Chapter 13

Stellate Ganglion Block

Anuj Bhatia (✉)
Department of Anesthesia, Toronto Western Hospital, University of Toronto, Toronto, ON, Canada
e-mail: Anuj.bhatia@uhn.ca

Philip W.H. Peng, MBBS, FRCPC
Department of Anesthesia, Toronto Western Hospital, University of Toronto, McL 2-405 Toronto Western Hospital, 399 Bathurst Street, Toronto, ON, M5T 2S8, Canada
e-mail: philip.peng@uhn.ca

Contents

D. Jankovic, P. Peng, *Regional Nerve Blocks in Anesthesia and Pain Therapy: Traditional and Ultrasound-Guided Techniques*,
DOI 10.1007/978-3-319-05131-4_13, © Springer International Publishing Switzerland 2015

Introduction

Stellate ganglion refers to the confluence of inferior cervical and the first thoracic sympathetic ganglia. Stellate ganglion block (SGB) is performed for the management of a variety of pain conditions, including complex regional pain syndrome, refractory angina, and ischemic pain in the upper limb from peripheral vascular disease [7, 24, 25]. More recently, preoperative SGB has been shown to reduce postoperative pain and analgesic requirements [15].

Anatomy

The peripheral sympathetic nerve supply to the head and neck is derived from preganglionic neurons whose cell bodies are located in the anterior lateral horn of the first and second thoracic spinal cord segment. The axons pass via the anterior roots of the same spinal nerve levels through the rami communicantes to join the upper cervical sympathetic ganglia: superior, middle, intermediate, and inferior. From these ganglia the postganglionic axons pass upward along the internal and external carotid and vertebral arteries to the structures within the cranium (Figs. 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, and 13.9). The axon may also join the gray rami communicantes; the latter join the cervical nerve supply to the neck and the upper extremity (the cervical portion of the brachial plexus). The stellate ganglion, formed by fusion of the inferior cervical and first thoracic ganglion, extends from the level of the head of the first rib to the inferior border of the transverse process of the seventh cervical vertebra (C7) and lies immediately adjacent to the dome of pleura and behind the subclavian artery. The postganglionic fibers from the stellate ganglion to the cervical nerves (seventh and eighth) and the first thoracic nerve provide sympathetic innervation to the upper limbs [8, 11, 27, 29]. The stellate ganglion is present in only 80 % of the population, so a more correct term for SGB is a cervicothoracic sympathetic trunk (CST) block [7]. The stellate ganglion is oval in shape and measures 2.5 cm long, 1 cm wide, and 0.5 cm thick. The stellate ganglion lies lateral to the longus colli muscle [12, 23]. The CST is located dorsal to the posterior fascia of the carotid sheath anteriorly and is embedded in the prevertebral fascia [6]. Since all the sympathetic flow to the head and neck structures either synapse here at the stellate ganglia or pass through it to the more cephalic sympathetic ganglia, SGB provides a more complete sympathetic denervation of the head and neck.

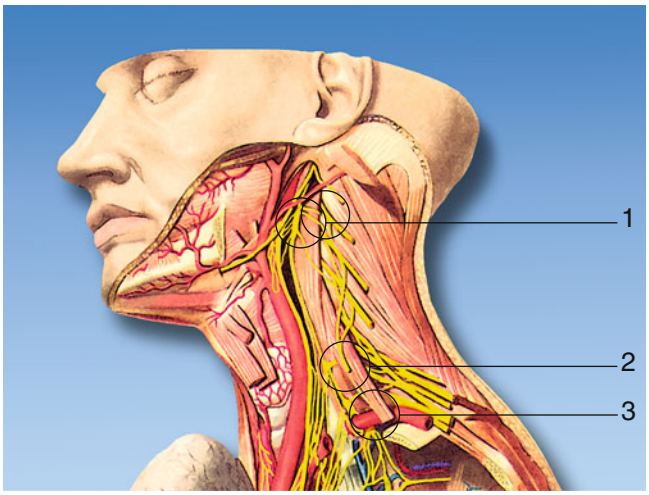


Fig. 13.1 The cervical ganglion trunk: (*1*) superior cervical ganglion, (*2*) middle cervical ganglion, and (*3*) cervicothoracic ganglion (With permission from Danilo Jankovic)

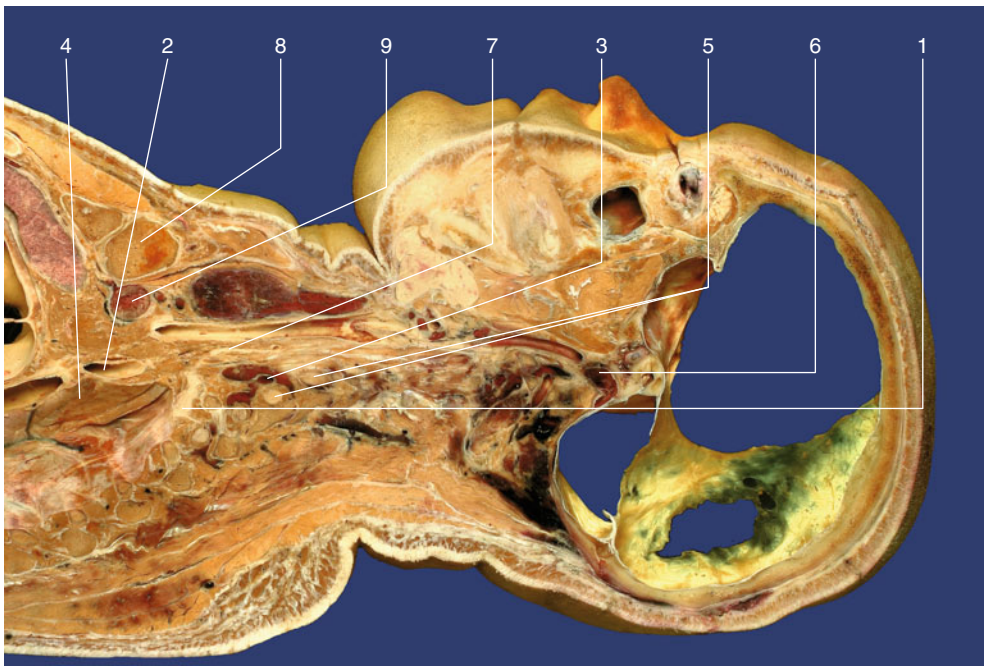


Fig. 13.2 Paramedian sagittal dissection (head and thorax): (*1*) stellate ganglion, (*2*) the subclavian artery, (*3*) the vertebral artery, (*4*) pleura, (*5*) the brachial plexus, (*6*) the carotid artery, (*7*) the vagus nerve, (*8*) clavicle, (*9*) V. brachiocephalica (With permission from Danilo Jankovic)

