12 Cervical Sympathetic Chain and Superior Cervical Ganglion Block

Paul Tumber and Danilo Jankovic

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P. Tumber (✉)
Department of Anesthesiology and Pain Medicine, University of Toronto, Toronto, ON, Canada
e-mail: paul.tumber@uhn.ca

D. Jankovic
Pain Management Centre DGS – Cologne – Huerth, Cologne-Hurth, Germany
e-mail: danilo@jankovic1.de

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General Considerations: Stellate Ganglion Block

Concurrent with the advent of ultrasound guidance technology, the stellate ganglion block (SGB) has become a sympatholytic procedure that can now be safely performed without the need for fluoroscopy or blind palpation techniques. The initial description of using ultrasound to directly visualize the spread of local anesthesia in the neck for an SGB was by Kapral and colleagues in 1995, and this was refined and validated by Gofeld and colleagues in 2009. The volume required to perform an SGB has been reduced from 10–15 cc to 4–5 cc, and with the refinement offered by a proper ultrasound technique, there has been an associated reduction in undesirable complications such as life-threatening hematoma.

Indications

The cervical sympathetic nervous system is involved with a myriad of structures, including viscera, sweat glands, and blood vessels, and the innervation extends to the eyes, face, brain, head and neck, heart, and upper extremity (Fig.12.1). Therefore, there is a corresponding range of indications and case reports highlighting the potential benefits of a SGB, although the effects may only be short-lived and may require repeat injections.

Painful medical conditions involving the head, neck, or upper extremity

- Sympathetically mediated pain/complex regional pain syndromes.
- Acute herpes zoster or post-herpetic neuralgia.
- Phantom limb pain.
- Headache (e.g., cluster, migraine, atypical facial pain).
- Intractable angina pectoris.
- Joint stiffness.
- Post-stroke pain (contralateral block).

Non-painful medical conditions

- Raynaud's.
- Hyperhidrosis.
- Lymphedema after breast amputation.
- Traumatic cerebral edema.
- Post-traumatic stress disorder.
- Vascular conditions (obliterative vascular disease, cerebral vasospasm).
- Cardiac conditions (refractory ventricular arrhythmias).
- Postmenopausal flushing.
- Ménierè's disease, sudden sensorineural hearing loss, and tinnitus.
- Positive effect on the immune system.

Contraindications

Anticoagulation treatment, contralateral paresis of the phrenic nerve or recurrent laryngeal nerve, glaucoma, severe emphysema, and simultaneous bilateral block.

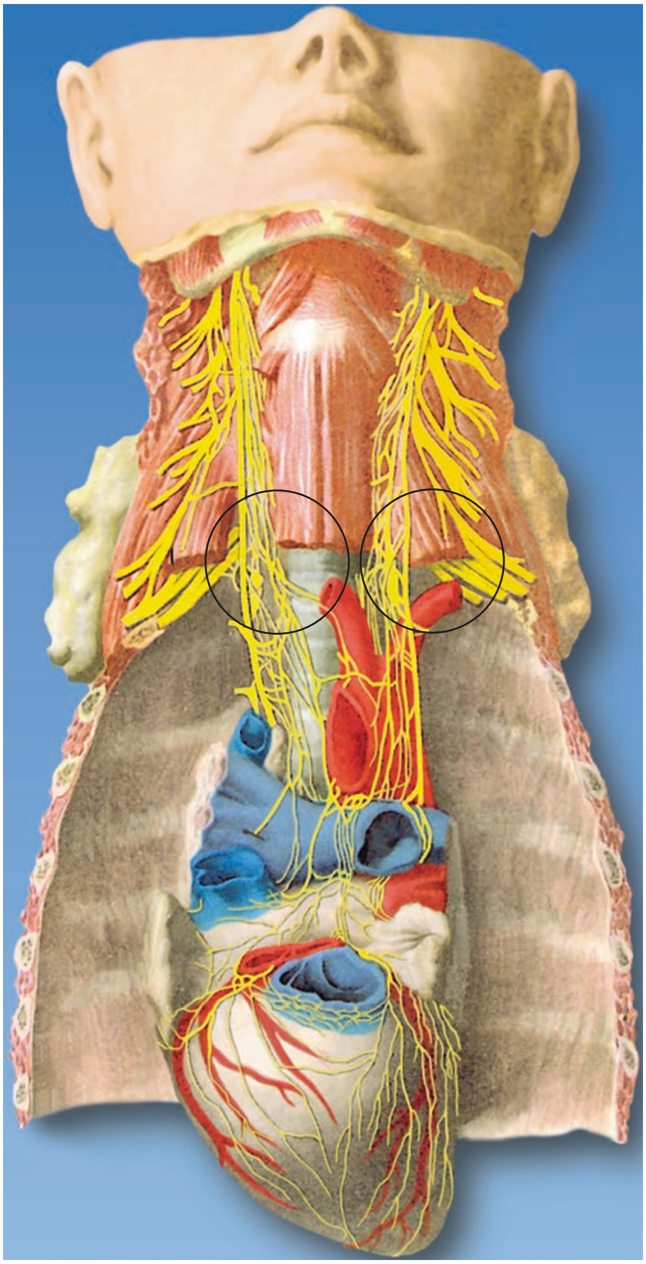

Fig. 12.1 Fibers from the gray rami communicantes *(circles)* supply the heart, esophagus, airways, and thymus (Reproduced with permission from Danilo Jankovic)

Functional Anatomy

Sympathetic nerve cell bodies exist in the first few thoracic segments and send preganglionic sympathetic nerve fibers that ascend through the paravertebral cervical sympathetic chain. These nerve fibers synapse in the superior, middle, and inferior cervical ganglions. In approximately 80% of the population, there is a fusion of the inferior cervical ganglion with the first thoracic ganglion, and this structure is termed the cervicothoracic ganglion but is more commonly known as the stellate ganglion. The size and development of the STG are subject to considerable variation. Average sizes of between 25 mm (15–50 mm) × 3–10 mm × 5 mm have been reported. This average corresponds to the superior cervical ganglion size and is much more voluminous than the middle cervical ganglion. Some authors have only been able to identify it in 38% of individuals studied (Fig. 12.2). The stellate ganglion is situated in the region of the lower part of C7 extending to the T1 transverse process. The STG is deep to the prevertebral fascia, is often just anterior or superior to the neck of the first rib, and is closely located medial or posterior to the vertebral artery in proximity to the dome of the pleura (Fig. 12.3). Some practitioners attempted to block the STG at the C7-T1 region, but several serious complications are possible at this level, and thus it has considered safer to block the cervical sympathetic ganglia and chain at the C6 level instead. The middle cervical ganglion is variable in location and size, although it is the smallest of the three cervical sympathetic ganglia and is likely blocked at the C6 level although this has not been rigorously studied. Performance of a STB at the C6 level relies on a planar spread of the local anesthesia between the prevertebral fascia layer and the surface of the longus colli muscle in order to block the stellate ganglion (Figs. 12.4, 12.5, and 12.6). It is also judicious to choose C6 as the level for the injection as the vertebral artery becomes protected from potential needle injury as it dives into the bony foramen transversarium in at least 90% of subjects (Fig. 12.7).

