TECHNICAL NOTE

CERVICOTHORACIC SYMPATHETIC BLOCK

SERVİKOTORASİK SEMPATİK BLOK

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Gazi Medical Journal 2002; 13: 207-213

SUMMARY: In this article, the anatomy of stellate ganglion and upper thoracic chain, which are frequently used in the diagnosis and treatment of sympathetically mediated pain, were reviewed. Several techniques, indications and complications are discussed.

Key Words: *Pain, Sympathetic Block, Upper Extremity.*

ÖZET : Bu makalede sempatik kökenli ağrının tanımı ve tedavisinde sıklıkla kullanılan stellat ganglion ve üst torasik sempatik zincirin anatomisi gözden geçirildi. Çeşitli teknikler, endikasyonlar ve komplikasyonlar tartışıldı.

Anahtar Kelimeler: *Ağrı, Sempatik Blok, Üst Ekstremite.*

INTRODUCTION

One of the methods used in pain treatment when pharmacological treatment fails is somatic and sympathetic nerve blockade. These blockades are performed on the upper extremity (brachial (1), suprascapular (2) and stellate (3)) are used for diagnostic, prognostic and therapeutic purposes.

Stellate ganglion and upper thoracic sympathetic blockades frequently mediate pain originating from the head, neck, upper extremity and upper thoracic region (3). Sympathetic blockade, accomplished by subarachnoid, epidural or paravertebral techniques, usually blocks both somatic and sympathetic fibers. Isolated sympathetic blockade to a region is characterized by loss of sympathetic tone without altered somatic sensation (4).

Preganglionic fibers to the head and neck exit with the ventral roots of T1 and T2 and then travel as white communicating rami before joining the sympathetic chain and passing cephalad to the synapse at the inferior (stellate), middle or superior cervical ganglion. Postganglionic fibers either follow the carotid arteries to the head or integrate as gray communicating rami before joining the cervical plexus or upper cervical nerves to innervate neck structures. To achieve successful sympathetic denervation of the head and neck, the stellate ganglion, where all preganglionic fibers either synapse or pass through on their way to more cephalad ganglia, must be blocked. The stellate ganglion is usually formed from a fusion of lower cervical and first thoracic ganglia. The ganglion is commonly 2.5 cm long, 1 cm wide and 0.5 cm thick. The stellate ganglion is limited medially by the longus colli muscle, laterally by the scalene muscles, anteriorly by the subclavian artery, posteriorly by the transverse processes and prevertebral fascia, and inferiorly by the posterior aspect of the pleura. The vertebral artery originating from the subclavian artery passes over the ganglion, enters the vertebral foramen and lies posterior to the anterior tubercle of the C6 vertebra. Other structures posterior to the stellate ganglion include the anterior divisions of the C8 and T1 nerves.

Preganglionic sympathetic fibers to the upper extremity originate from the T2-T8 and occasionally T9 vertebral segments. White communicating rami synapse at the second thoracic, first thoracic or stellate ganglion and occasionally the middle cervical ganglion. Gray communicating rami originating from the sympathetic ganglia join with the anterior divisions of the nerves, which form the brachial plexus at the level of C5-T1. Gray communicating rami that innervate distal structures of the upper extremity without passing through the stellate ganglion, but join the brachial plexus, are called Kuntz nerves. Some postganglionic fibers pass directly from the chain to form the subclavian perivascular plexus and innervate the subclavian, axillary and upper part of the brachial arteries.

Indications and Contraindications

The indications of cervicothoracic sympathetic block are listed in Table 1. Some of the indications are controversial, and reports of efficacy are based largely on case reports instead of large controlled studies. In the angina pectoris, blockade of the upper five thoracic sympathetic ganglia is required in addition to the stellate ganglion to achieve adequate effect (5). Absolute contraindications of the block include anticoagulant therapy, pneumothorax or pneumonectomy on the contralateral side, new myocardial infarcts, glaucoma and atrioventricular blocks.

Technique

Although the stellate ganglion block can be performed quickly and painlessly in skilled hands, necessary equipment and drugs for standard resuscitation, suction and oxygen must be readily accessible.

Anterior Paratracheal Approach

The anterior paratracheal approach is the easiest and most commonly performed technique. The patient lies supine with a thin pillow under the shoulders used to facilitate extension of the head and neck on the midline. Hyperextension of the neck causes the esophagus to become midline, away from the transverse processes on the left. The patient is asked to open his/her mouth slightly to relax the anterior cervical musculature.