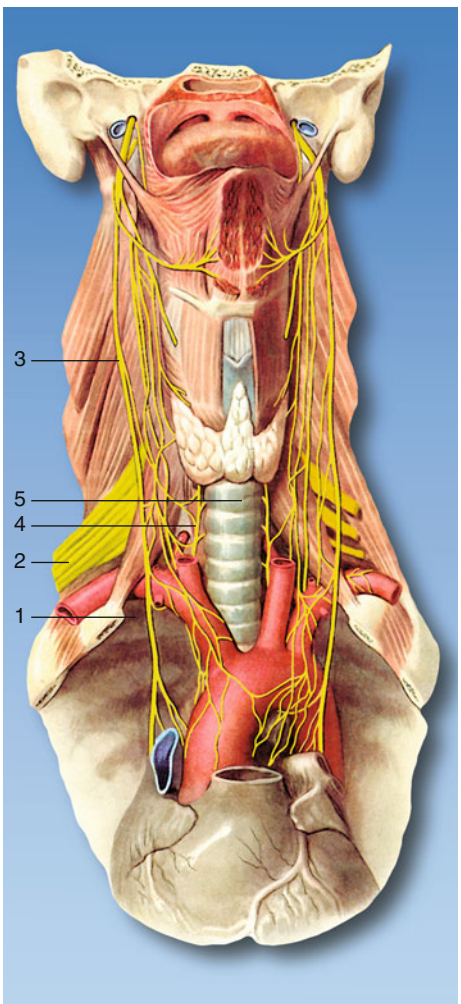


Fig. 13.3 The immediate vicinity of the stellate ganglion: (*1*) pleura, (*2*) brachial plexus, (*3*) vagus nerve, (*4*) recurrent laryngeal nerve, (*5*) trachea (With permission from Danilo Jankovic)

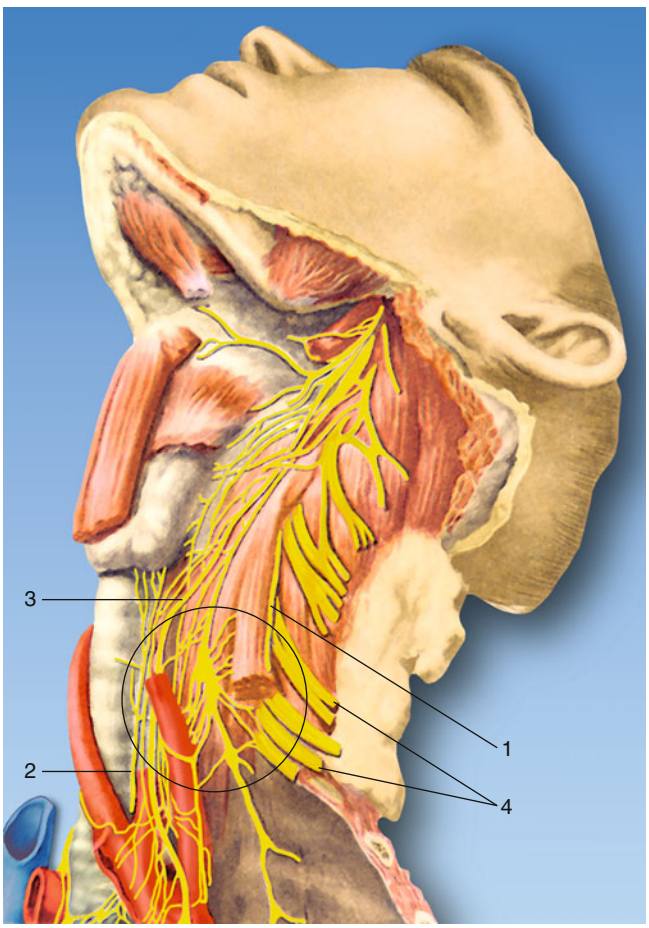


Fig. 13.4 Close anatomical connections in the ganglion trunk include those to (*1*) the phrenic nerve, (*2*) the recurrent laryngeal nerve, (*3*) the vagus nerve, and (*4*) the brachial plexus (With permission from Danilo Jankovic)