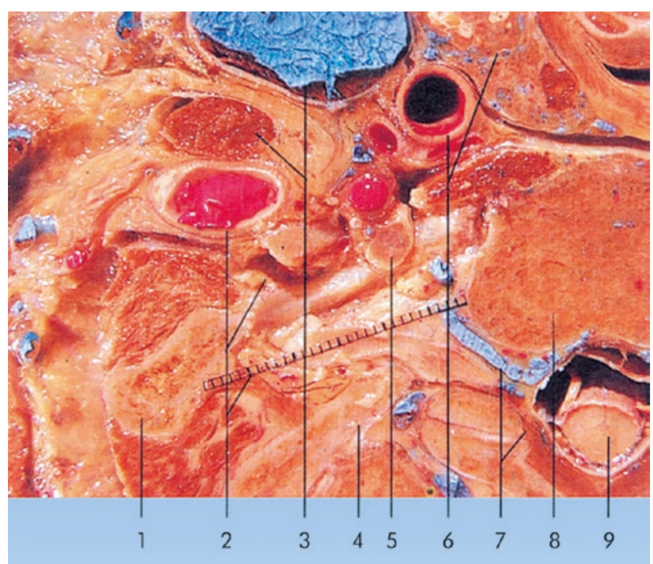

Fig. 12.2 The immediate vicinity of the ganglion (transverse section). *(1)* First rib, *(2)* subclavian artery and scalenus anterior muscle, *(3)* jugular vein, *(4)* second rib, *(5)* cervicothoracic ganglion, *(6)* common carotid artery and thyroid gland, *(7)* T2 intervertebral artery and zygapophyseal joint, *(8)* T2 vertebral body, *(9)* spinal medulla. The average size of the cervicothoracic ganglion is 25 mm × 3–10 mm × 5 mm (Reproduced with permission from Danilo Jankovic)

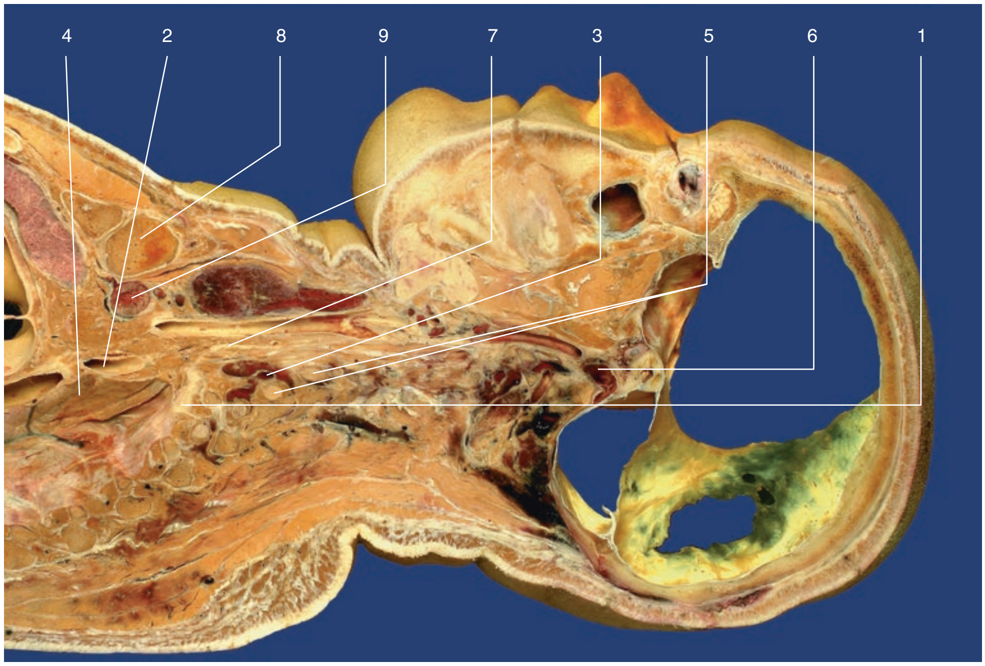

Fig. 12.3 Paramedian sagittal dissection (head and thorax): *(1)* Stellate ganglion, *(2)* the subclavian artery, *(3)* the vertebral artery, *(4)* pleura, *(5)* the brachial plexus, *(6)* the carotid artery, *(7)* the vagus nerve, *(8)* clavicle, *(9)* V. brachiocephalica (Reproduced with permission from Danilo Jankovic)

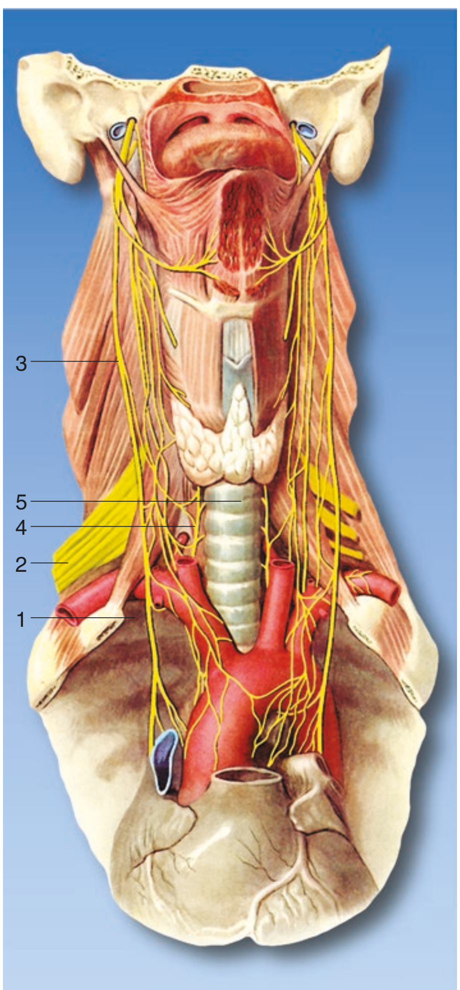

Fig. 12.4 The immediate vicinity of the stellate ganglion: *(1)* pleura, *(2)* brachial plexus, *(3)* vagus nerve, *(4)* recurrent laryngeal nerve, *(5)* trachea (Reproduced with permission from Danilo Jankovic)

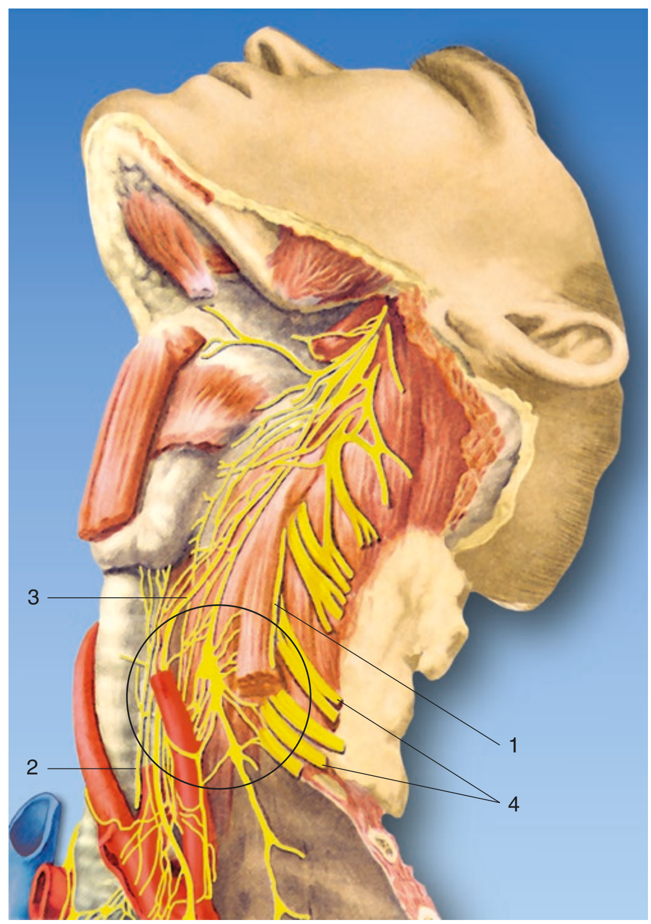

Fig. 12.5 Close anatomical connections in the ganglion trunk include those to *(1)* the phrenic nerve, *(2)* the recurrent laryngeal nerve, *(3)* the vagus nerve, and *(4)* the brachial plexus (Reproduced with permission from Danilo Jankovic)