The site of needle entry is below the cricoid cartilage at the C6 level (Chassaignac's tubercle). Generally, this level is approximately 3 cm cephalad to the sternoclavicular joint. Chassaignac's tubercle is located at the medial border of the sternocleidomastoid muscle, approximately 1.5 cm lateral to the midline. By inserting two fingers between the sternocleidomastoid muscle and trachea, the carotid artery is pushed away laterally and the trachea toward the midline with the fingers slightly separated, so that the tubercle lies between them. A 23G needle of 4-5 cm length is inserted perpendicular to the skin. The needle is advanced until it makes contact with either the C6 tubercle or the junction between the C6 vertebral body and the tubercle. Although the depth of these structures differs, it is rarely beyond 2 to 2.5 cm when the skin is properly displaced posteriorly by the nondominant finger. Once the bone is encountered, the needle is withdrawn 2-3 mm and the drug is injected.

Before injection of the drug, a careful aspiration for blood and cerebrospinal fluid must be performed, followed by a test dose. The patient is asked not to speak during the procedure as this may cause movement of the neck musculature resulting in dislodgement of the needle from its proper location. A high resistance to injection may indicate periosteal injection, and a significant but lesser resistance indicates that the needle is still in the prevertebral muscle, while radiating pain or paraesthesia in the hands or arms indicates that the needle is too deep, adjacent to the C6-7 nerve root. Repositioning of the needle is therefore necessary.

The total volume of the drug is determined by the level of block desired. If the needle is placed properly, a 5 ml volume is sufficient to block the stellate ganglion. An injection of 10 ml of solution may provide sympathetic denervation of the upper extremity, even in patients with Kuntz nerves. If it is performed to relieve the sympathetically mediated pain of the thoracic vissera including the heart, 15 to 20 ml of solution must be administered (5).

When the anterior approach to stellate ganglion at C7 is used, it is very difficult to palpate the C7 tubercle. A complete sympathetic denervation of the upper extremity can be achieved by using a low volume of local anesthetic injected 1.5 cm caudad from the inferior tip of Chassaignac's tubercle. The relatively rare incidence of recurrent laryngeal nerve paralysis may be an advantage of this approach. Two important disadvantages are the less pronounced landmarks and high risk of pneumothorax.

Posterior Thoracic Approach

The posterior technique can be used when Horner's syndrome occurs with an anterior approach without other signs of sympathetic denervation. Kuntz's nerves with atypical localization can only be blocked by the posterior approach. If the desired effect cannot be achieved despite repetitive, well-performed blocks, the patient may have a fascial tissue barrier preventing caudal diffusion of the drug. Sympathetic denervation of the upper extremity can be provided by the blockade of both the T2 and T3 levels. If hand pain is the predominant symptom, T2 and T3 are preferred for denervation.. Frequently T4 and occasionally T1 and T5 level blockade are also needed for optimal effect.

Different methods for the blockade technique have been described. In the classic method, the needle is inserted 6 cm from the midline. The risk of damage to pleura and parenchymal tissue is high with this approach. A distance of 3-4 cm from the midline also allows proper alignment. The posterior approach can be performed with the patient either prone or lateral with the side to be blocked uppermost. Under fluoroscopic guidance at T2 and T3 levels, a 8-10 cm long 22G needle is inserted 3-4 cm lateral from the spinous processes in the midline and advanced until it

Table 1: Indications of cervicothoracic sympathetic block.

Pain	**Peripheral vascular diseases**
Complex regional pain syndrome (CRPS)	Acute artery obliteration
Type I: Reflex sympathetic dystrophy	Thrombosis
Type II: Cosalgia	Embolism
Type III: Sympathetically maintained pain	Direct injury
Herpes zoster	Intraarterial thiopental injection
Acute Herpes zoster	Acute venous thrombosis
Postherpetic neuralgia	Chronic vasospastic diseases
Postamputation pain syndromes	Raynaud's disease
Phantom pain	Cold injury
Stump pain	Acrocyanosis
Cancer pain	Chronic arterial diseases
Pancoast tumors	Thromboangitis obliterans (Burger)
Extremity pain following mastectomy	Vascular and reimplantation surgery
Postradiation neuritis	To increase postoperative blood flow
Musculoskeletal system disorders	Scleroderma
Myofascial pain syndrome	
Acute bursitis, tendinitis, tenosynovitis	**Others**
Acute traumatic injuries	Hyperhydrosis
Other neuropathic pain	To increase local edema drainage
Hyperesthesia	Meniere's disease
Allodynia	Shoulder/hand syndrome
Susceptibility to cold	
Thalamic syndrome	
Central pain	
Paget's disease	
Thoracic visceral pain	
Angina pectoris	
Headaches	
Cluster headaches	
Some migraine type headaches	
Atypical facial neuralgia	

Table 2: Evaluation of the sympathetic block.