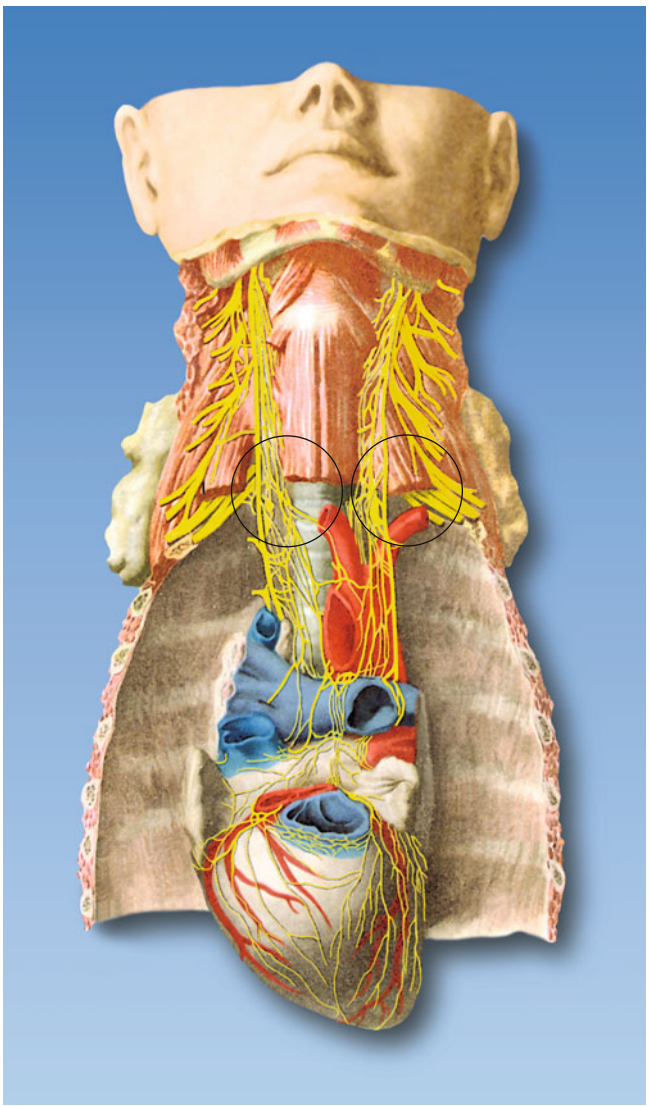


Fig. 13.5 Fibers from the gray rami communicantes (*circles*) supply the heart, esophagus, airways, and thymus (With permission from Danilo Jankovic)

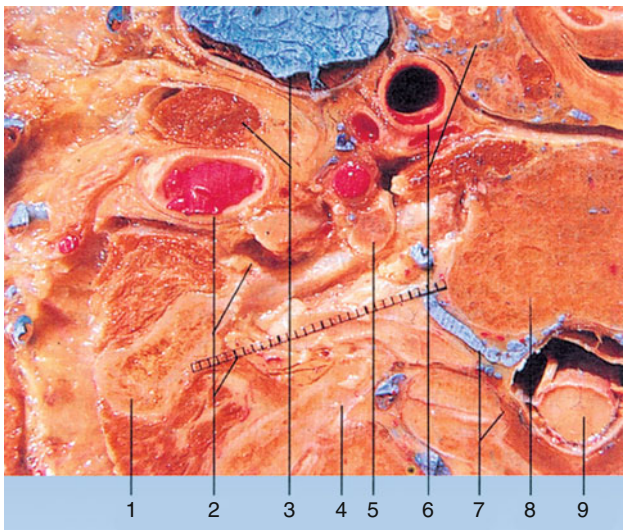


Fig. 13.6 The immediate vicinity of the ganglion (transverse section). (*1*) First rib, (*2*) subclavian artery and scalenus anterior muscle, (*3*) jugular vein, (*4*) second rib, (*5*) cervicothoracic ganglion, (*6*) common carotid artery and thyroid gland, (*7*) T2 intervertebral artery and zygapophyseal joint, (*8*) T2 vertebral body, (*9*) spinal medulla. The average size of the cervicothoracic ganglion is 25 mm × 3–10 mm × 5 mm (With permission from Danilo Jankovic)

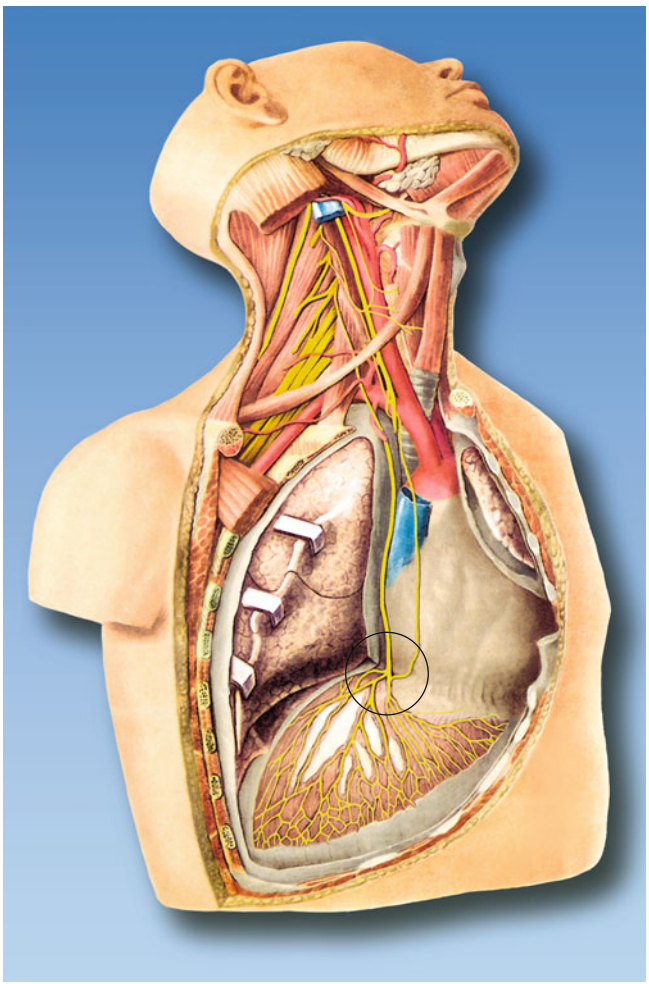


Fig. 13.7 Course of the phrenic nerve (*circle* shows the end position of the phrenic nerve) (With permission from Danilo Jankovic)

