often result in weakness of the longus colli muscles (Prushansky et al., 2005; Pearson et al., 2009), greater rates of cervical instability, a reversal of the cervical lordosis, vertigo (Liu et al., 2017), and a loss of muscular endurance (Kumbhare et al., 2005). The longus colli muscle appears to play a key role in stabilisation of the cervical spine (Kettler et al., 2002), posture, and maintaining the cervical lordosis (Mayoux-Benhamou et al., 1994), but the exact mechanisms are not well understood (Kennedy et al., 2017).

Fernández-Pérez and colleagues (2012) observed that individuals with acute whiplash-associated neck pain exhibited a higher prevalence of active TrPs in the levator scapulae and upper trapezius muscles and that the number of active TrPs increased with higher neck pain intensity and the number of days since the accident. Additionally it seems that active TrPs are more prevalent in whiplash-associated neck pain than in mechanical neck pain (Castaldo et al., 2014). The presence of TrPs in individuals with whiplash-associated neck pain can be related to the fact that these patients usually exhibit reduced cervical stability, muscle inhibition, and hyperirritability of the cervical muscles (Headley, 2005).

Finally, a few studies have demonstrated the effects of TrP inactivation in patients with whiplash-associated neck pain. Freeman and colleagues (2009) showed that infiltrations of 1% lidocaine into TrPs in the upper trapezius were effective in the short term for increasing cervical range of motion and pressure pain thresholds in individuals with chronic whiplash-associated pain. Carroll and colleagues (2008) reported that injections of botulinum toxin type A of cervical TrPs decreased pain in patients with chronic whiplash-related neck pain. A recent randomised clinical trial reported that DN and exercise was more effective than sham DN and exercise in reducing disability at 6 and 12 months in individuals with chronic whiplash-related neck pain, although its clinical relevance was questioned (Sterling et al., 2015).

DRY NEEDLING OF HEAD MUSCLES

Corrugator Supercilii Muscle

- *Anatomy:* The corrugator supercilii muscle arises from the medial end of the superciliary arch. Its fibres pass upward and lateral between the palpebral and orbital portions of the orbicularis oculi and are inserted into the deep surface of the skin, above the middle of the orbital arch.
- *Function:* The corrugator supercilii muscle draws the eyebrow downward and medially, furrowing the forehead.
- *Innervation:* Temporal branches of the facial nerve (VII par cranial).
- *Referred pain:* TrPs in the corrugator supercilii muscle refer pain into the forehead and deep into the head, inducing frontal headaches.
- *Needling technique:* The patient lies in supine position. The muscle is needled with a pincer palpation. The needle is inserted perpendicular to the skin from either the medial or the lateral aspect of the muscle, directed towards its midportion. The needle is inserted through the skin at a shallow angle, and advanced into the muscle belly (Fig. 7.1).
- *Precautions:* The eyebrows are well vascularised, and to avoid bleeding with needling, the needle should be placed close to the skull underneath the fleshy part of the eyebrows.

Procerus Muscle

- *Anatomy:* The procerus muscle arises from the fascia overlying the surface of the nasal bones and the superior parts of the upper lateral nasal cartilages and inserts into the skin of the inferior and medial forehead.
- *Function:* The procerus muscle wrinkles the skin of the bridge of the nose.
- *Innervation:* Buccal branches of the facial nerve (VII par cranial).
- *Referred pain:* TrP in the procerus muscle refer to the forehead and possibly deep into the head, inducing frontal headaches.
- *Needling technique:* The patient lies in supine position. The muscle is needled with a pincer palpation. The needle is inserted perpendicular to the skin from superior to inferior, coming from the forehead towards the nose, or from lateral to medial. The needle is inserted through the skin at a shallow angle and advanced into the muscle belly (Fig. 7.2).
- *Precautions:* None

FIG. 7.1 Dry needling of the corrugator supercilii muscle.

FIG. 7.2 Dry needling of the procerus muscle.