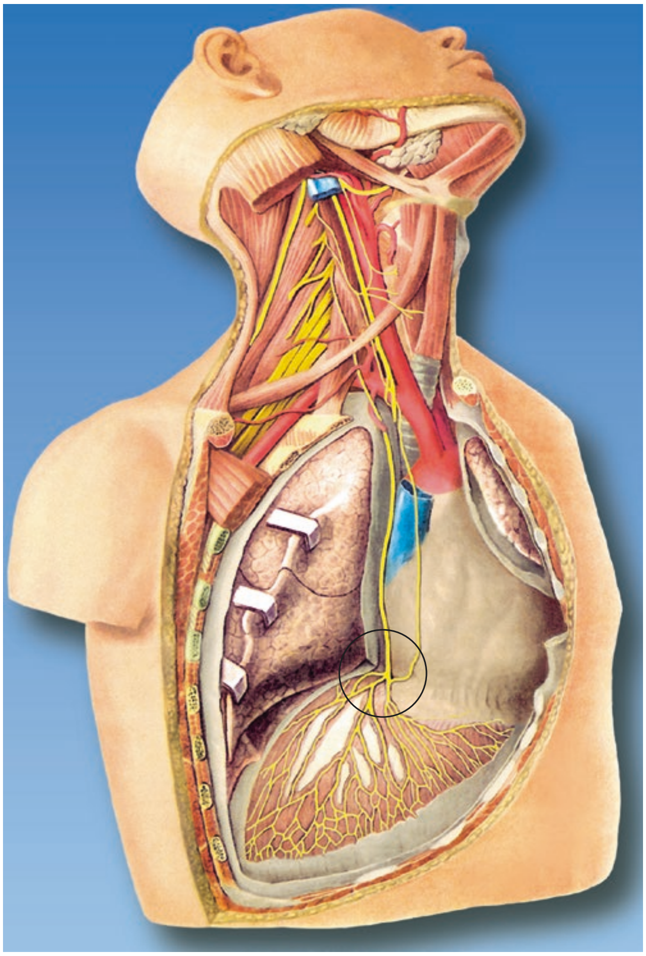

Fig. 12.6 Course of the phrenic nerve *(circle* shows the end position of the phrenic nerve). (Reproduced with permission from Danilo Jankovic)

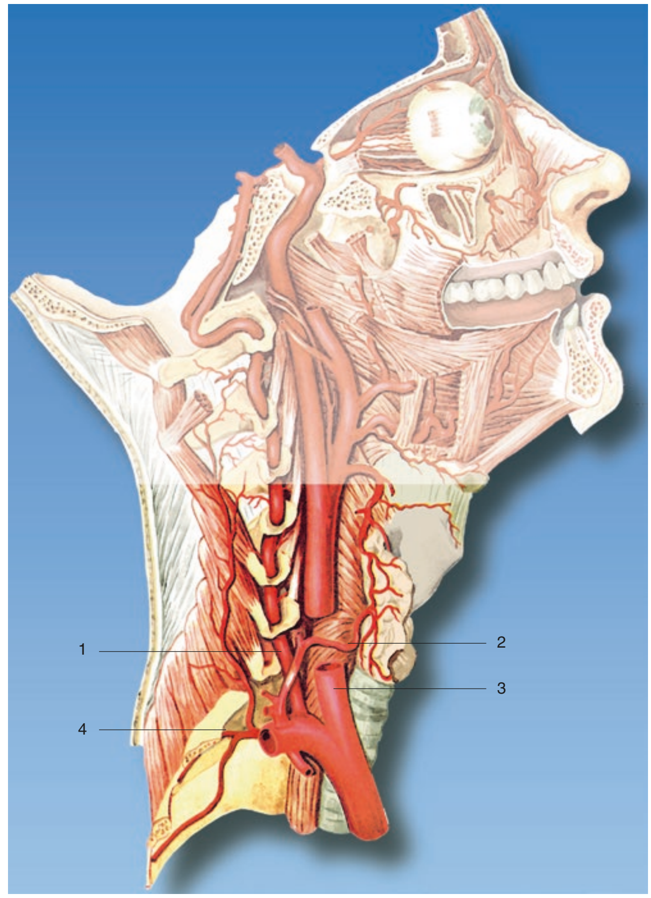

Fig. 12.7 Risk of intravascular injection into *(1)* the vertebral artery, *(2)* the inferior thyroid artery, *(3)* the carotid artery, and *(4)* the first intercostal artery (Reproduced with permission from Danilo Jankovic)

Effects of the Block: Characteristic Unilateral Symptoms

Block of the STG can denervate sympathetic supply to the head, neck, and upper extremity. A successful block is demonstrated most commonly by an ipsilateral Horner's syndrome (Fig. 12.8) and an increased skin temperature of at least 1° Celsius. Other techniques to confirm a successful block include the observation of an abolished skin resistance response and increased skin blood flow. It is possible to completely block the STG in some individuals, but there may still be sympathetic innervation maintained to the upper extremity. Such a situation may occur if there is anomalous sympathetic innervation via gray rami communicantes from the second thoracic sympathetic ganglia that pass directly to the upper limb via a second thoracic nerve that joins the first thoracic spinal nerve and ultimately onto the brachial plexus. These anomalous pathways are known as the Kuntz nerves and maybe a reason for a partial or failed effect of an STGB on the upper extremity.

Fig. 12.8 Horner's syndrome: Note ptosis, miosis, anhidrosis, and unilateral conjunctival engorgement. (Reproduced with permission from Danilo Jankovic)

Procedure for Ultrasound-Guided Stellate Ganglion Block

Preparation and Patient Positioning

The patient should be fasted as per standard anesthesia guidelines and have standard monitors applied, including an automated blood pressure cuff, electrocardiogram, and continuous pulse oximeter. Intravenous access should be established in order to treat any potential complication. Light sedation may be necessary to help the patient relax their neck muscles and shoulder, and a slight head up or reverse Trendelenburg position may help to reduce venous congestion and reduce the size of the internal jugular vein. The patient can be placed supine or turned slightly away from the side to be blocked with a wedge. The head is turned to the opposite side to help increase the distance from the carotid artery to the C6 anterior tubercle, and this can be adjusted to find the optimal position under real-time ultrasound scanning.

Scanning Technique and Sonoanatomy

A high-frequency linear ultrasound probe of 6–13 MHz is utilized (Fig. 12.9a, b). Transverse scanning can begin just above the clavicle to identify the carotid artery initially. Then deep and lateral to this can be visualized the pulsatile vertebral artery and C7 nerve root, lateral to which is the C7 posterior tubercle. The vertebral artery can then be tracked cephalad as the transducer maintains a transverse orientation, and it will disappear as it enters the C6 transverse process in 90% of individuals, whereas in the remainder, the vertebral artery will enter the bony canal at C5. The level of C6 is confirmed by the presence of a prominent anterior tubercle and a smaller posterior one, whereas at C5 the two tubercles are similar in size. At the C6 level, the longus colli muscle can be seen deep to the carotid artery and carotid sheath (which also contains the vagus nerve and internal jugular vein). Superficial and lateral to the longus colli may be seen a smaller muscle which may be the longus capitis muscle. The needle tip's target will be a plane deep to the prevertebral fascia between the longus capitis and longus colli muscles. The middle cervical ganglion or cervical sympathetic chain may be seen in some individuals immediately overlying the longus colli muscle.

Technique

Typically, the needle is directed from lateral to medial, and an in-plane approach is used to visualize the needle tip throughout the procedure. Once the target is identified, the probe should be adjusted such that the lateral end of the probe just overlies the US image of the anterior tubercle and not the corresponding foramen. This way, the needle has a direct and short path to the target from the probe's lateral end and can bypass the neurovascular structures lateral to the C6 anterior tubercle. A 25-gauge, 1.5-inch needle often suffices although some individuals will need a 25G or 22G spinal needle (3.5 inch) to reach the target. Before needle placement, a color Doppler scan should rule out the presence of