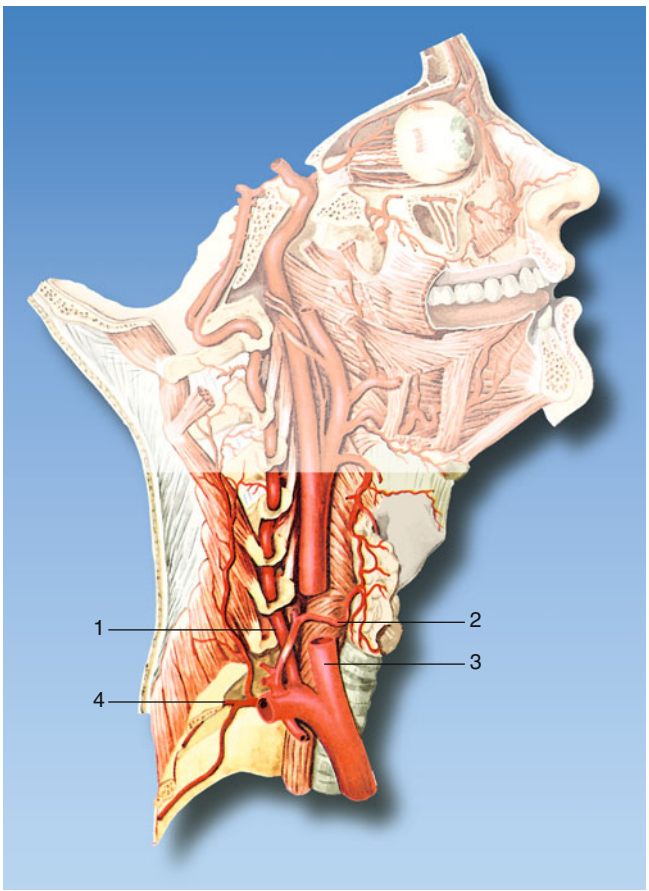


Fig. 13.9 Risk of intravascular injection into (*1*) the vertebral artery, (*2*) the inferior thyroid artery, (*3*) the carotid artery, and (*4*) first intercostal artery (With permission from Danilo Jankovic)

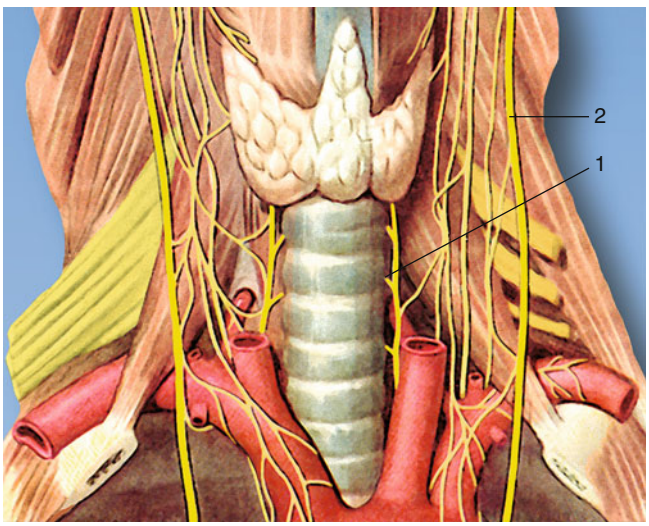


Fig. 13.8 Positions of (*1*) the recurrent laryngeal nerve and (*2*) the vagus nerve (With permission from Danilo Jankovic)

Traditional Approach for SGB

The most widely practiced approach to SGB is the anatomic-landmark- or fluoroscopy-guided paratracheal approach, in which the needle is inserted toward the anterior tubercle of the sixth (Chassaignac tubercle) cervical vertebra (Figs. 13.10 and 13.11). This approach is essentially a blockade of the cervical sympathetic chain in proximity to the middle cervical ganglion instead of the stellate ganglion, which is located opposite to the neck of the first rib. Thus, the classical approach is a cervical sympathetic trunk block rather than SGB.

There are significant limitations and potential hazards associated with traditional approaches. The cephalocaudal extent of the Chassaignac tubercle can be as narrow as 6 mm [13], and it can be easily missed with needle advancement with conventional techniques.

Possible consequences of non-ultrasound-guided approaches for SGB are:

1. *Potential for penetration of vascular structures and intravascular injection*:

   Retropharyngeal and cervicomediastinal hematomas after SGB has been reported despite negative aspiration of blood, and these can cause severe airway compromise [10, 20, 26]. Kapral et al., in one of the earliest papers examining US guidance, reported hematomas in three out of 12 patients who received SGB without US guidance [14]. Possibility of other arteries at 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 [18]. Siegenthaler and colleagues found that the vertebral or other arteries were located in the needle path for traditional approach for SGB in over 28 % of subjects [22], while Bhatia and colleagues reported that a 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 [2], and this has also been shown in other studies [4, 16]. A modified fluoroscopy-guided oblique approach has been proposed to reduce the risk of vertebral artery puncture as the needle is directed to the junction of the uncinate process and the vertebra body [1]. However, this technique directs the needle much closer to the esophagus (see below).
2. *Potential for penetration of esophagus, pleura, lateral lobes of thyroid gland, and cervical nerve roots*:

   Two 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 [2, 22]. The risk of esophageal penetration is greater than on the left side because of the anatomical location of the esophagus. Esophageal puncture can result in mediastinitis especially if the patient has an unrecognized diverticulum.

   Pneumothorax is also a potential complication with anatomic-landmark- or fluoroscopy-guided techniques, especially if 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.

Use of ultrasound enables the operator to visualize blood vessels, esophagus, pleura, nerve roots, and thyroid, and this can help avoid penetration of these structures [3, 17].

In addition to the risks of potential complications with traditional approaches for SGB, precision in deposition of the injectate and adequacy of its spread to the first and second thoracic vertebral levels are key 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 withdrawal of the needle by a few millimeters and then injection. The spread of injectate with these approaches has been shown to be anterior to the prevertebral fascia and in the paratracheal space in most patients, without much caudal spread [12], whereas subfascial injection results in more caudal spread, higher rate of sympathetic block of the upper limbs, and lower incidence of blockade of vagus or recurrent laryngeal nerve (causing hoarseness) [5, 21].