Blood flow	Sympathetic function
Plethysmography (muscle and skin) 9,10	Skin conduction response 23,24
Xenon-133 clearance(muscle and skin) 11	Sweat test
Sodium-24 clearance (muscle and skin) 12	Ninhydrin 25
Antipyrine clearance 13	Cobalt blue 26
Laser Doppler flowmetry 14,15	Skin plethysmography and ice response 26
Pulsation 16,17	
Skin temperature 18,19	**Pain**
Distal perfusion pressure 20,21	Pain score 26
Capillary oxygenation (muscle and skin) 22	Analgesic requirement
Venous saturation 18	Activity
Metabolism 18	

contacts the ipsilateral lamina. Then the needle is positioned laterally off the lamina until it passes through the anterior costotransverse ligament. The thoracic sympathetic chain is located at the junction of the anterior two thirds of the vertebral body with the posterior one third. Once proper localization is confirmed with a radioopaque material, 2-3 ml of local anesthetic or neurolytic drug is given with careful aspiration. The space lateral to the T1 spinous process can be used when a local anesthetic is given. Neurolytic interventions must be performed from T2 and T3 spinous processes under radiologic guidance.

The high risk of pneumothorax with the posterior approach as a result of the proximity of the lung apex to the upper thoracic ganglia can be eliminated by using CT. The risk of intravertebral diffusion of the drug necessitates close monitoring of the patient (6).

Evaluation of the Efficacy of Sympathetic Blockade

Horner's syndrome is a sign of successful cervical sympathetic blockade. Myosis, ptosis and enophthalmus may be associated with conjunctival and nasal congestion and facial anhydrosis. It must be kept in mind that these signs can be present without complete interruption of the sympathetic nerves to the upper extremity (7).

Sympathetic blockade of the upper extremity results in the visible engorgement of the veins on the back of the hand and forearm. There may be no change in peripheral circulation in patients with severe arterial obliteration despite complete sympathetic blockade. The lower the blood flow and temperature in the extremity before the block, the higher the increase in blood flow and temperature after the block (8). Different methods to evaluate the efficacy of sympathetic blockade are shown in Table 2 (9-26).

Side Effects and Complications

Side effects after the stellate ganglion block should be distinguished from complications. The most distressing side effects are ptosis, myosis and nasal congestion due to Horner's syndrome. Horner's syndrome is less frequent with the posterior approach when compared to the anterior. The risk decreases when T1 ganglion blockade is avoided.

Common complications occur from the diffusion of local anesthetic solution into nearby nervous structures. There may be complaints of hoarseness, feelings of a lump in the throat, and sometimes a subjective shortness of breath as a result of recurrent nerve blockade. Bilateral stellate block is not recommended because of the possible risk of respiratory compromise and loss of laryngeal reflexes due to bilateral recurrent nerve blockade. Loss of cardioaccelerator activity may result in bradycardia and hypotension. Phrenic nerve blockade can cause temporary paralysis of the diaphragm and respiratory compromise in patients with limited respiratory reserve. Spread of the drug along the prevertebral fascia and excessively deep needle localization can result in partial brachial plexus block (27).

The technical complications are pneumothorax, air embolism, hematoma, mediastinitis due to the puncture of the esophagus, and osteitis (5,6). As a result of the proximity of the lung apex to T1 and T2 ganglia, the risk of pneumothorax is higher in the posterior approach (4%) when compared to the anterior. However, the risk of pneumothorax also exists with the anterior approach in tall and thin patients if the C7 tubercle is used and the needle is inserted caudally.

The most important complications from a stellate ganglion block are intraspinal and intravascular injections. Thoracic sympathetic ganglia lie very close to the somatic roots near the neck of the ribs. The longus colli and anterior scalene muscles, which separate the sympathetic ganglia from the somatic roots in the cervical region, do not exist in the thoracic region. As a result of this, the risk of intravertebral diffusion is higher in the posterior approach (6). Epidural and intrathecal injections may result in respiratory embarrassment and the need for mechanical ventilation. If this occurs, sedation and control of the airway is required until the local anesthetic wears off. The vertebral artery is the most common site for intravascular injection. Small amounts of local anesthetic may result in unconsciousness, respiratory paralysis, convulsions and hypotension (28).

