innervation zone coincide. In the flexor carpi ulnaris and tibialis anterior muscles, fasciculi run deeply away from the surface toward the tendon so that the innervation zone is buried. In these muscles, as in the biceps brachii, precise correspondence between the motor points and innervation zones is lacking. In the peroneus longus and gastrocnemius muscles, the motor nerve runs parallel to the long axis of the muscle; the innervation zone is also aligned in that direction and does not underlie the motor point.

In summary, the motor point is a physiological concept, not an anatomically defined location. In any given muscle, the motor point may or may not overlie the innervation zone. The latter is the preferred site for injection of botulinum toxin; the former, although relatively easy to locate, does not serve as a marker or locator for the innervation zone in all muscles.

11. Orbicularis Oculi Motor Points, Motor Innervation, and Botulinum Toxin

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A motor point is defined as an area on the skin over a particular muscle for which the threshold to electric stimulation is minimal. This area is often interpreted as the entry point of a motor nerve into a muscle, or a point at which a motor branch lies closest to the skin. Because the orbicularis oculi muscle is flat and is located just under the skin, percutaneous electric stimulation defining the motor point probably indicates the entry site of branches of the facial nerve. The motor points of the orbicularis oculi were found in inconsistent locations in 12 eyelids in 6 subjects. An upper eyelid motor point was found in the extreme lateral extent of the upper lid fold, and the lower lid demonstrated a motor point medially just inferior to the anterior lacrimal crest. These findings suggest that the orbicularis oculi receives innervation superior-laterally from the temporalis branches of the facial nerve and inferior-medially from zygomatic and buccal branches. This interpretation correlates well with careful facial nerve dissections reported previously by Fujita in 1954. These findings are also consistent with observed orbicularis oculi function after reconstructive oculic plastic surgery.

After repeated injections of botulinum toxin, motor points can no longer be detected because of myoneural blockade. If the motor points represent not only the motor nerve penetration site, but an area of concentrated myoneural junctions as well, these areas should be more botulinum toxin sensitive. Ten patients with essential blepharospasm/Meige’s syndrome received 50 to 100% of their usual botulinum dose to the upper lid motor point on one eye during an injection cycle. No patient felt that the motor point-directed botulinum toxin injection worked as well as the usual method of four to six injection sites.

An attempt was made to assess concentration of myoneural junctions of orbicularis oculi from small stripes of muscle tissue usually discarded after routine ptosis surgery. Lateral and medial sections of orbicularis muscle were stained for acetylcholinesterase to outline myoneural junctions. The myoneural junctions were quantitated relative to the surface area of the muscle stained. There were no significant differences between the medial and lateral portions of the upper preapical orbicularis (57/mm², medial; 50/mm², lateral).

The “innervation zone” (distribution of myoneural junctions) appears to be diffuse for the upper orbicularis oculi muscle. The myoneural junction concentration does not correspond to the motor point. The diffuse distribution of myoneural junctions over the upper orbicularis oculi explains the generally poor result to motor point-directed botulinum toxin in this muscle. Whether points of high myoneural junction concentration sensitive to botulinum toxin can be determined for other muscle groups awaits further study.

12. Electromyographic Changes Occurring with Botulinum Therapy

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The technique of single fiber electromyography (SF-EMG) is described and the terms “jitter” and “fiber density” defined. Reasons for the SF-EMG becoming abnormal with use of botulinum toxin are discussed.

At the present time, both blepharospasm and torticollis patients have been treated with botulinum toxin. Serial studies have been performed in patients who received multiple injections and the time course of the action of botulinum toxin followed. Additionally, serial studies over 10 months have been possible in one patient after a single treatment. Our own studies have shown that virtually all patients receiving botulinum toxin demonstrate spread of toxin to distant muscles. There can also be persistent abnormality for months in distant muscles after a single treatment. However, caution should be used in the long-term use of serial injections of botulinum toxin.

13. Spastic Torticollis and Neck Dystonia Associated with Meige’s Syndrome

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Torticollis is an involuntary, either jerky (spasmodic) or sustained contraction of neck muscles producing abnormal movement and posture of the head. The term torticollis refers to rotation of the head in a lateral direction with chin pointing consistently to one of the shoulders. Antecollis means neck flexion, and retrocollis refers to dystonic neck extension; laterocollis means that the head (ear) is pulled toward one shoulder. All these abnormal postures belong to a group of movement disorders called dystonia. Dystonia, an involuntary sustained contraction of muscles causing twisting, pulling, or squeezing, is presumably an expression of a neurotransmitter abnormality in the basal ganglia or other brain structures concerned with control of movement. Dystonia affecting only the neck muscles is classified as focal (cervical) and is the most common form of adult-onset dystonia. However, cervical dystonia is often associated with dystonia of other, usually adjacent, muscles. For example, torticollis may be accompanied by involuntary contractions of the shoulder, jaw, and facial muscles. The combination of blepharospasm, oromanubular dystonia, and torticollis is categorized as cranial-cervical dystonia (Meige’s syndrome). Dystonia is often associated with another movement disorder, namely familial essential tremor. Furthermore, the frequent familial occurrence of dystonia suggests that genetic factors play an important role in the pathogenesis of torticollis and other forms of dystonia.

The estimated prevalence of torticollis is 1 in every 10,000 people. Although cervical dystonia can begin at any age, the