Role of Pectoral Nerve Block and Erector Spinae Plane Block in Perioperative Analgesia in Breast Cancer Surgeries

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Abstract:

Background: Regional anesthesia techniques constitute an important part of successful analgesia strategies in the perioperative care of patients undergoing breast surgery. Several nerve blocks have been studied for analgesia for breast surgery, including thoracic epidural, paravertebral block, pectoral nerve block and erector spinae plane block, each with its own advantages and disadvantages. Among the side effects of breast surgery in patients with cancer are nausea and vomiting, the risk of which is reduced through regional procedures that reduce the need for opioids.

Keywords: Pectoral Nerve Block, Erector Spinae Plane Block, Breast Cancer.

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Introduction:

Acute postoperative pain is an important risk factor in the development of chronic pain after breast cancer surgery. Persistent pain has a significant negative impact on quality of life in breast cancer survivors (1).

Multimodal analgesia can control postoperative pain and reduce complications of using single mode of analgesia. Reliance on opioid analgesia only, increases the incidence of side effects of opioids, such as respiratory depression, nausea and vomiting. Local anesthetic block may constitute a valid alternative to excessive opioid usage (2).

Ultrasound-guided modified pectoral nerve block and erector spinae plane block are simple regional techniques that can be used for perioperative analgesia as alternative to neuraxial and paravertebral blocks for breast cancer surgeries to decrease the consumption of opioids and decrease their side effects as well as devoid of complications of other regional techniques (3).

Pectoral Nerve Block

Pectoral nerve block (PECS block) is an interfascial peripheral nerve block described by **Blanco** since 2011. The original block is PECS I block, it is an interfascial plane block, in which local anesthetic is deposited between the pectoralis major muscle (PMM) and pectoralis minor muscle

(Pmm) to block the lateral pectoral nerve (C5, 6, 7) and medial pectoral nerve (C8, T1) providing analgesia to the anterior chest wall **(4).**

PECS II block is a modified PECS I. In which, local anesthetic is injected between the serratus anterior and pectoralis minor muscles at the 3rd rib in addition to the original block. It intended to block thoracic intercostal nerves (T2-6) including intercostobrachial nerve and long thoracic nerve (C5-C7). This modification aimed to extend analgesia to the axilla; this is needed for axillary clearance, wide excision, tumorectomy, lymph node excision and several types of mastectomies **(5).**

Anatomy:

- **Muscles of the Pectoral Region:**

The muscles of the pectoral region are pectoralis major, pectoralis minor and serratus anterior muscles **(Fig.1) (6).**