Masseter Muscle

- *Anatomy:* The masseter muscle extends from the inferior aspect of zygomatic process to the angle and lateral surface of the mandible (superficial layer); the midportion of the mandibular ramus (middle layer); and to the upper mandibular ramus and the coronoid process (deep layer).
- *Function:* The masseter muscle closes the mouth by elevating the mandible and can contribute to ipsilateral excursion of the mandible. The superficial layer also has a component of protrusion of the mandible, whereas the deep layer has a component of retraction.
- *Innervation:* Mandibular branch (V3) of the trigeminal nerve (V par cranial).
- *Referred pain:* The superficial layer refers pain to the eyebrow and retroorbital area, the maxilla, the anterior aspect of the mandible, and the upper or lower molar teeth. TrPs in the deep layer spread pain deep into the ear and to the temporomandibular joint area.
- *Needling technique:* The patient lies in supine position. The muscle is usually needled with a flat palpation, although it is also possible to treat the masseter muscle with an intraoral pincer palpation, whereby the palpating finger is placed inside the mouth against the buccal mucosa with two fingers on the external surface of the skin bracing the TrP. The needle is inserted perpendicular to the skin towards the TrP (Fig. 7.3).
- *Precautions:* None

Temporalis Muscle

- *Anatomy:* The temporalis muscle extends from the temporal fossa (except that portion of it which is formed by the zygomatic bone) to the anterior border of the mandibular coronoid process and to the anterior border of the ramus of the mandible.
- *Function:* The temporalis muscle closes the mouth by elevating the mandible. The temporalis muscle also helps lateral deviation of the mandible to the same side and is instrumental in the details of mouth closing.
- *Innervation:* Mandibular branch (V3) of the trigeminal nerve (V par cranial).
- *Referred pain:* TrPs in the temporalis muscle refer deep in the temporoparietal region and inside the head, contributing to temporal headache and maxillary toothache.
- *Needling technique:* The patient is in supine position. The muscle is needled with a flat palpation. The needle is fixed with the index and middle fingers of the nonneedling hand and then inserted perpendicular to the skin towards the TrP (Fig. 7.4).
- *Precautions:* The superficial temporal artery should be identified and avoided.