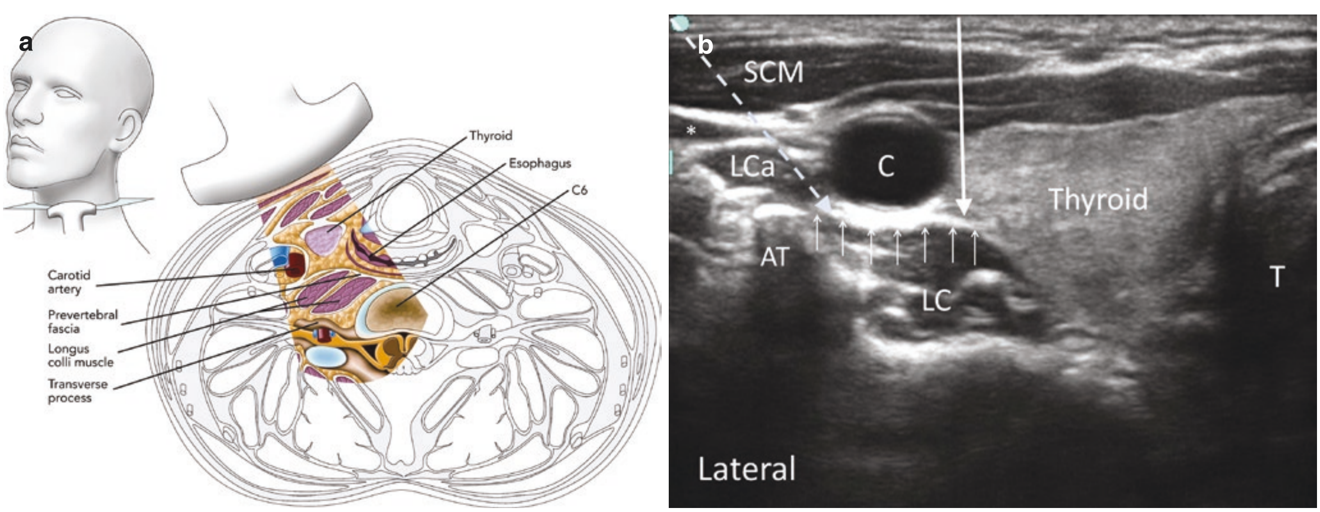

Fig. 12.9 (**a**) Cross section of the neck at the sixth cervical vertebral level correlating with the ultrasonographic image. (**b**) Ultrasonographic image of neck at C6. *C6* sixth cervical vertebra, *C* carotid artery, *, internal jugular vein (compressed), *SCM* sternocleidomastoid muscle, *LC* longus colli muscle, *LCa* longus capitis muscle, *T* airway, *AT* anterior tubercle. The prevertebral fascia is marked by small solid arrows. The needle paths of anterior and lateral approach are marked by long solid and dotted arrow, respectively. (Reproduced with permission from Philip Peng Educational Series)

any arteries such as the transverse inferior thyroid or smaller ascending cervical arteries that may be in the path of the needle (Figs. 12.10 and 12.11). Occasionally, a more medial out-of-plane approach may be necessary and care should be taken to visualize the needle tip as best possible as it may traverse vessels and the thyroid gland itself. In all cases, hydrodissection with small amounts of normal saline should be employed before any local anesthesia injection. Once the needle is in position, negative aspiration is confirmed.

A test dose of 0.5 mL of the local anesthetic may then be injected to confirm proper spread and lack of any immediate adverse response. A final volume of 4–5 mL is adequate to elicit a STGB, and bupivacaine 0.25–0.5% is often used (Fig. 12.12). An ipsilateral Horner's syndrome should develop within a few minutes, and the patient should be observed for a minimum of 30 minutes after the procedure to ensure a lack of any undesirable adverse effects such as a recurrent laryngeal nerve palsy.

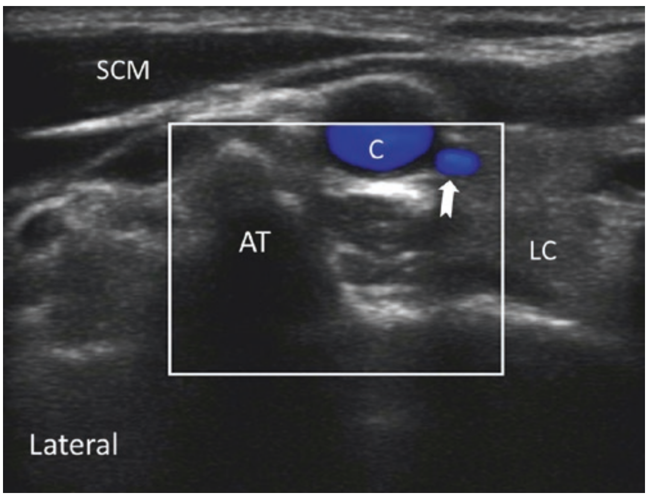

Fig. 12.10 Ultrasonographic image of neck at C6 level on the right side showing a vessel in the short axis (bold arrows). LC, longus colli muscle; C, carotid artery; SCM, sternocleidomastoid muscle; AT, anterior tubercle. (Reproduced with permission from Philip Peng Educational Series)

Dosage

Local anesthetic (e.g., 0.2–0.375–0.5 ropivacaine, 0.25–0.5% bupivacaine (0.25–0.5% levobupivacaine), or 1% prilocaine, 1% lidocaine, 1% mepivacaine).

– "Low dose" for indications in the head region (cerebrofacial effects): 2 mL (for traditional technique: 2–3 mL)
– "Medium-high dose" for indications in the shoulder and arm region: 4–5 mL (for traditional blind technique: 8–10 mL)

In acute intractable pain (e.g., postzosteric neuralgia), low dose of local anesthetic could be combined with steroids, opioids, or clonidine in mixture.

Block Series

If the clinical picture being treated does not show temporary improvement after the second block, there is no point in performing series of treatments. Otherwise, for all indications mentioned, a series of six to ten blocks can be carried out typically 5–7 days apart. In difficult cases (e.g., herpes zoster ophthalmicus), further blocks can also be carried out when there is a visible trend toward improvement.

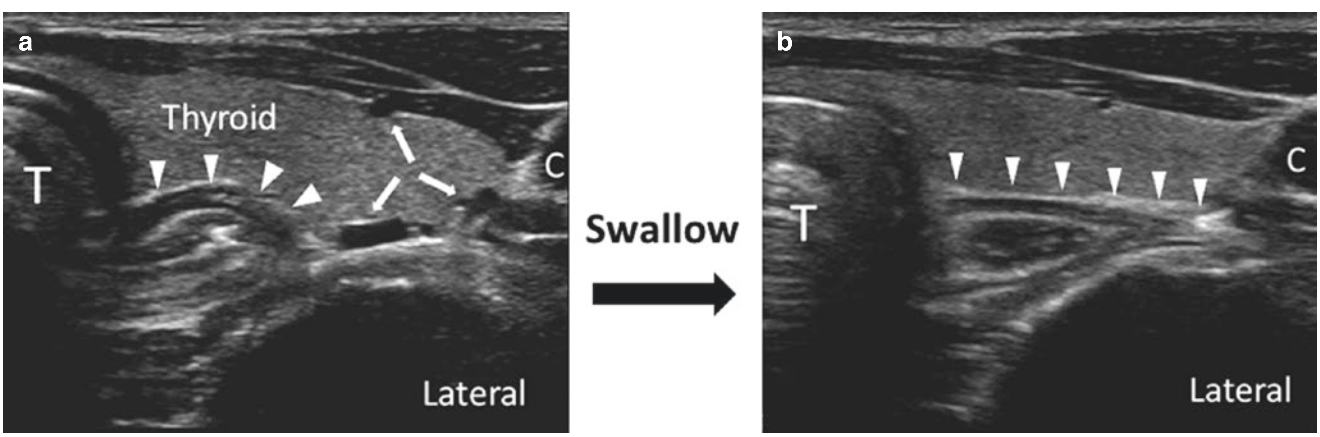

Fig. 12.11 (**a**, **b**) Ultrasonographic image of the neck at C7 level showing the variation of position of the esophagus with swallowing. (**a**) Before swallowing, the esophagus (arrow heads) was seen covering half of the distance between the trachea (T) and carotid artery (C); (**b**) During swallowing, the esophagus moved laterally toward the carotid artery, virtually covering the whole area between the trachea and carotid artery. Note that the bold arrows showed the presence of three vessels in the pre-swallow scan. Swallowing action was evident by the increased in hyperechogenic shadow in the trachea. (Reproduced with permission from Philip Peng Educational Series)

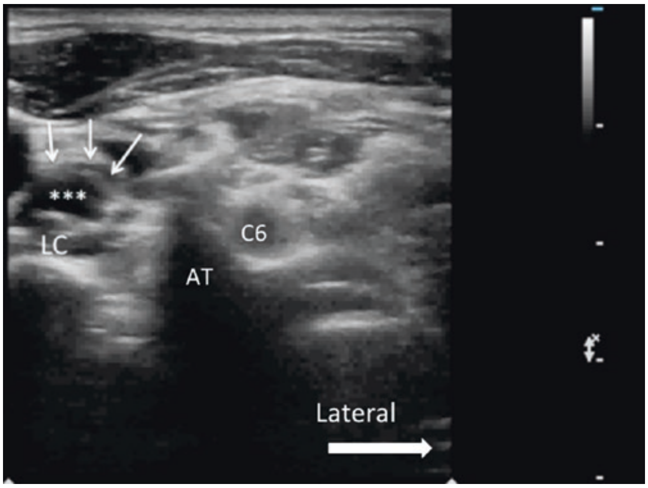

Fig. 12.12 Ultrasonographic image of the neck at C6 level showing the local anesthetic spread within the prevertebral fascia following the injection. *C6* C6 nerve root, *AT* anterior tubercle of C6, *LC* longus colli muscle, *arrows* prevertebral fascia; *** local anesthetic. (Reproduced with permission from Philip Peng Educational Series)