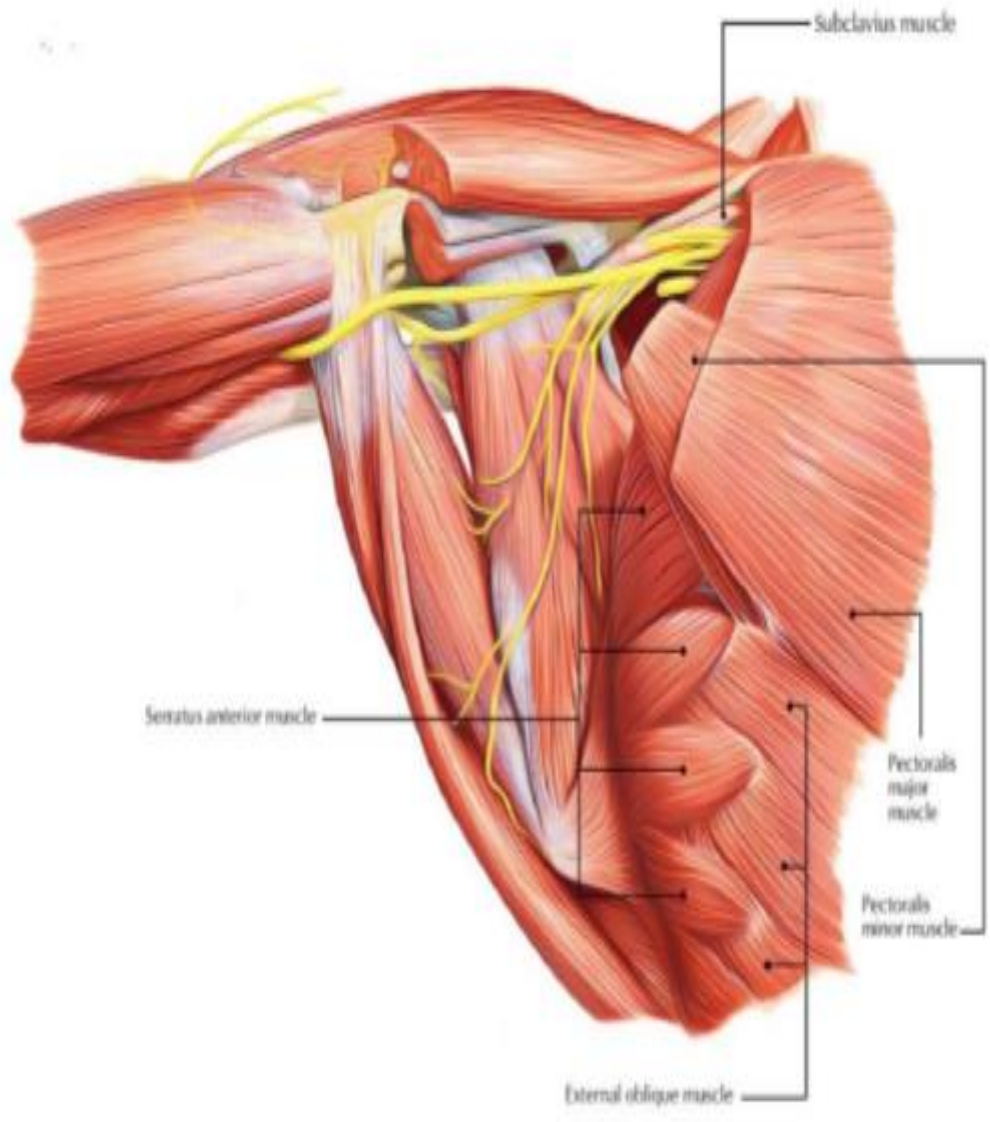

Figure (1): Muscles of the pectoral region (6).

- **The pectoralis major muscle:**

The pectoralis major muscle (PMM) is usually subdivided into clavicular and sternocostal heads. The clavicular head arises from the medial half of the anterior clavicular surface. The sternocostal head originates from the anterior surface of the sternum, second to sixth costal cartilages, and aponeurosis of the external oblique muscle. A common tendon arises from the fusion of the two heads, which inserts into the lateral lip of the bicipital groove (**Fig. 2**). The PMM has been reported to be innervated from C5 to T1 through the lateral and medial pectoral nerves **(7).**