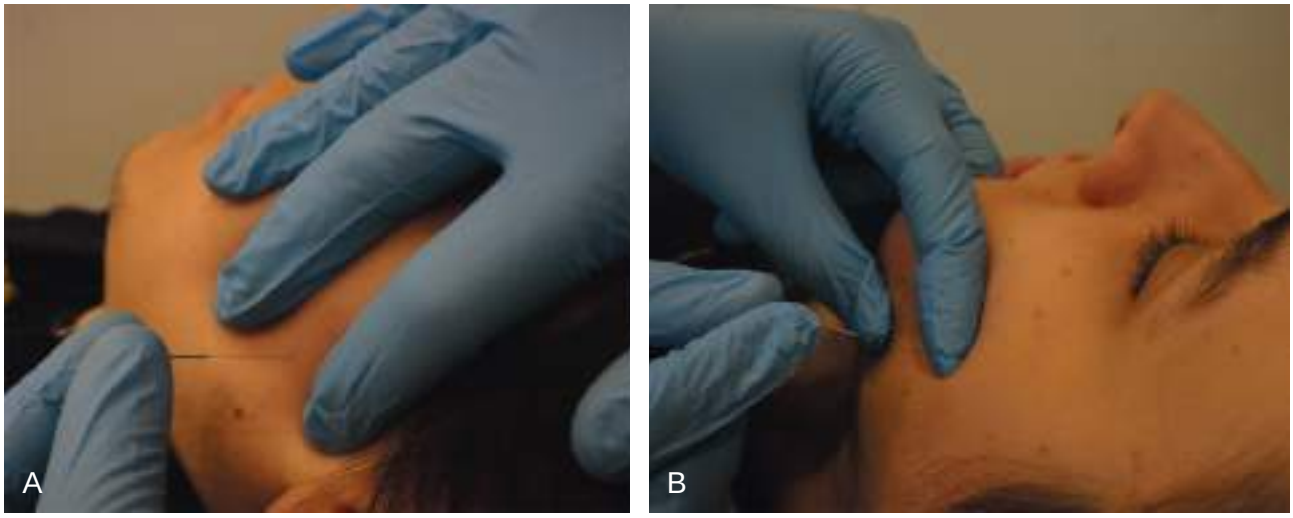

FIG. 7.3 Dry needling of the masseter muscle.

FIG. 7.4 Dry needling of the temporalis muscle.

Zygomatic Muscle

- *Anatomy:* The zygomatic major and minor muscles extend from the zygomatic bone and insert into the muscles of the mouth, including the orbicularis oris, the levator, and the depressor anguli oris.
- *Function:* The zygomatic muscles elevate the angle of the mouth as in smiling.
- *Innervation:* Facial nerve (VII par cranial).
- *Referred pain:* TrPs in the zygomatic muscles refer to the nose and forehead, and pain is perceived in an arc close to the side of the nose up to the forehead.
- *Needling technique:* The patient is in supine position. The zygomatic muscle can be needled with flat palpation or with an intraoral pincer palpation. The needle is inserted perpendicular to the skin towards the zygomatic bone using flat palpation. It is also possible to treat the zygomatic muscles with an intraoral pincer palpation, whereby the palpating finger is placed inside the mouth against the buccal mucosa with two fingers on the external surface of the skin bracing the TrP (Fig. 7.5).
- *Precautions:* None

Buccinator and Risorius Muscles

- *Anatomy:* The buccinator muscle forms the lateral wall of the oral cavity and attaches laterally to a pterygomandibular raphe, a tendinous inscription connecting the buccinator muscle with the more posterior superior pharyngeal constrictor muscle. Some fibres may attach to the maxilla and the mandible. The risorius muscle attaches to the parotid fascia over the fascia. Kim and colleagues (2015) identified three distinct variations of the risorius muscle, including the zygomaticus risorius, platysma risorius, and triangularis risorius muscles; the platysma risorius muscle was the most common variation. Anteriorly the buccinator and risorius muscles merge into the fibres of the orbicularis oris muscle. According to Kim and colleagues (2015), the risorius muscle attaches closely to the depressor anguli oris muscle in three distinct layers.
- *Function:* The buccinator muscle is one of the first muscles a baby can more or less control as the muscle is responsible for the sucking reflex. The risorius muscle is primarily a muscle of facial expression, especially smiling. Both muscles are involved in speech, vocalisations, chewing, whistling, and playing a wind instrument. For wind instrumentalists, these muscles are of prime importance and considered to be part of what is referred to as the embouchure, or the coordinated control of the facial muscles required to play the instrument.
- *Innervation:* Buccal branch of facial nerve (N. VII).