Fig. 13.10 Two-finger method of locating the level of C7 (With permission from Danilo Jankovic)

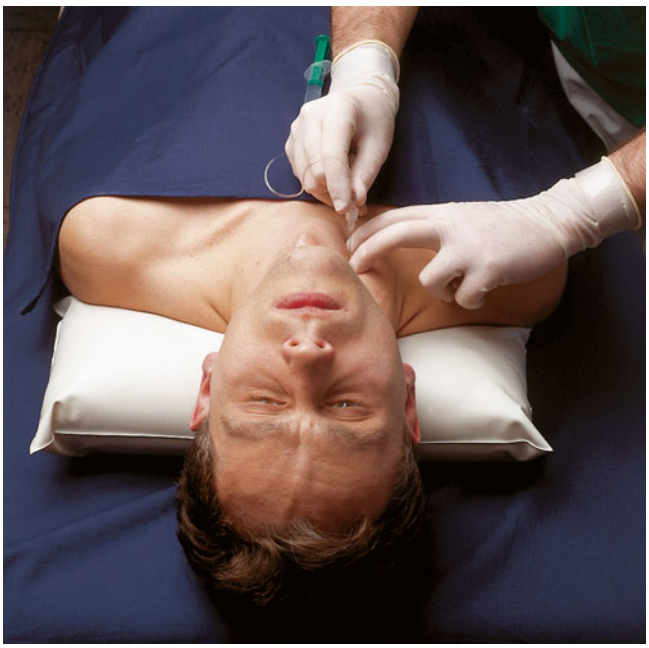


Fig. 13.11 Introducing the needle (With permission from Danilo Jankovic)

Sonoanatomy and Injection Technique for Ultrasound-Guided Stellate Ganglion Block

The patient is placed in the semi-lateral position with the procedure side nondependent and the neck in slight extension. A high-frequency linear US probe (6–15 MHz) is used and a probe with a small footprint is desirable. The probe placed transversely at the level of cricoid cartilage and the transverse process (TP) of the cervical vertebra is identified. If the TP has a prominent anterior tubercle and a smaller posterior tubercle, then this is likely to be the C6 level, but scanning should be continued in a caudal direction to allow recognition of the TP at C7 level that has only a posterior tubercle. The vertebral artery can easily be identified in cross section, its location being deeper and lateral to the common carotid artery at C7 level. Once the TP of the C6 vertebra has been identified, the longus colli muscle is identified in cross section (Fig. 13.12). This muscle is located anterior to the TP and medial to the anterior tubercle and is around 1 cm thick at this level [9]. The prevertebral fascia on the anterior surface of the muscle deep to the longus capitis muscle is then identified. Other important structures to recognize include the lateral lobe of the thyroid gland, blood vessels including the common carotid artery and the internal jugular vein, esophagus, exiting cervical nerve root, and any vessels that may be in the planned path of the injecting needle (Figs. 13.13 and 13.14).

The authors' preferred approach is the lateral, in-plane approach [9] in which the tip of the needle is directed to the prevertebral fascia between the carotid artery and the tip of C6 anterior tubercle. This needle path avoids traversing the lateral lobe of the thyroid gland. The US probe is adjusted (by putting more pressure on the medial end of the probe) so that the cervical nerve root is "removed" from the view – this reduces probability of encountering the nerve root while the needle is advanced. The internal jugular vein can be avoided by "pushing" away with the needle. A 25-gauge needle that is 4 cm in length or a spinal needle (8 cm length) can be used for this procedure. The alternative US-guided approach is an out-of-plane approach in which the patient is supine and the needle is directed at the prevertebral fascia on the surface of longus colli. This approach involves penetration of the thyroid gland and should be used only if the lateral approach is unsafe or nonviable because of anatomic variations. Irrespective of the approach, a pre-scan Doppler injection is advised to check for any vessels in the path of the needle.

Since there are two layers of prevertebral fascia and the cervical sympathetic chain is embedded inside the fascia, the needle tip should be placed deep to the prevertebral fascia (to avoid spread along the carotid sheath) but superficial to the fascia investing the anterolateral surface of the longus colli muscle (to avoid injecting into the muscle substance) [19]. Once the needle is in this position, hydrodissection with 0.9 % saline is recommended to ensure that the needle is in the correct plane (Fig. 13.15). This is followed by slow injection of a maximum of 5 mL of 0.5 % bupivacaine in 1:200,000 epinephrine. This volume has been shown to be adequate for spread from C4 to the first thoracic vertebral level [9].

Visualization of the spread of injectate under real-time scanning is important, as the absence of this may suggest unsuspected intravascular injection. Continuous hemodynamic and respiratory monitoring (ECG, blood pressure, pulse oximetry) is recommended during and for 5–10 min after the injection. A volume of 0.1 mL should be injected initially, and injection should be continued only if there is no evidence of intravascular spread (patient may report tinnitus, tingling or numbness around the lips and tongue, and lightheadedness, and signs include tachycardia, hypertension, and seizures). If the SGB is performed for relieving sympathetically mediated pain in the upper extremity, then skin temperature probes should be placed on both upper limbs prior to the procedure. An increase of 1–3 C is usually accepted as a sign of adequate sympathetic blockade though this has been contested in recent literature [28].