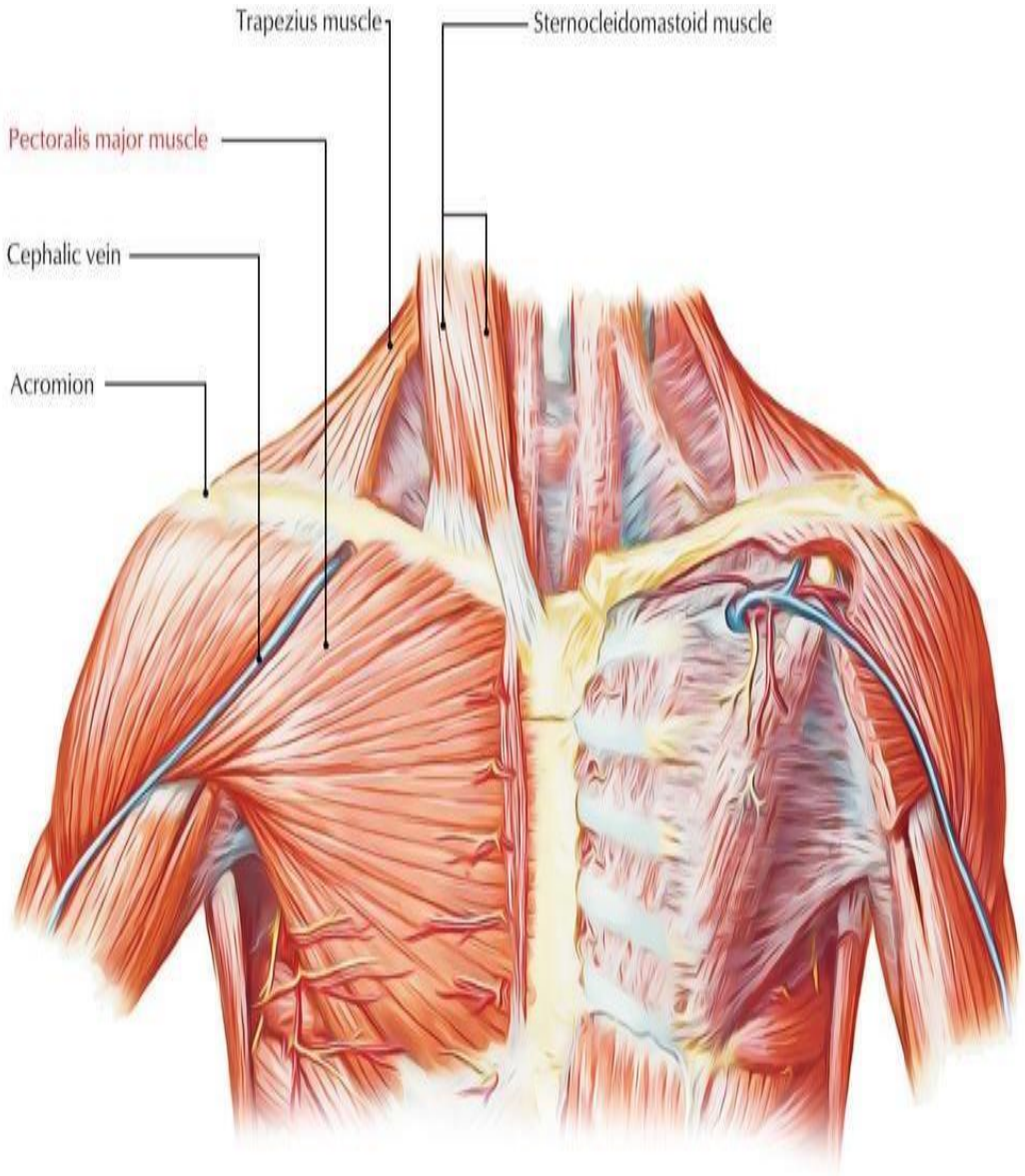

Figure (2): The pectoralis major muscle (7).

- **The pectoralis minor muscle:**

The pectoralis minor muscle (Pmm) arises from the third, fourth, and fifth ribs, near their costochondral junction, and laterally inserts onto the coracoid process **(Fig.3)**. The Pmm has been considered to be supplied by C6 to C8 or by C7 to T1 through the medial pectoral nerve **(6).**

Figure (3): The pectoralis minor muscle (6).

- **The serratus anterior muscle:**

The serratus anterior muscle (SAM) is a fan shaped muscle at the lateral wall of the thorax. Its main part lies deep under the scapula and the pectoral muscles. It arises from the first to ninth rib and inserted at the ventral surface of the medial border of the scapula **(Fig.4)**.

Due to its course it has a serrated or saw toothed appearance. It is supplied by the long thoracic nerve (C5-7) which is a branch of the brachial plexus. It takes blood supply from the lateral thoracic and thoracodorsal arteries **(7).**

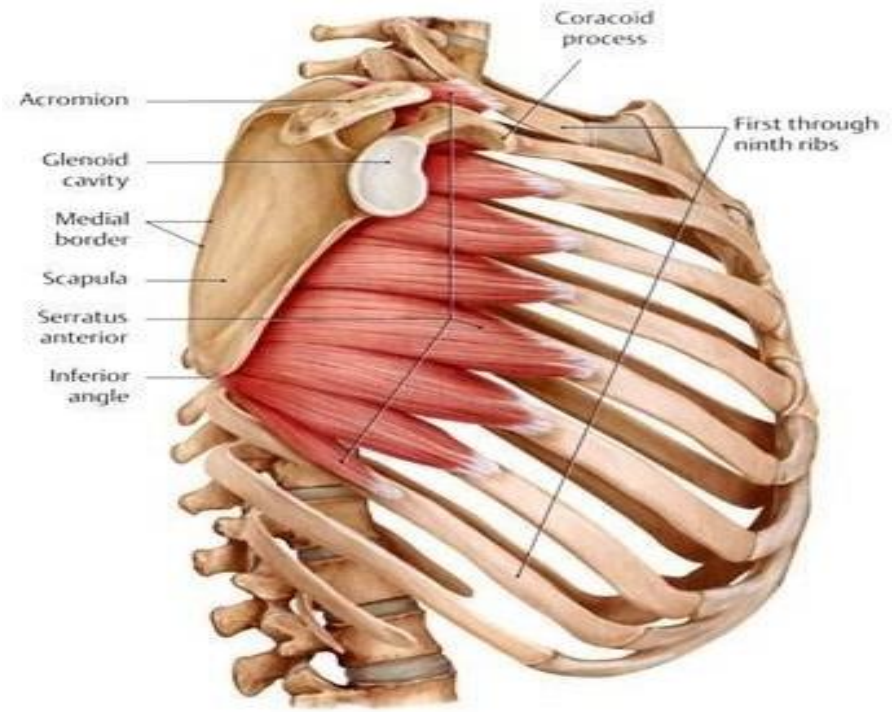

Figure (4): Serratus anterior muscle **(7).**

- **Anatomy of nerves involved in pectoral nerve block:**

A) First set of nerves:

They involve the pectoral nerves, which are the main branches of the brachial plexus that provide motor innervation to pectoral muscles, 2 principal nerves are described; the lateral and medial pectoral nerves **(Fig. 5) (8)**.