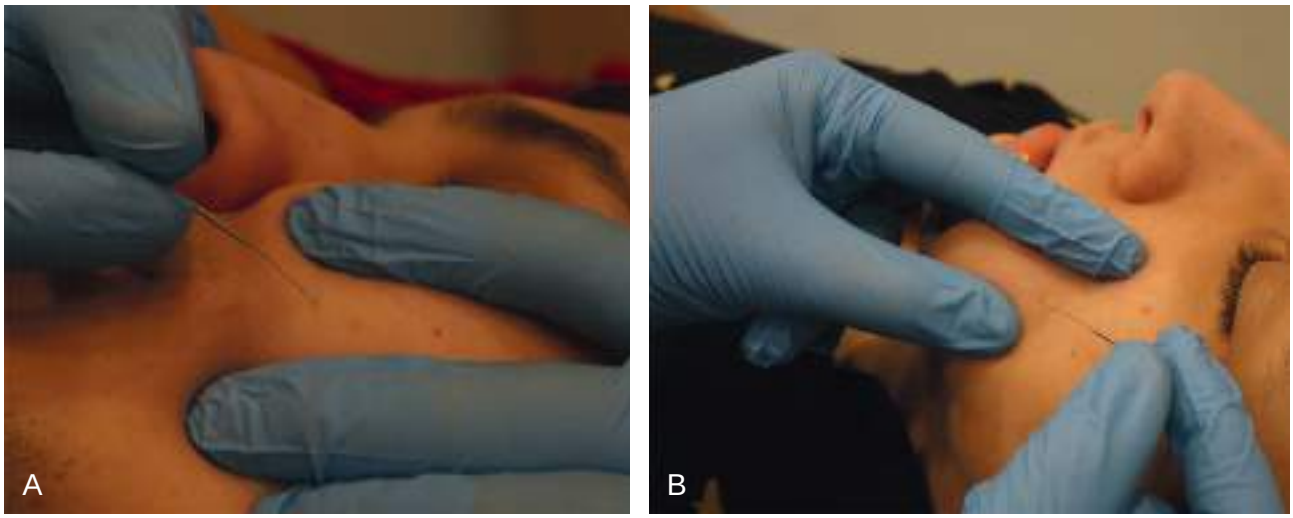

FIG. 7.5 Dry needling of the zygomatic muscle.

- *Referred pain:* TrPs in the buccinator muscle refer pain deep to the cheek experienced as an aching sensation underneath the zygomatic arch. The referred pain pattern of TrPs in the risorius muscle has not been described.
- *Needling technique:* The patient is in supine position. The buccinator and risorius muscle can be needled with flat palpation or with an intraoral pincer palpation. The needle is inserted perpendicular to the skin using flat palpation (Fig. 7.6). It is also possible to treat the muscles with an intraoral pincer palpation, whereby the palpating finger is placed inside the mouth against the buccal mucosa with two fingers on the external surface of the skin bracing the TrP similarly to the zygomaticus approach.
- *Precautions:* None

Superior Pharyngeal Constrictor Muscle

- *Anatomy:* The superior pharyngeal constrictor muscle originates anteriorly from the pterygoid hamulus, with occasional attachments to the posterior margin of the medial pterygoid plate, the pterygomandibular raphe, the mylohyoid line of the mandible, and the side of the tongue and it attaches to the pharyngeal tubercle of basilar part of the occiput. The posterior and lateral walls of the oropharynx are enclosed by the superior pharyngeal constrictor muscle.
- *Function:* The superior pharyngeal constrictor muscle constricts the upper part of the pharynx and assists in moving a bolus of food into the oesophagus, but it can also exert force on the mandible via its connections to the buccinator muscle.
- *Innervation:* The cranial part of the accessory nerve from the pharyngeal plexus.
- *Referred pain:* Rocabado (1983) described a 'buccinator aponeurosis pharyngeal syndrome' characterised by retrusion of the mandible and posterior cranial rotation, with three primary areas of pain, including ipsilateral posterior condylar pain, suboccipital pain, and pain in the buccinator pharyngeal aponeurosis pain. Ernest (2006) reported pain at the superior lateral pharynx, pain at the medial edge of the temporomandibular joint, ear aches, temporal pain, soreness and pain on swallowing, and dyscoordination of the swallowing reflex. Referred pain patterns of TrPs in the superior pharyngeal constrictor muscle have not yet been described.
- *Needling technique:* The superior pharyngeal constrictor muscle can be needled immediately posterior to the pterygomandibular raphe and the buccinator muscle underneath the anterior aspect of the superficial masseter muscle (Fig. 7.7).
- *Precautions:* None

Medial Pterygoid Muscle

- *Anatomy:* The medial pterygoid muscle originates on the medial surface of the lateral pterygoid plate of the sphenoid bone, the maxillary tuberosity, and the pyramidal process of the palatine bone and inserts into the lower back part of the medial surface of the ramus and angle of the mandible.
- *Function:* The medial pterygoid muscle closes the mouth by elevating the mandible. It has a component of retraction of the mandible.
- *Innervation:* Medial pterygoid nerve, via the mandibular branch (V3) of the trigeminal nerve (V par cranial).
- *Referred pain:* TrPs in the medial pterygoid muscle refer to poorly circumscribed areas in the mouth, including the tongue, hard palate, and pharynx, but also deep into the ear and the throat.