Neurolysis and Radiofrequency Thermocoagulation

The duration of the effect of stellate ganglion blockade is short despite the use of long-acting local anesthetics. However, in peripheral vascular diseases, a long-term effect can be achieved with a series of repetitive injections up to 10-15 times. In the anterior approach, a continuous blockade by introducing a radiopaque Teflon catheter under fluoroscopic guidance has been described. There is a risk of infection and the catheter can migrate into the vertebral artery, dural cuff or other structures (29).

The spread of neurolytic agent into the intrathecal space or brachial plexus may result in serious irreversible complications in neurolytic stellate ganglion blockade. Neurolysis of the stellate ganglion has been avoided because of the risk of producing permanent Horner's syndrome.

Surgical methods can also be used for sympathetic denervation. This is usually done at the T2-4 level, leaving the ganglion at T1 intact, so that Horner's syndrome is avoided. However, even with this technique incomplete pain relief and recurrences can occur.

Radiofrequency (RF) current was first used to produce a permanent lesion for lumbar facet blockade in 1975. RF denervation of the stellate ganglion was described in 1988. RF lesioning is a few millimeters in diameter and therefore will not cause total destruction of the ganglion. RF denervation, which does not cause Horner's syndrome like other sympatholytic procedures, can be repeated if necessary. Test blocks should be performed with local anesthetics under fluoroscopic guidance before thermal lesioning. The volume of local anesthetic must not exceed 2 ml to achieve a high success rate with RF. RF lesioning must be performed at the level where the best efficacy with test blocks is achieved. In some cases, both cervical and thoracic level denervation may be necessary.

Under fluoroscopic guidance, an RF cannula with a 5 mm active tip is advanced from an anterior approach until the superolateral aspect of the C7 body is encountered. The cannula is pulled back approximately 2 mm anteriorly as the active tip is positioned anterior to the longus colli. The correct stimulation technique is crucial to avoid injury to the phrenic and recurrent laryngeal nerves. A triangular zone of thermal interruption of sympathetic fibers is created with three lesions. The first of the lesions is at the point just described above, the second point just lateral and caudal, on the medial aspect of the transverse process, and the last point 1 cm caudal, on the anterolateral aspect of the vertebral body. Prior to each lesion, it must be confirmed that the stimulation is negative with 2 V at 50 Hz. While stimulating with 2.5 V at 2 Hz, the patient is asked to say the letter "E". Impairment of the ability to articulate this letter shows that the cannula is very close to the laryngeal nerve. At the same time, a hand is placed just under the rib cage to feel the movement of the diaphragm. The phrenic nerve is lateral to the lesion region. If any movement is felt in the diaphragm, the cannula must be directed medially for proper position. After proper stimulation parameters have been met, 0.5 ml local anesthetic is injected through the cannula and a lesion is made at 80°C for 30 s. The same process is repeated at the other points. The lesion on the medial aspect of the transverse process must be performed with extreme care.

The anterior portion of the transverse process is quite narrow at this point, and so the cannula must be positioned correctly in order to prevent injury to the segmental nerves or vertebral artery. A fourth lesion can be made to interrupt some of the thoracic sympathetic fibers by directing the RF cannula in a caudal fashion where the head of the first rib meets the ventrolateral aspect of the body of T1.

The patient is placed in a prone position on the fluoroscopy table if denervation is to be performed from the T2 and T3 levels. An RF cannula with a 10 mm active tip is advanced toward the lateral edge of the vertebral body inferior to the level of the rib. Stimulation at 50 Hz with 1 V will cause deep aching in the chest and back, but paresthesia of the thoracic segmental nerves should be absent. Intercostal fasciculation must not be seen at 2 Hz, 3 V motor stimulation. After the injection of 1 ml local anesthetic, a thermal lesion is performed at each level for 60 s at 80°C. The cannula is repositioned to make second and third lesions 5 mm cranially and 5 mm caudally. After RF denervation, 15% of patients may experience neuritis as a burning sensation in the area of the breast and upper chest wall for 1 to 2 weeks.

Sympathetic denervation with RF is an alternative therapeutic method for long-term pain control (30-34). However, more controlled clinical studies should be performed to describe the efficacy and duration of action of sympathetic denervation using this technique.

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