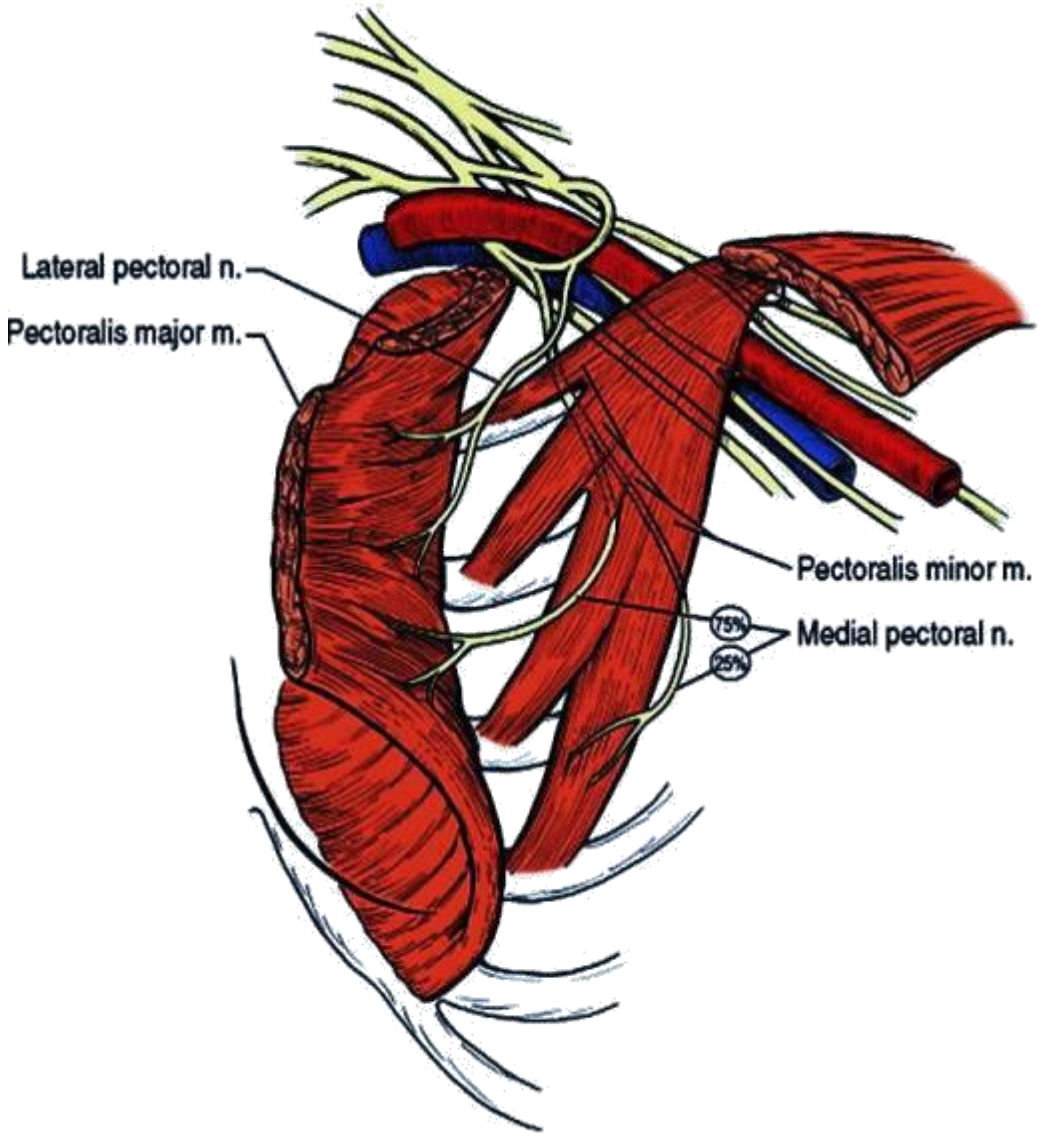

Figure (5): Medial and lateral pectoral nerves (8).

- **The lateral pectoral nerve:**

Lateral pectoral nerve (LPN) arises from the lateral cord of the brachial plexus. Its origin is C5, C6, and C7 spinal nerves **(Fig. 6)**. It is the larger of the two pectoral nerves. Shortly after branching from the lateral cord of the brachial plexus, it may donate a communicating branch to the medial pectoral nerve forming a loop known as the ansa pectoralis. The LPN runs close to the pectoral branch of the thoracoacromial artery in a fascial plane between the PMM and Pmm. The nerve

then passes inferiorly piercing the clavicopectoral fascia, and then it is distributed to the deep surface of the pectoralis major and innervates its clavicular head **(4).**