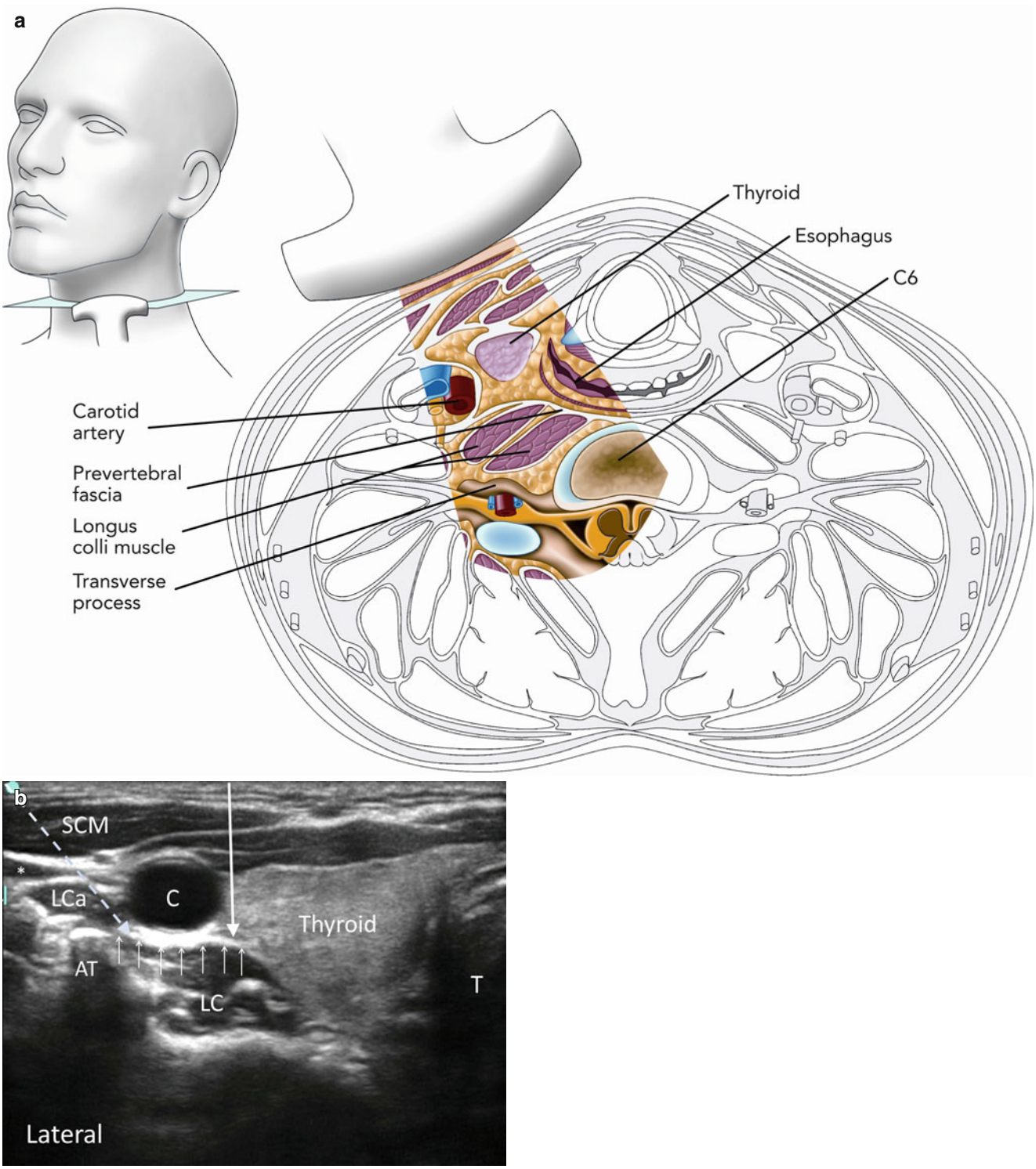


Fig. 13.12 (**a**) Cross section of the neck at the sixth cervical vertebral level correlating with the ultrasonographic image. (**b**) Ultrasonographic image of neck at C6. *C6* sixth cervical vertebra, *C* carotid artery, * internal jugular vein (compressed), *SCM* sternocleidomastoid muscle, *LC* 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)

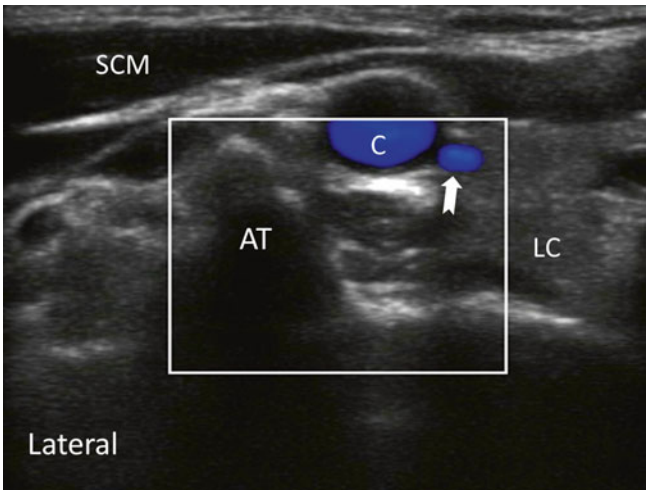


Fig. 13.13 Ultrasonographic image of neck at C6 level on the right side showing a vessel in the short axis (*bold arrows*). *LC* longus colli muscle, *C* carotid artery, *SCM* sternocleidomastoid muscle, *AT* anterior tubercle (Reproduced with permission from Philip Peng Educational Series)