Side Effects

- Partial block of the following nerves :
  - *Phrenic nerve* (ipsilateral phrenic nerve palsy and hemidiaphragm paralysis), main symptom: dyspnea with normal auscultation findings (Fig. 12.6).
  - *Vagus nerve*, main symptom: tachycardia and hypertension (Fig. 12.4).
  - *Recurrent laryngeal nerve*, main symptom: foreign body sensation in the throat and hoarseness. It should be noted here that in ca. 43% of individuals, anastomoses with the cervicothoracic ganglion are found (Figs. 12.4 and 12.5).
  - *Brachial plexus*: a partial brachial plexus block may occur if the local anesthetic spreads into the area of the roots of C6–T1 (Fig. 12.5).
- Hematoma formation (may occur in the neck but is rarely dangerous when proper ultrasound techniques are employed). Carotid puncture in a patient with atherosclerosis can lead to cerebrovascular ischemia or stroke.
- Persistent coughing.
- Locked-in syndrome.
- Bradycardia.

Complications

Intravascular Injection

Leading to seizure, coma, and cardiovascular collapse as it is recognized that even small amounts of local anesthesia injected in arteries in the neck can lead to disastrous effects (see Chap. 5, "Local Anesthetic Systemic Toxicity"). In particular, there is a risk of injection into the vertebral artery (the diameter of which is ca. 0.3 mm larger on the left side than on the right). More rarely, there is a risk of puncturing the carotid artery, the inferior thyroid artery, or the first intercostal artery (Fig. 12.7).

Epidural or Subarachnoid Injection

(See Chap. 41, Neuraxial Blocks: Spinal and Epidural Anesthesia; Complications, p.604). There is a risk of perforating the dural membrane if the needle is inserted incorrectly toward the nerve root. Cerebrospinal fluid (CSF) pressure is very low in the cervical area and it is almost impossible to aspirate CSF. High epidural anesthesia or high spinal anesthesia is extremely rare. It can lead to bradycardia, hypotension, and possibly to respiratory arrest and loss of consciousness. The first signs are heaviness in the limbs, sweating, dyspnea, apprehension, and anxiety.

Pneumothorax (Figs. 12.3 and 12.6)

The incidence of this complication is low. If it occurs at all, it usually produces a small pneumothorax that resolves spontaneously. If there is suspicion of a pneumothorax, a chest radiograph is required after 4–6 h.

- Esophageal perforation or tracheal perforation (extremely rare)
- Cardiac arrest

Practical Tips

Patients should be forewarned about the expected development of a Horner's syndrome as a sign of a successful block and the expected warmth that develops in the upper extremity if it is cold beforehand. Patients should understand beforehand the challenge posed by the STGB and that it is not unusual to have some degree of hoarseness, dysphagia, and foreign body sensation for hours after the block. When performing the US-guided block, it is easy to apply enough pressure with the transducer to occlude the internal jugular vein, so the pressure should be minimal at first to help identify this structure, and then more pressure is applied as it improves visualization of the target. It may be necessary for the needle to traverse the IJ vein and this does not normally cause a problem. In some patients, it may be helpful to angle the probe with the medial end more caudad than the lateral end of the probe as this may help improve the visualization of a clear trajectory from lateral to medial and assist in avoiding the carotid artery contents. Inject only a small amount of lidocaine to anesthetize the skin before needle placement as the lidocaine may cause undesirable numbness on the side of the neck by blocking branches of the superficial cervical plexus. If the correct subfascial plane is not easy to visualize, then one can deliberately advance the needle into the longus colli muscle. Then an injection of small 0.5 mL aliquots with slow withdrawal of the needle tip will allow visualization of the change in the spread seen from the typical intramuscular injection pattern to the anticipated planar spread pattern seen just under the prevertebral fascia (the injectate should envelope the longus colli muscle in an inverted U shape).

Literature Review

There are various case reports of STGB being therapeutic for several painful and non-painful conditions involving the upper extremity, head, neck, and heart. Typically, local anesthesia is employed, but there have been reports of using pulsed radiofrequency of the stellate ganglion. There is also a report of using long-acting liposomal bupivacaine to try and prolong the benefit from a STGB as well as placing a catheter for continuous infiltration of local anesthesia. In current practice, a stellate ganglion block is commonly performed with US guidance at the C6 level, and it blocks a length of the cervical sympathetic chain from about C4 to the first thoracic vertebral level. Ultrasound has the added benefit of being a portable technique that allows one to avoid radiation exposure. The use of US guidance allows for identifying important structures relevant to the successful blockade of the cervical sympathetic chain. It is critical to maintain real-time visualization of the needle as it advances toward the target in addition to using hydrodissection with normal saline before active drug administration. There is still a need for more research to support many of the reported indications for stellate ganglion blockade.

Traditional Approach for SGB (Paratracheal Anterior Technique)

The injection can be made at the level of C6 or C7. The transverse process of the sixth cervical vertebra is easily palpated at the level of the cricoid; the distance from the pleura is greater and there is less danger of puncturing the vertebral artery. Block at the level of C7 can extend as far as T3, with a reduced dose of local anesthetic. However, the likelihood of injuring the pleura or puncturing the vertebral artery is greater here (Fig. 12.13). For palpation of the site between the larynx and the sternocleidomastoid muscle, a cushion is placed under the shoulder blades and the head is tilted back. The index and middle fingers are moved between the trachea and sternocleidomastoid muscle to locate the pulse in the common carotid artery. This is displaced laterally together with the medial margin of the sternocleidomastoid muscle. After skin infiltration, a 22-gauge, 3–5-cm needle with injection tube (depending on patient's anatomy) is introduced vertical to the skin at this point and advanced until bone contact is made with the transverse process (2–4 cm). After bone contact, the needle is withdrawn about 1–2 mm, and with careful aspiration at various levels, an initial test dose of 0.5–1 mL of the local anesthetic is injected (Fig. 12.14). After approximately 1 min, slow injection of the remaining dose can be injected in small portions. Two effects of the block need to be distinguished: after 1–2 min, Horner's syndrome develops due to cerebral facial spread. This can be achieved with a low dose of the local anesthetic. Complete block, including the shoulder and arm region, requires a higher dose, and the local anesthetic needs to spread as far as T4.

Practical Tips

If there is no bone contact or paresthesias in the brachial plexus are elicited, the needle must be withdrawn and corrected medially. If the transverse process is still not reached, the needle's direction should be carefully corrected caudally or cranially. A single test dose by no means guarantees correct positioning of the needle. The remaining dose must never be injected quickly and carelessly. It must be adminis-

Fig. 12.13 Two-finger method of locating the level of C7 (Reproduced with permission from Danilo Jankovic)

Fig. 12.14 The immobile needle with injection tube is introduced vertical to the skin and advanced until bone contact is made with the transverse process. After bone contact, the needle is withdrawn ca. 1–2 mm. The injection is carried out after aspiration in various levels. (Reproduced with permission from Danilo Jankovic)

tered slowly in small quantities (several test doses) with constant aspiration.

Disadvantages and Limitations of Non-ultrasound-Guided Approaches

Possible consequences of non-ultrasound-guided approaches are as follows:

- Potential for penetration of vascular structures and intravascular injection:

  Retropharyngeal and cervicomediastinal hematomas after SGB have been reported despite negative aspiration tests, causing severe airway compromise. Possibility of other arteries of risk (e.g., the ascending cervical branch of the inferior thyroid artery, transverse cervical artery) that traverse over the C6 anterior tubercle has also been mentioned. Narouze and Siegenthaler found that the vertebral or other arteries were located in the needle path for traditional approach for SGB in over 28% of subjects, while Bhatia and colleagues reported that major vessel was observed in up to 29 and 43% of patients at the C6 and C7 levels, respectively. It was also noted that the vertebral artery was outside the foramen transversarium in 7% of subjects at the C6 level.