The lateral pectoral nerve primarily supplies the PMM and due to a communicating branch to the medial pectoral nerve, some lateral pectoral nerve fibers pass to and innervate the Pmm. The LPN also carries nociceptive and proprioceptive fibers. It has fibers that innervate the acromioclavicular joint, periosteum of the clavicle and anterior articular capsule of the shoulder joint and costoclavicular ligaments **(9).**

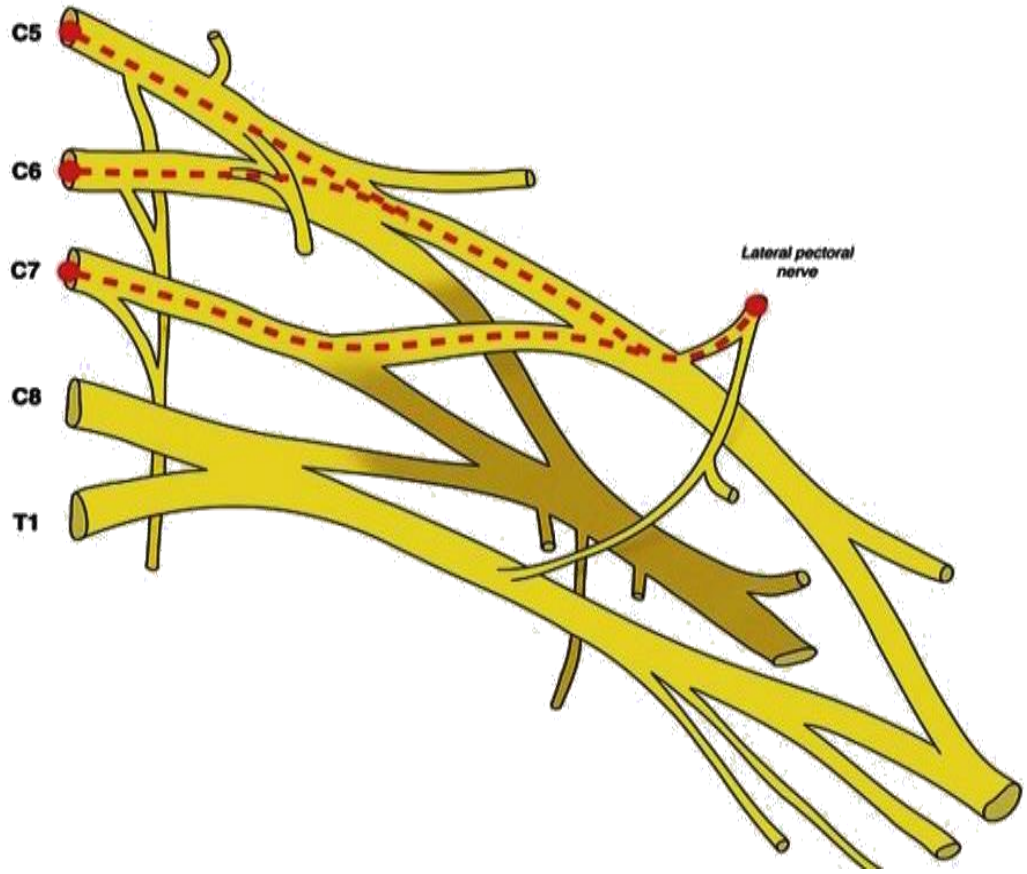

Figure (6): Lateral pectoral nerve **(8).**

- **The medial pectoral nerve:**

The medial pectoral nerve (MPN) comes from the medial cord of brachial plexus. It arises from C8–T1 spinal nerves **(Fig.7)**. The MPN arises posterior to the axillary artery. It curves anteriorly to lie between the axillary artery and vein, then after receiving a communicating branch from the lateral pectoral nerve (the ansa pectoralis), it pierces the Pmm where it divides into many branches, which supply the muscle. Two or three branches pierce the muscle and pass around the lower border of it and end in the pectoralis major to innervate its costal head. It gives sensory innervation to the ventral aspect of the arm and the chest wall near the axilla, mostly in conjunction with the intercostobrachial nerve **(10)**.