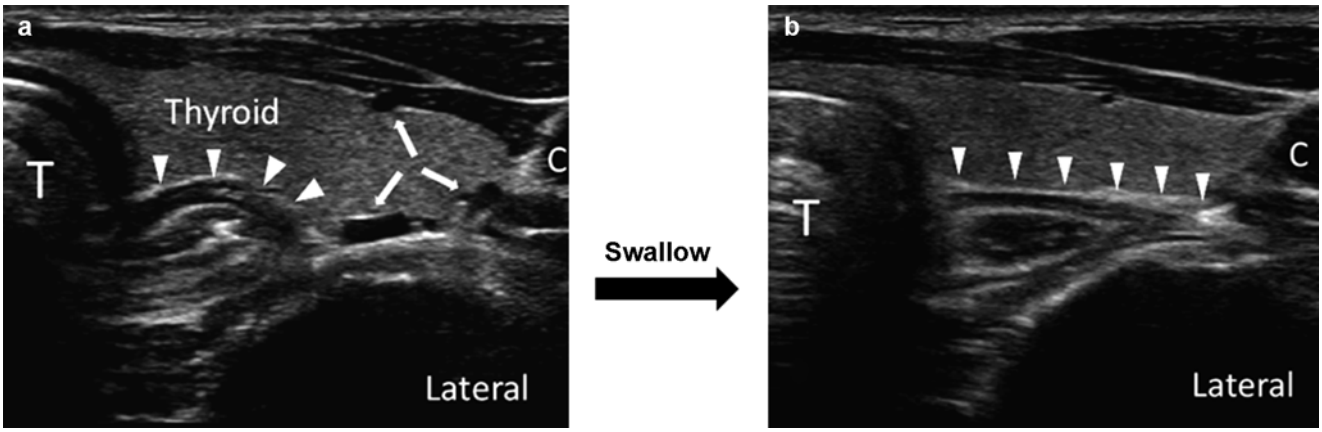


Fig. 13.14 Ultrasonographic image of neck at C7 level showing the variation of position of esophagus with swallowing. (**a**) Before swallowing, the esophagus (*arrow heads*) was seen covering half of the distance between trachea (*T*) and carotid artery (*C*); (**b**) during swallowing, the esophagus moved laterally toward the carotid artery, virtually covering the whole area between 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 increase in hyperechogenic shadow in the trachea (Reproduced with permission from Philip Peng Educational Series)

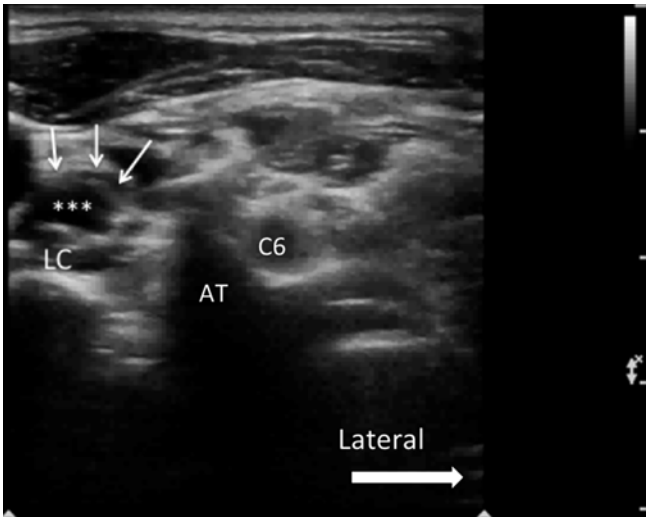
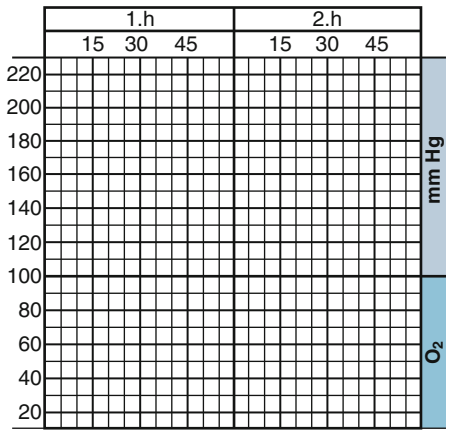


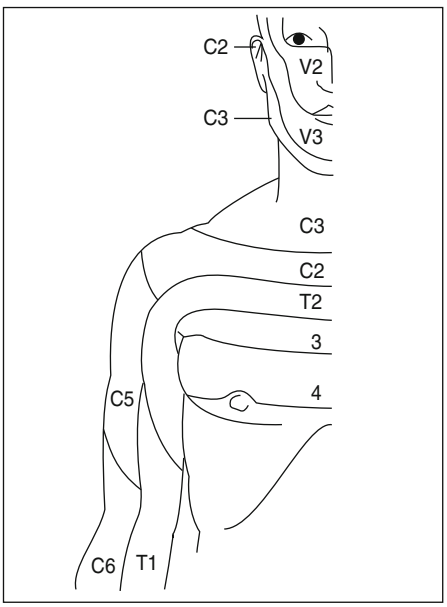
Fig. 13.15 Ultrasonographic image of neck at C6 level showing the local anesthetic spread within the prevertebral fascia following the injection. *C6* C6 nerve root, *AT* anterior tubercle of C6, *LC* longus colli muscle, *arrows* prevertebral fascia, *** local anesthetic (Reproduced with permission from Philip Peng Educational Series)

Conclusions

The use of ultrasound for SGB allows identification of important soft tissue structures relevant to the cervical sympathetic chain. Real-time visualization of the needle during advancement, ability to confirming spread of injectate in the appropriate fascial plane, and avoidance of exposure to radiation are other benefits of using US for this procedure. There is reasonable support in the published literature for performing US-guided SGB for enhancing accuracy, efficacy, and safety.

Record and checklist





With permission from Danilo Jankovic

Cervicothoracic ganglion (stellate ganglion)

Block no. ☐ Right ☐ Left

Name: _____ Date: _____

Diagnosis: _____

Premedication: ☐ No ☐ Yes _____

Purpose of block: ☐ *Diagnostic* ☐ *Therapeutic*

Needle: ☐ *22 G* ☐ *40 mm long* ☐ *50 mm long*

i.v. access: ☐ *Yes*

Monitoring: ☐ *ECG* ☐ *Pulse oximetry*

Ventilation facilities: ☐ *Yes (equipmet checked)*

Emergency equipment *(drugs):* ☐ *Checked*

Patient: ☐ *Informed*

Position: ☐ *Supine* ☐ *Neck extended*

Approach: ☐ *Paratracheal* ☐ *C6* ☐ *C7*
☐ *Ultrasound - guided*
☐ *Transducer* ☐ *Linear*
☐ *In plane* ☐ *Out of plane*

Local anesthetic: _____ *ml* _____ *%* _____

Test dose: _____ *ml*

Addition to
Injection solution: ☐ *No* ☐ *Yes* _____

Patient's remarks during injection:
☐ *None* ☐ *Pain* ☐ *Paresthesias* ☐ *Warmth*

Nerve region _____ _____ _____

Objective block effect after 15 min:
☐ *Cold test* ☐ *Temperature measurement right* ____ *°C left* ____ *°C*