- Potential for penetration of the esophagus, pleura, lateral lobes of the thyroid gland, and cervical nerve roots:

  The recent studies have indicated that the *esophagus* is frequently located in the needle path of SGB performed using traditional approaches. The esophagus was located along the needle path in 37–50% and 65–74% of subjects at the C6 and C7 levels, respectively, in these studies. *Pneumothorax* is also a potential complication with anatomic landmark- or fluoroscopy-guided techniques, primarily if a SGB is performed at the C7 level. Finally, a needle traversing through the *thyroid gland* can result in a hematoma, and exiting *cervical nerve roots* can also be traumatized during SGB.

Conclusion

In addition to the risk of potential complications with traditional approaches for SGB, *precision in the deposition of the injectate and adequacy of its spread to the first and second thoracic vertebral levels* are vital considerations for ensuring efficacy. The location of CST is in the loose connective tissues of the prevertebral fascia. However, traditional approaches rely on contact with bony landmarks (transverse processes of C6 or C7) followed by the needle's withdrawal by a few millimeters and then injection. The spread of injectate seen with these approaches has been anterior to the prevertebral fascia and in most patients' paratracheal space, without much caudal spread In contrast a subfascial injection results in a more caudal spread, a higher rate of sympathetic block of the upper limbs, and a lower incidence of blockade of the vagus or recurrent laryngeal nerve.

General Considerations: Superior Cervical Ganglion Block

The SCG is the largest of the three cervical sympathetic ganglia. Selective block of this ganglia can be therapeutic for a variety of craniofacial conditions, and the block may now be performed with ultrasonography whereas in the past a blind intraoral or fluoroscopic/CT approach was required. Most of the evidence reported about this selective block is limited to case series or retrospective analysis. More research is needed to determine the optimal technique and volume of local anesthesia to use and understand its role versus a standard cervical sympathetic ganglion block performed at the C6 level. This does not appear to be a common block, and there are no active research trials underway according to Clinical Trials.gov.

Indications

The areas of application are partly identical to those for the stellate block, but due to its marked cerebro-facial effects, the superior cervical ganglion block (SCGB) is particularly suitable in situations where there was pain or dysfunction involving the head and face, such as:

- Migraine,
- Cluster headache, headaches of cervical origin,
- Neuropathic pain of the head/neck region,
- Cerebral vasospasm and microvascular ischemia,
- Central post-stroke syndrome (contralateral block!),
- Peripheral facial paralysis facial pain,
- Vertigo (of vertebral origin),
- Tinnitus,
- Trigeminal neuralgia in the 1st and 2nd branches*,
- Acute herpes zoster or post-herpetic neuralgias (otic, ophthalmic)*,
- Glossopharyngeal neuralgia,
- Hyperhidrosis in the head region,
- Asthma, allergic coryza,
- Depression (S.below)

* SCGB in combination with pterygopalatine ganglion block may be useful (Coauthors clinical experience over many years) (See. Chaps. 8 and 9)

Contraindications

(See above, SGB)

Functional Anatomy (Figs. 12.15, 12.16, 12.17, and 12.18)

The SCG is usually formed by the fusion of the upper four cervical paravertebral sympathetic ganglia and contains the preganglionic sympathetic nerve fibers that synapse with postganglionic sympathetic fibers that travel widely to the head and neck. Rami communicants connect the SCG with structures such as the carotid arteries, the pharyngeal plexus of CN IX (glossopharyngeal) and CN X (vagus) (Figs. 12.15, 12.16, and 12.17) the eye, tympanic and choroid plexus, lacrimal gland, salivary glands, thyroid and pineal gland. The widest part is often noted to be at the C2-3 level, and it often assumes a vertical fusiform shape but may also appear flattened. In cadavers, it may be an average length of 26.6 mm (14–43 mm), 7.2 mm in width and 3.4 mm in depth.

In a cadaveric study of 30 subjects, the SCG was reliably located just above the carotid artery bifurcation. The SCG lies in a plication of the deep cervical fascia, separate from the sheath that encloses the carotid artery, vagus nerve and internal jugular vein. An MRI study confirms that the SCG is usually located medial to the internal carotid sheath and superficial to the longus capitis muscle at the level of C2.

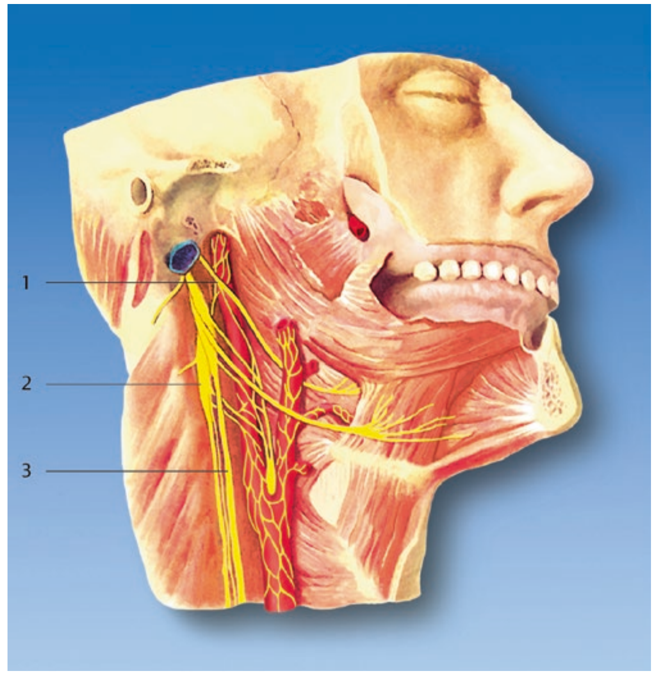

Fig. 12.15 Topographic position of the superior cervical ganglion. The widest part is often to be at the C2-3 level (carotid artery bifurcation). (1) glossopharyngeal nerve, (2) superior cervical ganglion, (3) vagus nerve. (Reproduced with permission from Danilo Jankovic)

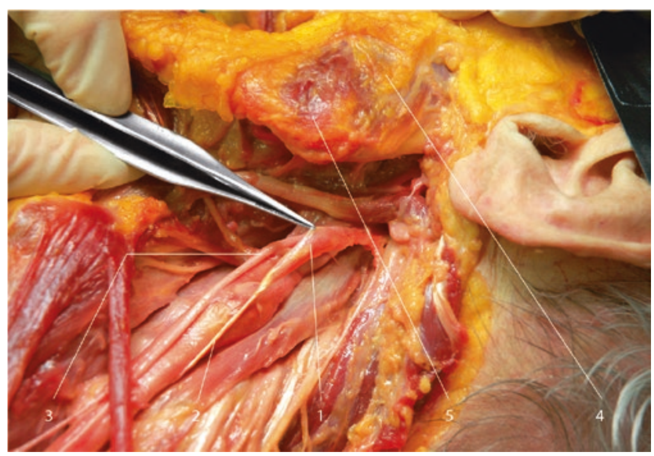

Fig. 12.16 The superior cervical ganglion has an average size of: 26.6 mm (14–43 mm) × 7.2 mm × 3.4 mm. *(1)* Superior cervical ganglion above the carotid artery bifurcation *(2)* sympathetic trunk, *(3)* vagus nerve with inferior vagal ganglion, *(4)* masseter muscle, *(5)* angle of the mandible. Hypoglossal nerve-underneath of angulus mandible. (Reproduced with permission from Danilo Jankovic)