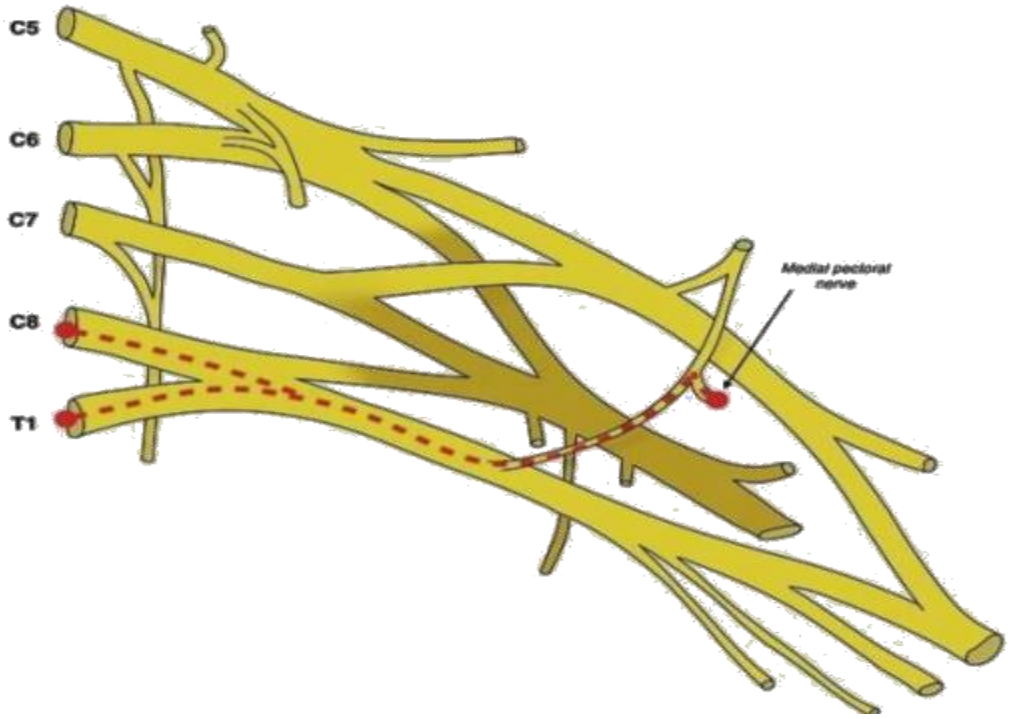

Figure (7): Medial pectoral nerve (8).

B) Second set of nerves:

They involve the anterior divisions of T2 to T6 intercostal nerves including the intercostobrachial nerve (T2). They run in-between the intercostal muscles **(8)**. The intercostal nerves follow the subcostal groove, together with the intercostal vein and artery, arranged from superior to inferior; vein, artery, nerve (VAN). They divide into anterior and lateral cutaneous branches **(10)**.

- **Anterior cutaneous branches:**

The anterior cutaneous branches pierce the intercostal muscles and the fascia in the parasternal line and divide into medial and lateral branches. They supply the medial third of the anterior thoracic wall including medial aspect of the breast after piercing the internal intercostal muscle and PMM in front of the internal mammary artery **(11)**.

The medial branch crosses the lateral border of the sternum while the lateral terminal branch takes inferolateral course and divides to more terminal branches to end at skin of the breast or at areolar edge **(10)**.

- **The lateral cutaneous branches:**

The lateral cutaneous branches pierce the external intercostal and serratus anterior muscles at midaxillary line and they take an inferomedial course to reach the border of the pectoral muscles where it divides into anterior and posterior terminal branches, except the lateral cutaneous branch of the second intercostal nerve as it does not divide and is named the intercostobrachial nerve (T2). Anterior and posterior terminal branches of lateral cutaneous branches innervate the skin of the lateral breast. The anterior branches supply the lateral two thirds of the anterior thoracic wall **(11).**

C) Third group of nerves:

They involve the long thoracic and the thoracodorsal nerves.

- **The long thoracic nerve:**

It arises from the ventral rami of C5, C6, C7 roots. It enters the axilla behind the rest of the brachial plexus and rests on serratus anterior muscle and supplies it, and if it is damaged by axillary clearances or radical mastectomies it may produce winging scapula, especially when the arm is lifted forward **(9).**

- **The thoracodorsal nerve:**

It arises from the posterior cord, which made up of the three posterior divisions of the trunks of the brachial plexus. It follows the thoracodorsal artery and innervates the latissimus dorsi muscle in the posterior wall of the axilla. It lies very deep; it is of great importance during latissimus dorsi flaps for breast reconstructions **(10).**e important structures and anatomy of nerves that involved in ECS block are illustrated in **(fig. 8) (8).**