Horner's syndrome: ☐ *Yes* ☐ *No*

Segment affected: ☐ *C2* ☐ *C3* ☐ *C4* ☐ *C5* ☐ *T* ____

Monitoring after block: ☐ *< 1 h* ☐ *> 1 h*

Time of discharge _____

Complications: ☐ *None*
☐ *Yes (intravascular, epidural, subarachnoid injection, other)* _____

Side effects: ☐ *None*
☐ *Yes (recurrent laryngeal nerve, phrenic nerve, vagus* _____

Subjective effects of the block: *Duration:* _____
☐ *None* ☐ *Increased pain*
☐ *Reduced pain* ☐ *Relief of pain*

VISUAL ANALOG SCALE

0 10 20 30 40 50 60 70 80 90 100

Special notes:
_____
_____
_____

References

1. Abdi S. A new and easy technique to block the stellate ganglion. Pain Physician. 2004;7:327–31.
2. Bhatia A, Flamer D, Peng PW. Evaluation of sonoanatomy relevant to performing stellate ganglion blocks using anterior and lateral simulated approaches: an observational study. Can J Anaesth. 2012;59:1040–7.
3. Bhatia A, Brull R. Review article: is ultrasound guidance advantageous for interventional pain management? A systematic review of chronic pain outcomes. Anesth Analg. 2013;117:236–51.
4. Bruneau M, Cornelius JF, Marneffe V, Triffaux M, George B. Anatomical variations of the V2 segment of the vertebral artery. Neurosurgery. 2006;59:20–4.
5. Christie JM, Martinez CR. Computerized axial tomography to define the distribution of solution after stellate ganglion nerve block. J Clin Anesth. 1995;7:306–11.
6. Civelek E, Kiris T, Hepgul K, Canbolat A, Ersoy G, Cansever T. Anterolateral approach to the cervical spine: major anatomical structures and landmarks. J Neurosurg Spine. 2007;7:669–78.
7. Elias M. Cervical sympathetic and stellate ganglion blocks. Pain Physician. 2000;3:294–304.
8. Fitzgerald MJT. Neuroanatomy: basic and clinical. 3rd ed. London: WB Saunders; 1996.
9. Gofeld M, Bhatia A, Abbas S, Ganapathy S, Johnson M. Development and validation of a new technique for ultrasound-guided stellate ganglion block. Reg Anesth Pain Med. 2009;34:475–9.
10. Higa K, Hirata K, Hirota K, Nitahara K, Shono S. Retropharyngeal hematoma after stellate ganglion block. Anesthesiology. 2006;105:1238–45.
11. Hogan QH, Erickson SJ. MR imaging of the stellate ganglion: normal appearance. AJR Am J Roentgenol. 1992;158:655–9.
12. Hogan Q, Erickson S, Haddox D, et al. The spread of solution during stellate ganglion block. Reg Anesth. 1992;17:78–83.
13. Janik JE, Hoeft MA, Ajar AH, Alsofrom GF, Borrello MT, Rathmell JP. Variable osteology of the sixth cervical vertebra in relation to stellate ganglion block. Reg Anesth Pain Med. 2008;33:102–8.
14. Kapral S, Krafft P, Gosch M, Fleischmann M, Weinstabl C. Ultrasound imaging for stellate ganglion block: direct visualization of puncture site and local anesthetic spread. A pilot study. Reg Anesth. 1995;20:323–8.
15. Kumar N, Thapa D, Gombar S, Ahuja V, Gupta R. Analgesic efficacy of pre-operative stellate ganglion block on postoperative pain relief: a randomised controlled trial. Anaesthesia. 2014;69:954–60.
16. Matula C, Trattnig S, Tschabitscher M, Day JD, Koos WT. The course of the prevertebral segment of the vertebral artery: anatomy and clinical significance. Surg Neurol. 1997;48:125–31.
17. Narouze S, Vydyanathan A, Patel N. Ultrasound-guided stellate ganglion block successfully prevented esophageal puncture. Pain Physician. 2007;10:747–52.
18. Narouze S. Beware of the “serpentine” inferior thyroid artery while performing stellate ganglion block. Anesth Analg. 2009;109:289–90.
19. Narouze S. Ultrasound-guided stellate ganglion block: safety and efficacy. Curr Pain Headache Rep. 2014;18:424.
20. Okuda Y, Urabe K, Kitajima T. Retropharyngeal or cervicomediastinal haematomas following stellate ganglion block. Eur J Anaesthesiol. 2003;20:757–9.
21. Shibata Y, Fujiwara Y, Komatsu T. A new approach of ultrasound-guided stellate ganglion block. Anesth Analg. 2007;105:550–1.
22. Siegenthaler A, Mlekusch S, Schliessbach J, Curatolo M, Eichenberger U. Ultrasound imaging to estimate risk of esophageal and vascular puncture after conventional stellate ganglion block. Reg Anesth Pain Med. 2012;37:224–7.
23. Slapppendel F, Thijssen H, Crul BJ, et al. The stellate ganglion in magnetic resonance imaging, a quantification of anatomic variability. Anesthesiology. 1995;83:424–6.
24. Stanik-Hutt JA. Management options for angina refractory to maximal medical and surgical interventions. AACN Clin Issues. 2005;16:320–32.
25. Stanton-Hicks MD, Burton AW, Bruehl SP, et al. An updated interdisciplinary clinical pathway for CRPS: report of an expert panel. Pain Pract. 2002;2:1–16.
26. Takanami I, Abiko T, Koizumi S. Life-threatening airway obstruction due to retropharyngeal and cervicomediastinal hematomas following stellate ganglion block. Thorac Cardiovasc Surg. 2009;57:311–2.
27. Tubbs RS, Loukas M, Remy AC, Shoja MM, Salter EG. The vertebral nerve revisited. Clin Anat. 2007;20:644–7.
28. van Eijs F, Geurts J, van Kleef M, Faber CG, Perez RS, Kessels AG, Van Zundert J. Predictors of pain relieving response to sympathetic blockade in complex regional pain syndrome type 1. Anesthesiology. 2012;116:113–21.
29. Williams PL. Gray’s anatomy. 38th ed. New York: Churchill Livingstone; 1995.