The effectiveness of different techniques of interscalene brachial plexus block with general anesthesia for shoulder arthroscopy

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Abstract

Background: Interscalene brachial plexus block is usually used for analgesia and anesthesia for shoulder surgeries. Different techniques of interscalene brachial plexus block can be used which will be discussed in this article.

Keywords: Interscalene, brachial plexus block, ultrasound, peripheral nerve stimulator.

Introduction: Peripheral nerve blocks are now commonly used for postoperative analgesia or together with general anesthesia and sometimes instead of it in a wide variety of surgical procedures. This occurs by applying the local anesthetic on the nerve plexus so it will be anesthetized. Block of the brachial plexus is widely used for upper limb procedures. **(Blavias et al., 2011)**

Anatomy of brachial plexus:

The brachial plexus is a complex anatomical network of nerves that mainly supplies the upper limb. **(Emamhadi et al., 2016).**

It most commonly originates from the anterior divisions (ventral rami) of the lower 4 cervical spinal nerves (C5-C8) and the first thoracic spinal nerve (T1). The major role of the brachial plexus is to provide nerve supply to the upper extremity, but it also has sensory and motor branches to the upper thoracic wall and some cervical structures (**Sala-Blanch et al., 2016).**

Nerve anatomy

As the nerve roots exit the cervical and thoracic foramina they unite and branch in a well described pattern in the following order: roots, trunks, divisions, cords, terminal branches and peripheral nerves. The roots represent the ventral rami of the C5 to T1 spinal nerves that unite in the neck, between the anterior and middle scalene muscles, to form the trunks after giving segmental supply to the prevertebral and scalene muscles **(Feigl et al., 2020).**

The upper three roots (C5 to C7) exit above their numbered cervical vertebra, while the C8 and T1 roots exit below the seventh cervical and first thoracic vertebrae, respectively. A prefixed plexus describes contribution from C4 to the C5 anterior divisions, and a postfixed plexus describes contribution from T2 to T1. Neither variant is frequent, but the prefixed pattern has been reported more frequently than the postfixed one. **(Park et al., 2017).**

The dorsal scapular nerve (C5), long thoracic nerve (C5, C6 & C7), and first intercostal nerve (T1), are branches that arise from the roots before they unite to form the trunks. The phrenic nerve also receives and gives contribution to the brachial plexus at this level (Fig. 1). The phrenic nerve can be seen coursing from C4 distally. It often gives contributions to C5, as evidenced by the nerve being thicker proximal to the C5 root and thinner distally, indicating that it has contributed axons to C5 before entering the thorax **(Leonhard et al., 2016).**

The trunks of the brachial plexus are located in the lower part of the posterior cervical triangle of the neck. The upper trunk forms from C5 and C6 and gives off the suprascapular nerve and the nerve to subclavius. The middle trunk represents the continuation of the C7 nerve root. Finally, the lower trunk is formed from the union of the C8 and T1 nerve roots. Each trunk then divides into anterior and posterior divisions as they pass beneath the clavicle. There are no nerve branches at this level **(Griffith, 2018).**

The divisions converge in the axilla, beneath the pectoralis minor muscle, to form the posterior, lateral, and medial cords. The cords are named based on their position with respect to the axillary artery. The posterior divisions of all three trunks unite to form the posterior cord. Therefore, this cord receives input from all levels of the brachial plexus (C5 to T1). Three nerves that originate from the posterior cord: the upper and

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lower subscapular and the long thoracic nerves. The posterior cord then continues and terminates as the axillary and radial nerves **(Claassen et al., 2016).**

The lateral cord is formed by the union of the anterior divisions of the upper and middle trunks, receiving input from C5, C6 and C7. It gives off the lateral pectoral nerve and then terminates as the musculocutaneous nerve and the lateral root of the median nerve. The medial cord is the continuation of the anterior division of the lower trunk, taking its input mainly from C8 and T1. Branches arising from the medial cord include the medial pectoral nerve, the medial brachial cutaneous nerve, and the medial antebrachial cutaneous nerve. This cord terminates as the ulnar nerve and the medial root of the median nerve, which unites with the lateral root of the nerve from the lateral cord to form the median nerve proper (obtaining input from C5, C6, C7, C8 and T1) **(Nwawka, 2019).**