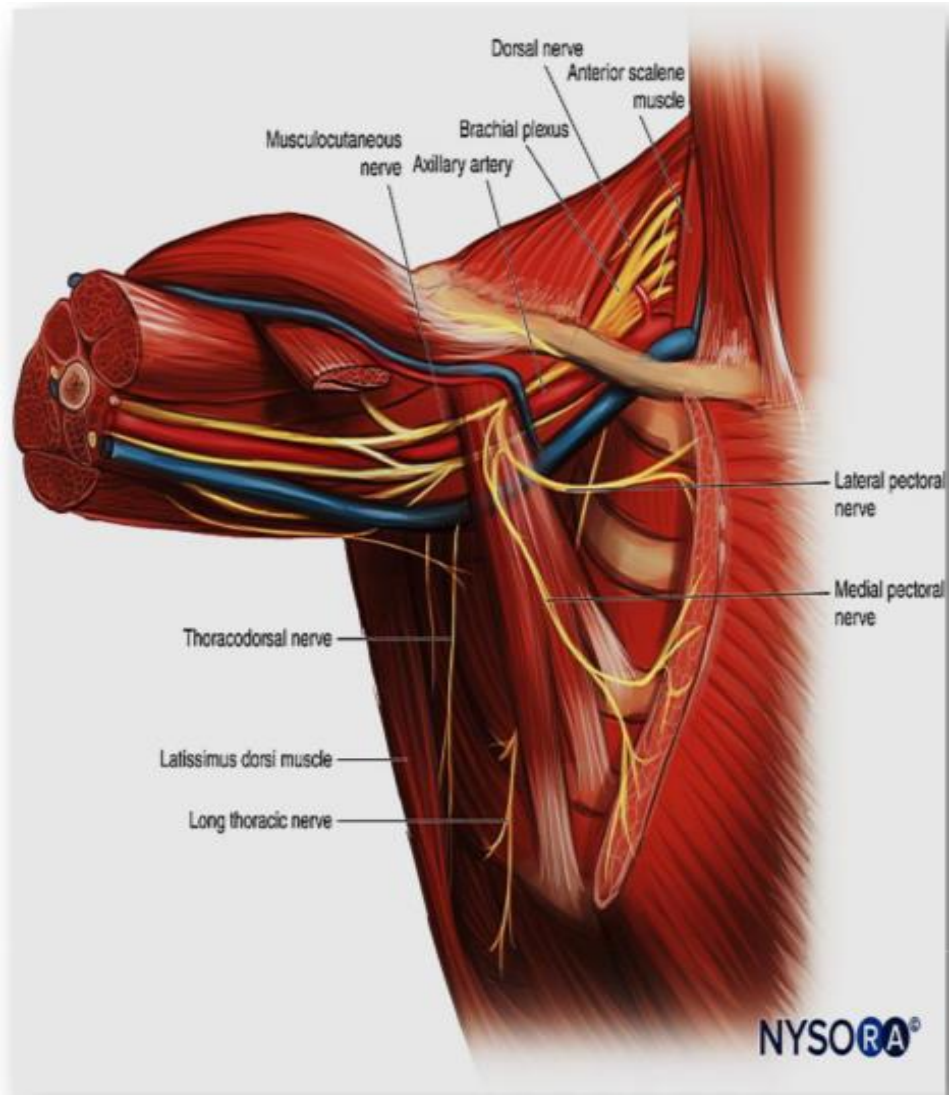

Figure (8): Nerves and structures included in pectoral nerve block (8).

Indications:

The Pecs I and II blocks can be used to provide analgesia for a wide variety of surgical procedures including insertion of breast expanders and submuscular prosthesis, port-a-caths, pacemakers, implantable cardiac defibrillators, anterior thoracotomies, anterior shoulder surgery, tumor resection, mastectomies and axillary dissection **(12).**

Contraindications:

- Patient refusal or infection at the site of injection are absolute contraindications to performing a Pecs block.
- Anticoagulation may be a relative contraindication to Pecs block I and II, although there are no specific guidelines **(12).**

Technique of pectoral nerve block:

For PECS I block, after cleaning the infraclavicular and axillary regions while the patient is placed in supine position with the ipsilateral upper limb abducted 90°, the probe is positioned under the lateral third of the clavicle. The following structures should be identified (subcutaneous tissue, pectoralis major muscle, pectoralis minor muscle, axillary artery, axillary vein, and pleura) from superficial to deep, and in between PMM and Pmm, there are thoracoacromial artery and the lateral pectoral nerve **(Fig.9)**. The skin puncture point is infiltrated with 2% lignocaine, and then the block is performed by using a 22-gauge block needle. The needle is advanced to the tissue plane between the PMM and Pmm, and 10 mL of 0.25% bupivacaine is deposited with frequent aspiration **(13)**.