FIG. 7.6 Dry needling of the buccinator and risorius muscles.

FIG. 7.7 Dry needling of the superior pharyngeal constrictor muscle.

- *Needling technique:* The patient is in supine position. The muscle can be needled in its superior–medial or inferior–lateral part. The superior–medial part of the muscle is needled through the mandibular fossa, similar to needling the inferior lateral pterygoid muscle (Fig. 7.8). With a flat palpation, the needle is fixed between the index and middle fingers of the nonneedling hand and inserted through the skin at a shallow angle towards the medial surface of the ramus and angle of the mandible (Fig. 7.9). This approach is similar to needling TrPs in the supraspinatus and the iliacus muscles.
- *Precautions:* Avoid needling the lingual nerve with the superior–medial approach and the alveolar nerve with the inferior–lateral approach.

Lateral Pterygoid Muscle

- *Anatomy:* The superior lateral pterygoid muscle arises from the infratemporal surface of the greater wing of the sphenoid bone, and the inferior lateral pterygoid muscle arises from the lateral surface of the lateral pterygoid plate. The inferior head attaches to the neck of the mandible. Two types of attachments have been identified for the superior head (Omami & Lurie, 2012). With the Type 1 insertion, the superior head attaches only to the intraarticular disc, whereas with the Type 2 insertion, it attaches to the disc and condyle (Omami & Lurie, 2012). The lateral pterygoid muscle also attaches to the intraarticular cartilage of the temporomandibular joint.
- *Function:* The superior division of the lateral pterygoid muscle may play a role in the positioning of the intraarticular disc. Both heads contribute to protrusion and contralateral deviation of the mandible. The inferior head may initiate mouth opening even before the digastric muscles are activated (Moyers, 1950).
- *Innervation:* Lateral pterygoid nerve, via the mandibular branch (V3) of the trigeminal nerve (V par cranial).
- *Referred pain:* TrPs in the lateral pterygoid muscle project to the maxilla and the temporomandibular joint.
- *Needling technique:* The patient is in supine position. For the superior division, the needle is inserted perpendicular to the skin through the mandibular fossa, which is located anterior to the temporomandibular joint and posterior to the coronoid process. The needle is directed superior–medial-forward direction underneath the zygomatic arch towards the sphenoid bone (Fig. 7.10). Using an alternate approach, the needle is inserted above the zygomatic arch just behind the eye socket and directed in an inferior direction (Fig. 7.11). For the inferior division, the patient needs to open the mouth slightly. The needle is inserted perpendicular to the skin through the mandibular fossa and directed towards in a medial-forward direction towards the sphenoid bone (Fig. 7.12).

FIG. 7.8 Dry needling of the medial pterygoid muscle through the mandibular fossa.

FIG. 7.9 Dry needling of the medial pterygoid muscle at the mandible.

FIG. 7.10 Dry needling of the superior division of the lateral pterygoid muscle through the mandibular fossa.

FIG. 7.11 Dry needling of the superior division of the lateral pterygoid muscle behind the zygomatic bone.

FIG. 7.12 Dry needling of the inferior division of the lateral pterygoid muscle.

- *Precautions:* The maxillary artery overlies the lateral pterygoid muscle and should be avoided by needling close to the coronoid process. In patients taking anticoagulants, extra caution is warranted as it is not possible to apply hemostasis after the needling procedure. Use of sonography in Doppler mode can accurately locate the maxillary artery. Needling the temporomandibular joint can easily be avoided by accurately locating the mandibular fossa and needling slightly posterior to the coronoid process.