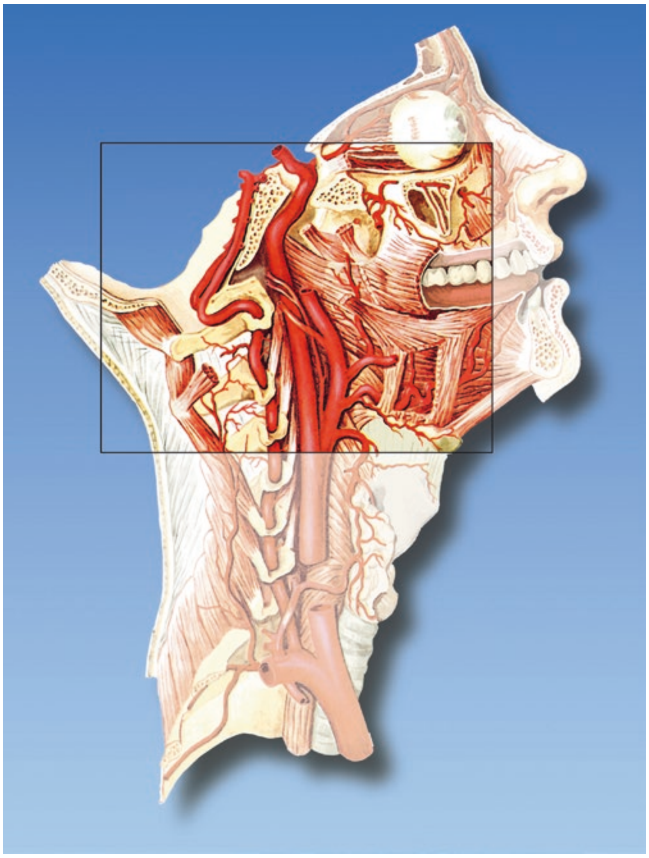

Fig. 12.17 Arteries in the immediate vicinity of the ganglion. Course of the vertebral artery and internal carotid artery bifurcation (risk of intra-arterial injection) (Reproduced with permission from Danilo Jankovic)

Fig. 12.18 Immediate vicinity of the superior cervical ganglion: (1) *sternocleidomastoid* muscle, repositioned dorsally, and the accessory nerve, (2) anastomosis between the C2 vertebral branch and CN XII, (3) scalenus medius muscle, (4) superior cervical ganglion, (5) hypoglossal nerve, (6) external branch of the superior laryngeal nerve, (7) neurovascular fascicle, repositioned anteriorly (Reproduced with permission from Danilo Jankovic)

Procedure for Ultrasound-Guided Superior Cervical Ganglion Block

Siegenthaler and colleagues first described how to block the SCG using ultrasonography in 2013, utilizing a cadaveric model to confirm the accuracy of the approach. Subsequently, there has been a case report using US guidance to block the SCG by pulsed RF ablation to treat refractory migraine and another case report using local anesthesia to improve recovery from abducens nerve palsy caused by microvascular ischemia.

Patient Positioning

The patient is placed supine, and the head is rotated in a slightly contralateral direction.

Scanning Technique and Sonoanatomy

A short length US probe is ideal for minimizing contact with the jaw medially, and the head may need to be extended to help improve imaging. A high-frequency linear ultrasound probe is placed transverse across the neck in order first to identify the C6 transverse process (Fig. 12.19a). After that, the probe is translated cephalad to count the cephalad transverse processes and arrive at the C3 level (Fig. 12.19b,c).

Injection Technique

Attention is drawn to visualize the start of the *bifurcation of the common carotid artery* (Figs. 12.16, 12.17, and 12.19d). At this point, the SCG may be visualized superficial to the longus capitis muscle and deep to the carotid artery and sheath. It is recommended to advance the 25G to 22G needle

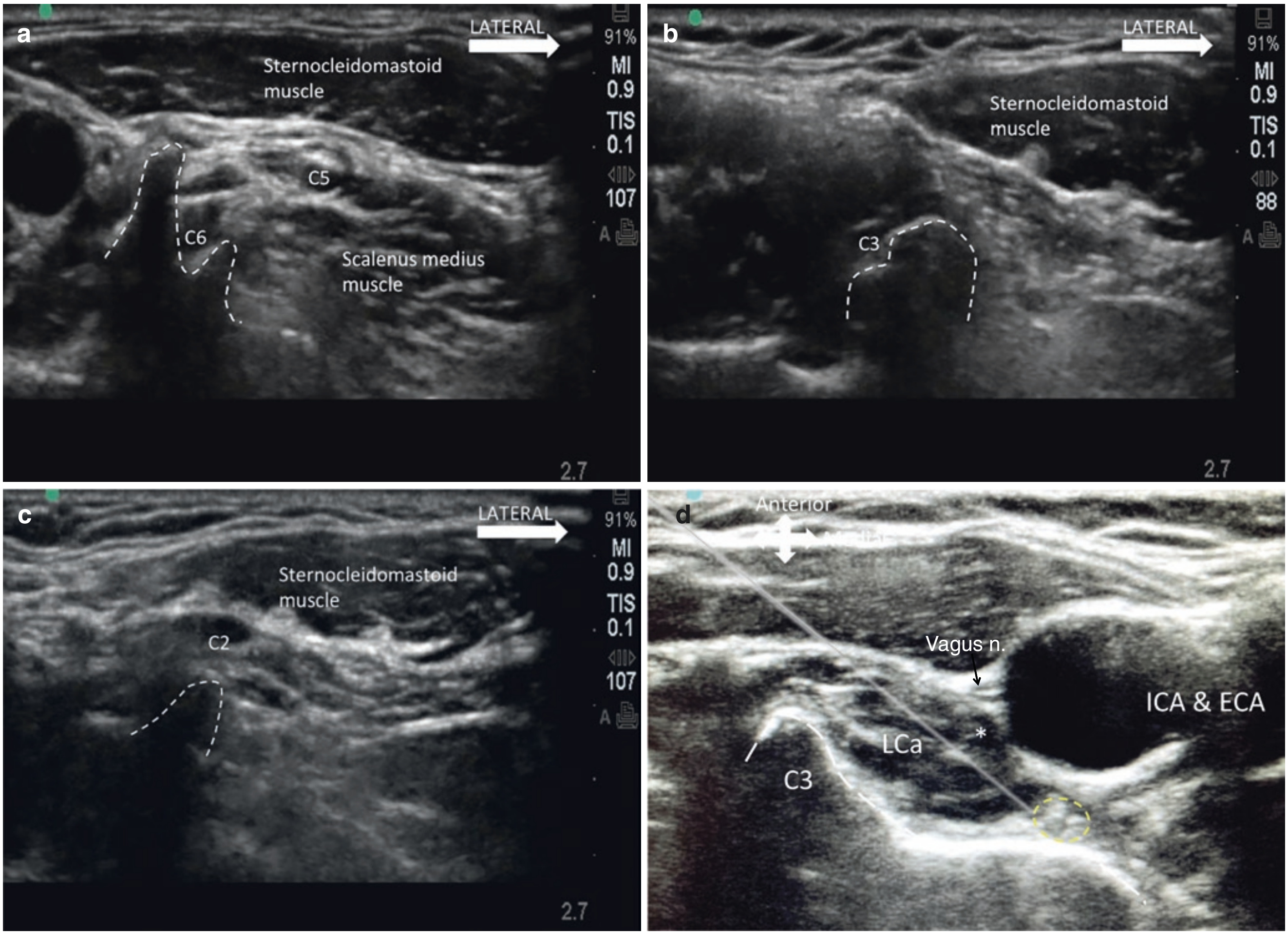

Fig. 12.19 (**a**) Sonogram showing the transverse process of C6. Note the prominent anterior tubercle of C6. (Reproduced with permission from Philip Peng Education Series). (**b**) Sonogram of C3. Note the discrepancy in the shape of anterior and posterior tubercle. (Reproduced with permission from Philip Peng Education Series). (**c**) Sonogram of C2. Note the prominence of the posterior tubercle. (Reproduced with permission from Philip Peng Education Series). (**d**) Sonogram of C3. Carotid bifurcation, vagus nerve, longus capitis muscle. Needle path and target for hydrodissection. (Reproduced with permission from Paul Tumber)

from lateral to medial in-plane with the US transducer and hydrodissect with small aliquots of normal saline until the needle tip is in position. After that one author injected 5mL of 0.2% ropivacaine to elicit an SCG block. Further research is necessary to determine the ideal or minimal volume required as the transoral route may only require 1mL of volume according to a cadaver study Whereas Wisco and colleagues(2010)' report indicated a maximum of 2.5 mL should suffice by the US or CT guided approach.

Effects of the Block

Characteristic signs of a successful block are radiation and a warm sensation in the area of the back of the head, ear, eyes, and corner of the mouth and the ipsilateral half of the face (Figs. 12.23 and 12.24). Conjunctival injection, increased tear production, and ipsilateral nasal congestion are equally characteristic, as is Horner's syndrome – which is by no means restricted to stellate block, but occurs in all blocks of the sympathetic cervical trunk.

