriorly and laterally within the skull, but the anterior–posterior axis of each eye lies in the sagittal plane during normal forward vision (Fig. 20.24). The differences between the axes of the eye and the axes of the orbit contribute to the complexity of the motions produced by the extrinsic muscles of the eye. Additionally, the extrinsic muscles cannot be observed or assessed by palpation; EMG analysis also is rarely possible. Consequently, these muscles are not well studied. The following provides a basic description of the current understanding of the muscles that move the eye. Effects of weakness are discussed following the descriptions of all the muscles.

**MEDIAL AND LATERAL RECTUS MUSCLES**

Both the medial and lateral rectus muscles lie close to the transverse plane when vision is focused on the horizon, so their activity produces movement about a vertical axis through the eye [44] (Muscle Attachment Box 20.20).

**Actions**

The reported action of the medial rectus is to rotate the eye medially, or adduct it. The reported action of the lateral
rectus is to rotate the eye laterally, or abduct it. The two muscles work together to turn the gaze to the right or left [25,44]. As the head faces anteriorly, gaze to the left requires contraction of the left lateral rectus and the right medial rectus (Fig. 20.25).

SUPERIOR AND INFERIOR RECTUS MUSCLES

The actions of the superior and inferior rectus muscles are more complex than those of the medial and lateral recti because the superior and inferior recti are more or less aligned along the walls of the orbit and, therefore, pull obliquely with respect to the axes of the eye (Muscle Attachment Box 20.21).

Actions

The reported actions of the superior rectus are

- Elevation
- Medial rotation
- Intorsion

The superior rectus clearly contributes to elevation of the orbit of the eye, but its contribution to the other motions is less obvious. Careful observation of the attachment of the superior rectus reveals that it lies medial to the anterior–posterior and vertical axes, which explains the muscle’s contributions to medial rotation and intorsion, respectively [25,44] (Fig. 20.26).

The reported actions of the inferior rectus are

- Depression
- Medial rotation
- Extorsion

The attachment of the inferior rectus muscle on the inferior surface of the eye explains its role as a depressor of the eye. It passes medial to the vertical axis to participate in medial rotation and attaches lateral to the anterior–posterior axis to contribute to extorsion [25,44] (Fig. 20.25).

SUPERIOR OBLIQUE

The superior oblique muscle travels a circuitous route to the eye, wrapping around a pulley-like structure and traveling posteriorly and laterally to attach posterior to the medial-lateral and vertical axes and lateral to the anterior-posterior axis [25,44,45] (Muscle Attachment Box 20.22) (Fig. 20.22).
The reported actions of the superior oblique muscle are

- Depression
- Lateral rotation
- Intorsion

The inferior oblique muscle travels posteriorly and laterally to its attachment posterior and lateral to the axes of the eye [25,44,45] (Muscle Attachment Box 20.23).

### Actions

The reported actions of the inferior oblique muscle are

- Elevation
- Lateral rotation
- Extorsion

### Weakness of the Muscles that Move the Eye

Movements of the eyes appear to be the result of a complex and rhythmic coordination of the muscles of the eye. The eye is moving continuously in individuals with normal motor control of the eyes, and it is likely that all of the muscles of the eyes contract together, producing a steady gaze even when the body or the target moves in space. An imbalance among the extrinsic muscles of the eye produces strabismus, the inability to direct the gaze of both eyes toward an object [45]. Strabismus in adults may produce double vision, or diplopia, although young children are often able to accommodate by ignoring the input from the misaligned eye. Weakness of either medial or lateral rectus may impair the ability to scan from side to side, creating difficulties in such activities as reading. For example, a lesion of the abducens (sixth cranial nerve) produces weakness of the lateral rectus muscle. The antagonistic medial rectus pulls the eye into medial rotation, producing a “crossed eye.” Peripheral vision also is challenged if the lateral rectus is impaired, although compensations by head movements may be available.

Weakness of the superior oblique deserves special note, since it alone is innervated by the trochlear nerve (fourth cranial nerve). Although both the inferior rectus and superior oblique muscles depress the eye, only the superior oblique can depress the eye when the eye is medially rotated. An
individual with weakness of the superior oblique muscle has difficulty looking down and in, a requirement of many activities of daily living such as descending stairs or examining the keyboard of a computer [45].

**CLINICAL RELEVANCE: TROCHLEAR NERVE INJURY**

A patient may be seen for complaints of frequent tripping when descending stairs. Such complaints commonly result from weakness in the lower extremities. However, visual disturbances specifically associated with weakness of the superior oblique muscle of the eye also may produce complaints of difficulty descending stairs. Trochlear nerve lesions may need to be considered in the absence of direct associations between impairments in the lower extremities and the functional complaints.

**SUMMARY**

This chapter presents the function of the muscles of facial expression and the muscles that move the eye. The muscles of facial expression are organized around the orifices of the head, ears, eyes, nose, and mouth. The muscles surrounding the eyes and mouth play a vital role in opening and closing their respective orifices. The muscles of utmost importance are the orbicularis oculi, which closes the eye, protecting it from foreign matter and helping to lubricate it, and the orbicularis oris, which closes the mouth, essential for normal chewing and speech. The muscles surrounding the nose help control the size of the nasal opening and passages during respiration and speech.

Weakness in the muscles of facial expression poses a significant threat to the eye and produces impairments in chewing and speech. In addition, weakness of the muscles of facial expression alters the normal facial responses and often results in asymmetrical and grotesque facial postures. In many cases the facial skin is pulled toward the strong muscles, producing smooth unwrinkled skin on the weakened side and excessively wrinkled and puckered skin on the strong side.

The extrinsic muscles of the eye work in concert to produce smooth, well-coordinated eye movements, allowing an individual to maintain a steady gaze even as the individual or target moves. Weakness in any of these muscles impairs the coordinated movements of both eyes and may lead to double vision or reduced vision in a specific field.

The muscles of the face and eyes work together in complex combinations to produce finely controlled facial expressions and discrete eye movements. Impairments of single muscles are uncommon, and isolated examination of individual muscles is unrealistic. Therefore, the physician needs to appreciate the types of disturbances in movement patterns that can occur with weakness of these muscles.

**References**