Digastric Muscles

- *Anatomy:* The posterior digastric muscle arises from the mastoid notch at the mastoid process of the temporal bone at the digastric groove, whereas the anterior digastric muscle arises from the inferior border of the mandible, close to its symphysis. The two muscles are joined together by a common tendon that is indirectly anchored to the hyoid bone through a fibrous loop.
- *Function:* The digastric muscles protrude and open the mouth by descending the mandible.
- *Innervation:* Digastric branch, via the facial nerve (VII par cranial) for the posterior digastric muscle; and mylohyoid nerve, via the mandibular branch (V3) of the trigeminal nerve (V par cranial) for the anterior digastric muscle.
- *Referred pain:* TrPs in the posterior digastric muscle refer pain to the upper part of the sternocleidomastoid muscle, whereas TrPs in the anterior digastric muscle project pain to the four lower incisor teeth.
- *Needling technique:* The patient is in supine. For the posterior digastric muscle, the needle is directed towards the mastoid process using a flat palpation technique (Fig. 7.13). For the anterior belly the head and neck of the patient are slightly extended. The muscle is then needled with a flat palpation technique. The TrP is fixed between the index and middle fingers of the nonneedling hand, and the needle is inserted perpendicular to the skin (Fig. 7.14).

FIG. 7.13 Dry needling of the posterior belly of the digastric muscle.

FIG. 7.14 Dry needling of the anterior belly of the digastric muscle.

- *Precautions:* When needling the posterior digastric muscle, avoid the external jugular vein. To avoid needling through the very thin muscles, a superficial to slowly deeper needling technique is recommended.

DRY NEEDLING OF NECK–SHOULDER MUSCLES

Several of the shoulder muscles are reviewed in Chapters 8 and 10.

Trapezius Muscle: Upper Portion

- *Anatomy:* The superior region (descending part) of the trapezius muscle arises from the external occipital protuberance, the medial third of the superior nuchal line of the occipital bone, the ligamentum nuchae, and the spinous process of C7 and inserts into the posterior border of the lateral third of the clavicle.
- *Function:* When the upper trapezius contracts unilaterally, it induces ipsilateral sidebending and contralateral rotation of the head and elevation of the shoulder. When it contracts bilaterally, it extends the neck.
- *Innervation:* Accessory nerve (XI par cranial) and cervical spinal nerves C3-C4.
- *Referred pain:* TrPs in the upper trapezius muscle refer pain ipsilaterally from the posterior–lateral region of the neck, behind the ear, and to the temporal region.
- *Needling technique:* The patient is in sidelying, prone, or supine position. The muscle is needled with a pincer palpation. The needle is inserted perpendicular to the skin and directed towards the practitioner's finger. The needle is kept between the fingers in the shoulder. The needle can be inserted from anterior to posterior (Fig. 7.15) or posterior to anterior (Fig. 7.16). Needling the muscle in supine position is indicated to reach the anterior fibres of the upper trapezius muscle (Fig. 7.17).
- *Precautions:* The most common serious adverse event is penetrating the lung and producing a pneumothorax. This is minimised by needling strictly between the fingers holding the muscle in a pincer grasp and needling directed towards the practitioner's finger.

FIG. 7.15 Dry needling of the upper portion of the trapezius muscle in sidelying position.

FIG. 7.16 Dry needling of the upper portion of the trapezius muscle in prone position.

FIG. 7.17 Dry needling of the upper portion of the trapezius muscle in supine position.

Levator Scapulae Muscle

- *Anatomy:* The levator scapulae muscle originates from the dorsal tubercles of the transverse processes of C1 to C4 vertebrae and inserts on the superior medial angle and adjacent medial border of the scapula.
- *Function:* The levator scapulae muscle extends and sidebends the neck. When the head is turned to the opposite side and forward flexed, it rotates the head towards the midline. The muscle rotates the scapula glenoid fossa downward when the neck is fixed.