Dosage

2.5–5 mL local anesthetic (e.g. 0.2% ropivacaine, 0.125–0.25% bupivacaine/ levobupivacaine, 0.5–1% procaine, 0. 5–1% lidocaine, 0. 5–1% mepivacaine).

In acute intractable pain (e.g. postzosteric neuralgia), low dose of local anesthetics could be combined with steroids, opioids, or clonidine in mixture.

Block Series

(See above, SGB)

Fig. 12.20 Landmarks for locating the needle insertion position. Angle of the mandible, mastoid, medial margin of the sternocleidomastoid muscle (Reproduced with permission from Danilo Jankovic)

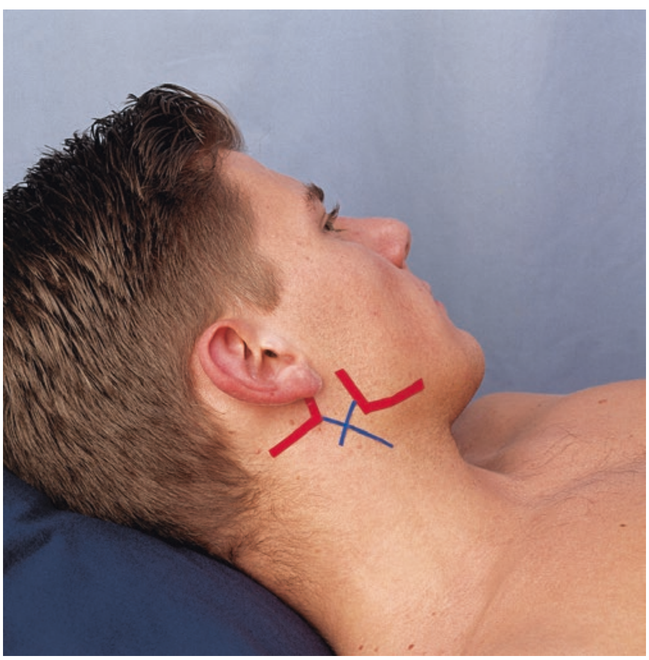

Fig. 12.21 Marking the injection site (Reproduced with permission from Danilo Jankovic)

Fig. 12.22 Craniodorsal puncture in the direction of the *contralateral mastoid.* No injection without prior bone contact! (Reproduced with permission from Danilo Jankovic)

Fig. 12.23 Characteristic directions of radiation during the injection (Reproduced with permission from Danilo Jankovic)

Side Effects and Complications

(See above, SGB)

This is a potentially hazardous block to perform via blind or transoral techniques as there several structures (nerves and vessels) in the vicinity of the SCG. The side effects and complications are mostly the same as by SGB except for a reduced risk of pneumothorax, esophageal perforation, or tracheal perforation. When giving consent, the patient must be informed about all the potential risks.

Fig. 12.24 Distribution of the block (Reproduced with permission from Danilo Jankovic)

Side Effects

Partial blockade of the phrenic nerve can lead to shortness of breath; the recurrent laryngeal nerve leading to hoarse voice; vagus nerve (CN X) block leading to tachycardia and hypertension; glossopharyngeal nerve (CN IX) leading to paresis of the pharyngeal muscles and numbness in the posterior third of the tongue; hypoglossal nerve (CN XII)- motor nerve of tongue muscles may be anesthetized (Figs. 12.15, 12.16, and 12.17); cervical plexus spread leading to anesthesia along C2-3 dermatomes especially (See above SGB).

Complications

A vascular puncture can lead to a hematoma, and a carotid puncture in a patient with atherosclerosis can lead to cerebrovascular ischemia or stroke. If the needle tip is not visualized correctly on ultrasound, intravascular injection of small volumes of local anesthesia can lead to local anesthetic systemic toxicity (See Chap. 5), and epidural or spinal anesthesia can result if the needle is placed too deep to the intended target. (See above, SGB).

Practical Tips

If available, it is helpful to review an MRI scan of the patient before attempting this block. Particular attention is drawn to the location of the SCG in relation to the *common carotid artery bifurcation* (Fig. 12.19d) as this is readily visualized using ultrasonography. The *location of the C3 transverse process* (Fig. 12.19b) *and longus capitis muscle* are also crucial landmarks. One should consider the presence of lymph nodes that may mimic the appearance of the SCG. It would be prudent to ensure negative aspiration through the needle and then inject a small test dose of 0.5 mL and wait a minute to assure the absence of any undesirable side effects. After the procedure, the patient should be kept with the head elevated to maintain comfort in the event of any recurrent laryngeal nerve blockade, and the patient should be monitored for at least 30 min to ensure there is no adverse spread of the local anesthesia or hematoma. As ultrasound technology continues to improve, this is a block that will become more familiar.

Traditional Approach for SCG (Lateral Extraoral Technique)

An experienced regional anesthetist should only carry out this block. The patient should have a full explanation of the procedure before it is performed. The patient should be fasted as per standard anesthesia guidelines (See above SGB).

Patient Positioning and Landmarks

The patient is placed supine, and the head is turned about 30–40° to the opposite side. Landmarks for locating the needle are: mastoid process, angle of the mandible, medial margin of the sternocleidomastoid muscle (Figs. 12.20 and 12.21).

Injection Technique

After skin infiltration, a 4–5 cm 23-G long needle is introduced in the direction of the *contralateral mastoid* at a *craniodorsal angle of about 20°*(Fig. 12.22). In normal anatomy, bone contact is made mostly at about 3.5–4 cm, and careful aspiration is carried out at various levels after the needle has been minimally withdrawn. Only then can a test dose of 0.5 mL of the local anesthetic be administered. After about 1 min, slow injection of the remaining dose can be carried out. The patient's upper body is then raised.

Dosage

4–5 mL local anesthetic-e.g., 0.5–1% procaine, 0.5–1% lidocaine, and 0.5–1% prilocaine, 0.2% ropivacaine and 0.125% bupivacaine (levobupivacaine) Side Effects and complications (see above).

Practical Tips

Most complications arise when the local anesthetic is administered without prior bone contact. A single test dose by no means guarantees the correct positioning of the needle. The remaining dose must never be injected quickly or carelessly. It must be administered slowly in small quantities (several test doses) with repeated aspiration. Bilateral block of the superior cervical ganglion is contraindicated, since bilateral paralysis of the recurrent laryngeal nerve or phrenic nerve is life-threatening. Due to the potential complications, the patient must be monitored after the injection has been carried out—for at least 30 min after procaine administration and at least 60 min after administration of ropivacaine or bupivacaine.

Disadvantages

Possible consequences of non-ultrasound-guided approaches (See above, SGB).

Superior Cervical Ganglion Blocks in Pain Therapy or as an Option in Depressive Conditions

In the coauthor's clinical experience over many years with the superior cervical ganglion block (10–12 on average per series), there have been surprisingly good results in a large number of patients. These observations principally concern patients with pain-associated depression in chronic pain (especially in various types of headache, migraines, facial pain, post-nucleotomy pain, fibromyalgia, etc.). In the superior cervical ganglion block, the volume of 5 mL of local anesthetic (e.g. 1% procaine) covers neighboring nerves such as the vagus nerve, for example. The superior cervical ganglion is often barely distinguishable from the vagus nerve. Left-sided vagus stimulation with an implantable electrode has been successfully used since 1938 to treat various neurological diseases such as epilepsy, treatment- resistant depression, anxiety states, sleep disturbances, and other conditions. Dysfunction of the autonomic nervous system is almost always present as an accompanying symptom of depression The long-term analgetic effect of vagus stimulation was demonstrated in a study by Kirchner 2001. Like the anti-epileptic and antidepressive action of vagus stimulation, this is probably due to neurobiochemical effects. For example, patients receiving vagus stimulation show a significant increase in norepinephrine and serotonin levels and a significant decrease in proalgetic excitatory amino acids such as aspartate and glutamate. The same group of authors reported marked symptomatic improvement during vagus stimulation in a patient with chronic tension headaches. In this context, answers will have to be found in the future to the following questions: What role does the superior cervical ganglion play in this? Is the functioning of the superior cervical ganglion more important than that of the vagus nerve? It should not be forgotten that the superior cervical ganglion is the last station where information from the body can be modulated before entering the CNS.

Suggested Reading

General Considerations: Stellate Ganglion Block

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General Considerations: Superior Cervical Ganglion Block

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