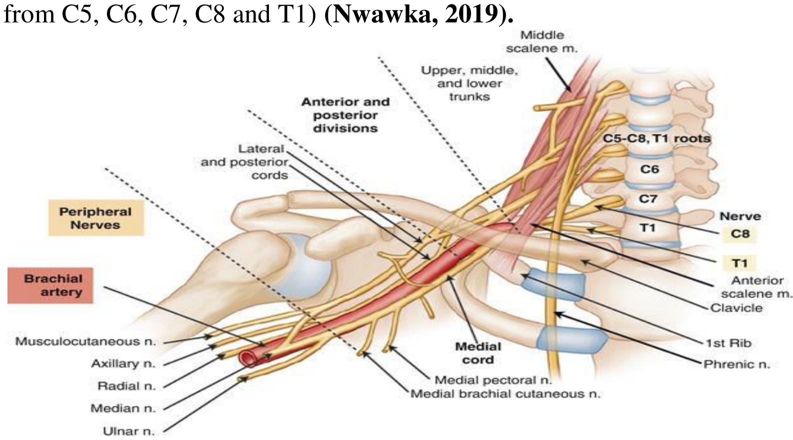

Fig. 1. Anatomy of the brachial plexus. (Reproduced with permission from **Bentz ML, Bauer BS, Zuker RM**. Principles & Practice of Pediatric Plastic Surgery. St. Louis: Quality Medical Publishing, Inc., **2018**.)

Anatomy of Interscalene Triangle:

The inter-scalene triangle is a region of the neck that holds fundamental structures to the upper extremity function. The triangle is composed of two muscles and the first rib. The two neck muscles are the anterior and middle scalenes. This triangle is integral for upper extremity anesthesia because it identifies the location of the brachial plexus **(Dahlstrom et al., 2012).**

The brachial plexus is the source of the nerves of the rest of the arm and is fundamental in the extremity's functionality. Issues with this plexus, specifically at the level of the inter-scalene triangle, can be detrimental to the quality of life of a patient; these issues are otherwise known collectively as thoracic outlet syndrome. Other problems can occur with the vascular structures of the triangle, specifically the subclavian artery and the neighboring subclavian vein. Occlusions can lead to aneurysms and weakness of the arm **(Georgakopoulos & Lasrado., 2020).**

Boundaries of the Interscalene Triangle: (Fig 3)

The two muscles that form the triangle include the anterior and middle scalenes, while the structure creating the base is the first rib (which is actually the insertion point for both muscles). The anterior scalene arises from the transverse processes of the anterior tubercles of C3 to C6. The middle scalene arises from the transverse processes of the posterior tubercles of C2 to C7 **(Farina et al., 2019).**

The anterior side of the triangle is created by the anterior scalene, while the middle scalene forms the posterior side of the triangle **(Abdel Ghany et al., 2017).**

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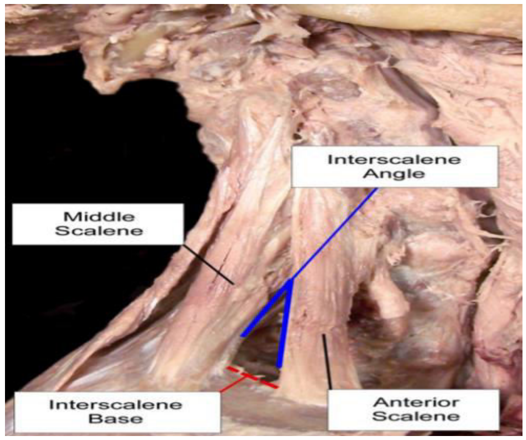

Fig 3. Depiction of the interscalene triangle, illustrating the scalene musculature as well as the interscalene angle and interscalene base **(Georgakopoulos & Lasrado., 2020).**

The anterior and middle scalene allow for flexion of the cervical spine. These muscles are also accessory muscles of respiration when the cervical spine is stationary; this is possible because of their insertion onto the first and second ribs. This triangle is not classically known for its respiratory functionality; regardless of this, its insertion onto the first two ribs allows for this important physiological mechanism of life **(Ghany et al., 2017).**

The subclavian artery and vein are at the base of the inter-scalene triangle. The subclavian artery passes directly through the triangle with the brachial plexus, while the vein remains at the lower border. Compression of these vascular structures can lead to weakness, numbness, and vascular compromise **(Wijeratna et al., 2014).**

Related Nerves:

Near the inter-scalene angle, located at the upper part of the triangle, lay the anterior rami of the third through fifth cervical spinal nerves. The base of the triangle is the location of the brachial plexus **(Ghany et al., 2017).**

The plexus is involved with the motor and sensory function of the shoulder down to the fingertips. Injuries to this plexus can lead to significant deficits in quality of life **(Ferreira et al., 2017).**

Oblique to the anterior scalene and passing anteriorly to the subclavian artery is the phrenic nerve. The phrenic nerve controls the diaphragmatic muscles for breathing **(Hamada et al., 2015).**