- *Innervation:* Cervical spinal nerves C3-C5 via the dorsal scapular nerve.
- *Referred pain:* TrPs in the levator scapulae muscle refer to the angle of the neck and along the vertebral border of the scapula.
- *Needling technique:* The patient is in the lateral decubitus position. The muscle is needled via a pincer palpation. For the superior (cervical) portion, the muscle is felt as a ropy muscle band. The needle is inserted perpendicular to the skin and directed towards the practitioner's thumb (Fig. 7.18). For the lower (shoulder) portion, the muscle is identified over the superior medial border of scapula. The needle is inserted through the skin at a shallow angle and directed towards the upper, medial border of the scapula (Fig. 7.19). Placing the arm in a hammerlock position (hand on the lower back with the arm in internal rotation and support under the shoulder) makes it easier to palpate the muscle.
- *Precautions:* Do not needle towards the rib cage to avoid creating a pneumothorax.

Sternocleidomastoid Muscle

- *Anatomy:* The two heads of the sternocleidomastoid muscle (sternal and clavicular) originate in the mastoid process of the temporal bone. The sternal head attaches to the anterior surface of the manubrium sterni and the clavicular head attaches to the superior border and anterior surface of the medial third of the clavicle.

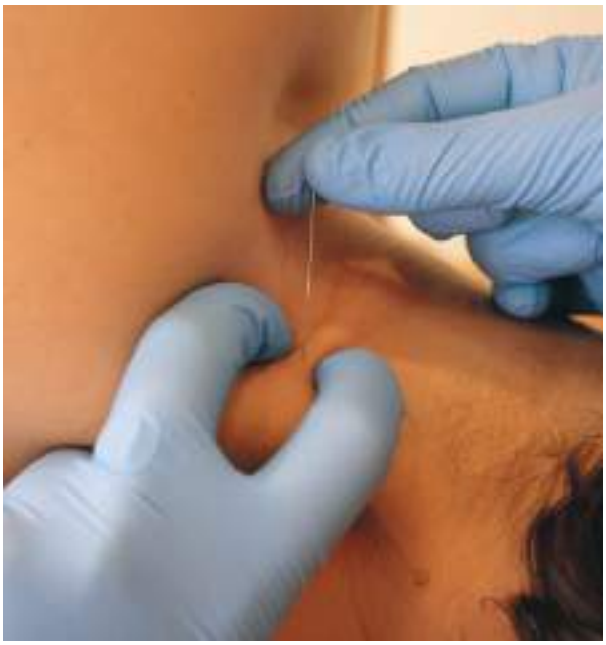

FIG. 7.18 Dry needling of the superior portion of the levator scapulae muscle.

FIG. 7.19 Dry needling of the inferior portion of the levator scapulae muscle.

- *Function:* When the sternocleidomastoid muscle contracts unilaterally, it sidebends the head to the same side, rotates it to the opposite side, and tilts the chin upward. When the sternocleidomastoid muscle contracts bilaterally, it flexes the neck against gravity.
- *Innervation:* Accessory nerve (XI par cranial) and cervical spinal nerves C2-C3.
- *Referred pain:* TrPs in the sternal division may refer pain to the vertex, to the occiput, across the cheek, over the eye, to the throat, and to the sternum, whereas TrPs in the clavicular division refer pain to the forehead and deep into the ear, inducing frontal headache and earache.
- *Needling technique:* The patient is in supine position. Both heads, clavicular and sternal, are needled by pincer palpation. The needle is inserted perpendicular to the skin and directed towards the practitioner's thumb (Fig. 7.20). The more proximal part of the muscle can also be treated in sidelying position using a flat palpation. The needle is placed perpendicular to the skin about 1 cm caudal of the TrP.