Although the phrenic nerve is not within the triangle, it is similar to the subclavian vein in that because of its relative location to the triangle, it is easily prone to compromise. Another associated nerve is the long thoracic nerve. One of its anterior branches, specifically C7, crosses within the triangle. This nerve becomes subcutaneous near the first and second rib and innervates the serratus anterior muscle **(Jones et al., 2019).**

Techniques of interscalene brachial plexus block:

The Interscalene brachial plexus block can be performed by classic blind technique of Winnie , nerve stimulator (NS)-guided, ultrasound (US)-guided technique or dual technique (ultrasound guidance during nerve block). **(Ahuja et al., 2016).**

Classic blind technique of Winnie:

It is done while patient is lying in supine position with the head turned away from the side to be blocked, after identification of interscalene groove and application of local anesthetic, the needle is inserted 3-4 cm deep, perpendicular to skin in all plains in slightly caudad, medial and posterior direction aimed at localizing ventral rami of C5-C7 nerve roots. On eliciting paresthesia (explained to the patient as sensory perception, tingling or current like) on shoulder, arm, elbow was accepted as evidence of correct needle placement. **(Ahuja et al., 2016).**

The nerve stimulator technique:
During this technique, the fingers of the palpating hand should be gently pressed between the anterior and middle scalene muscles to reduce the distance between the skin and brachial plexus. A needle connected to a nerve stimulator is inserted between the palpating fingers and advanced at an angle almost perpendicular to the skin and in a slight caudal direction. The nerve stimulator should be initially set to deliver 1 mA (2 Hz, 100 µsec). The needle is advanced slowly. Once any motor response of the brachial plexus is elicited, 15–20 mL of local anesthetic is injected slowly, with intermittent aspiration. **(Ahuja et al., 2016).**

The ultrasound guided technique:
With the patient properly positioned, the skin is disinfected, and the transducer is placed over the neck until the appropriate landmarks and structures are identified. There are 2 commonly accepted techniques for finding the proper image. Firstly, the transducer is placed at the level of the cricoid cartilage medial to the sternocleidomastoid muscle, and the carotid artery is identified. The transducer is then slid laterally until the brachial plexus in between the anterior and middle scalene muscles are identified. The second method is to place the transducer just above the clavicle and identifying the subclavian artery with brachial plexus (the image for a supraclavicular block). The transducer is then moved cephalad towards the patient's neck while keeping the brachial plexus nerves in view until the "stop-light" image is seen. The needle is then inserted in-plane to the transducer entering lateral to medial. If preferred the needle can be inserted medial to lateral as well. Once the needle reaches the interscalene groove, after careful aspiration, the local anesthetic is injected. If a nerve stimulator is used, the patient should exhibit a motor response of the shoulder and arm. **(Franco & Williams, 2016).**

The dual guidance technique:
IBPB is performed in a manner similar to ultrasound guided but the needle is attached to peripheral nerve stimulator set. In this technique, the placement of the needle is confirmed in two ways; visually and by electrostimulation, and thus increasing the accuracy and effectiveness of the block. **(Kolny et al., 2017).**
Suitable equipment and technique are keys in providing safe and effective regional anesthesia. While the implementation of ultrasound has significantly increased both safety and effectiveness, successful administration of regional anesthesia depends on additional factors such as physicians' training, patient and block selection (**Barrington et al., 2018).**

In order to avoid regional anesthesia-related peripheral nerve injury, reliable nerve localization is of paramount importance. However, despite sophisticated simulation opportunities, numerous publications, and extensive discussion, little is known about anesthetists' current clinical practice and the technical approaches they use to localize peripheral nerves for regional anesthesia (**Hewson et al., 2018).**

It is done to anesthetizes nerve roots from the cervical plexus (C3, C4, supraclavicular nerve) and upper and middle trunks of the brachial plexus (C5-C7). For positioning, the patient is placed in a supine position with the head turned away from the side of the block. Sternal notch, the sternal and clavicular heads of the sternocleidomastoid muscle, and clavicle are identified and marked. A probe is placed in a transverse position with its long axis across the neck just above the clavicle if using ultrasound. The carotid artery and internal jugular vein are visualized. The subclavian artery is identified by directing the beam towards the first rib. Nerves are then traced cephalad. At the C6 nerves of the brachial plexus are visualized in a vertical orientation within the interscalene groove. A needle is then placed in-plane or out-of-plane and directed toward the nerves. A needle tip is placed next to the nerve roots. A total of 12 cc to 30 cc of local anesthetic is injected. **(Vassiliou, T. et al., 2016).**

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