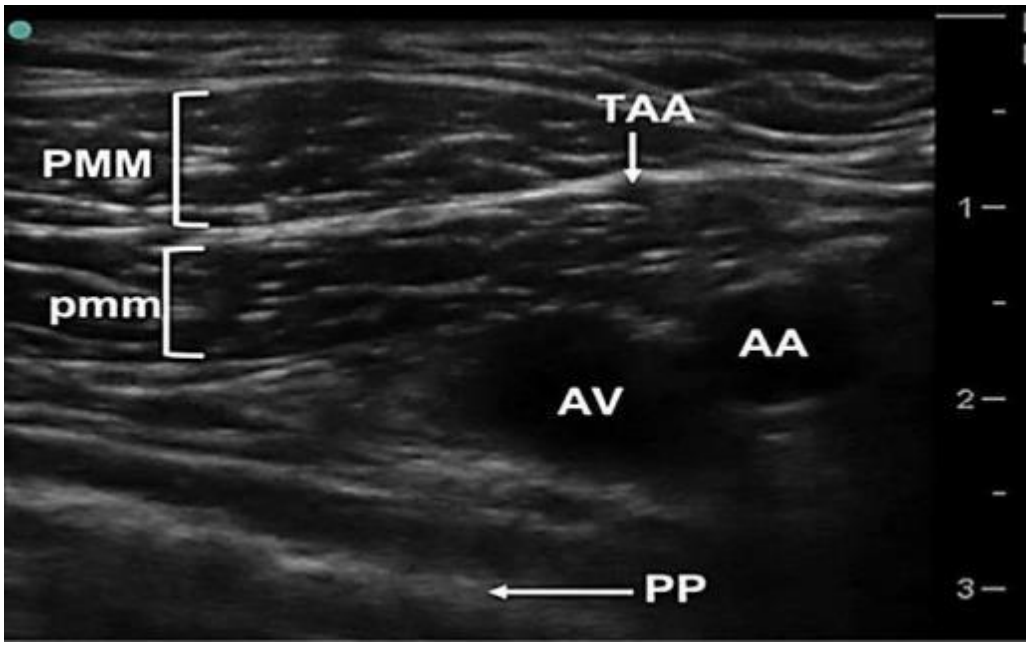

Figure (9): Ultrasound visualization for pectoral nerve block I. The pectoralis major muscle (PMM), pectoralis minor muscle (pmm), thoracoacromial artery (TAA), axillary artery (AA), axillary vein (AV), and parietal pleura (PP) are identified (14).

For the PECS II block, the target is to reach the level of 2 nd, 3 rd, and 4th ribs at which the lateral border of the Pmm is present. The probe is positioned under the lateral third of the clavicle, then moved laterally and distally until the third rib and the lateral border of the Pmm is visualized **(Fig.10)**. At the 3rd rib, another muscle, the serratus anterior muscle (SAM), and covering 2nd, 3rd, and 4th ribs, also parietal pleura is visualized deep to this muscle between the ribs **(Fig.11).** The skin puncture point will be infiltrated with 2% lignocaine. The needle is advanced, in-plane, medially to laterally; 20 mL of 0.25% bupivacaine will be deposited with frequent aspiration at the level of the third rib between Pmm and the SAM **(15).**

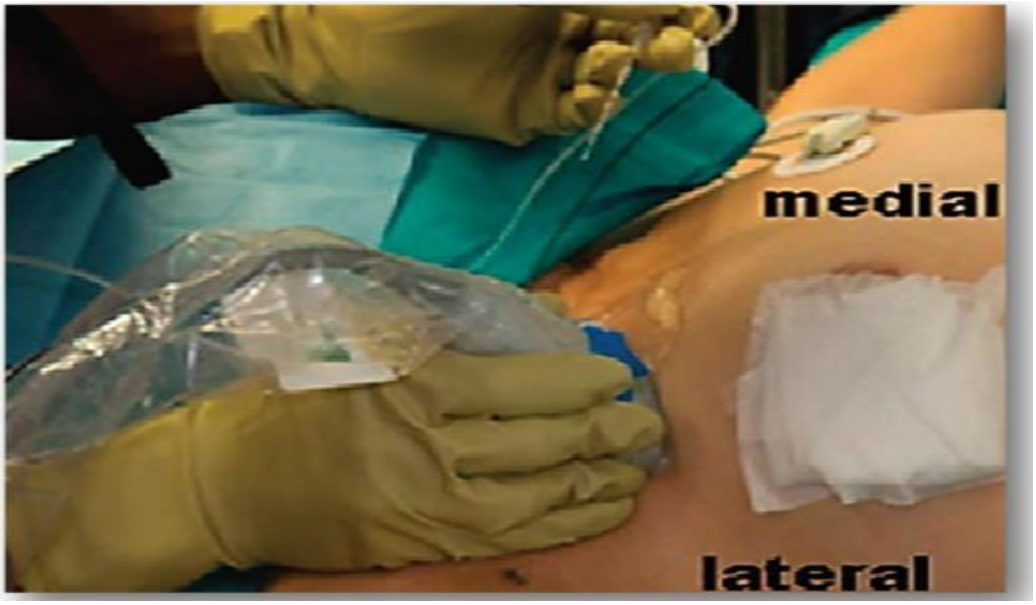

Figure (10): Image showing external probe position during pectoral nerve block II (16).

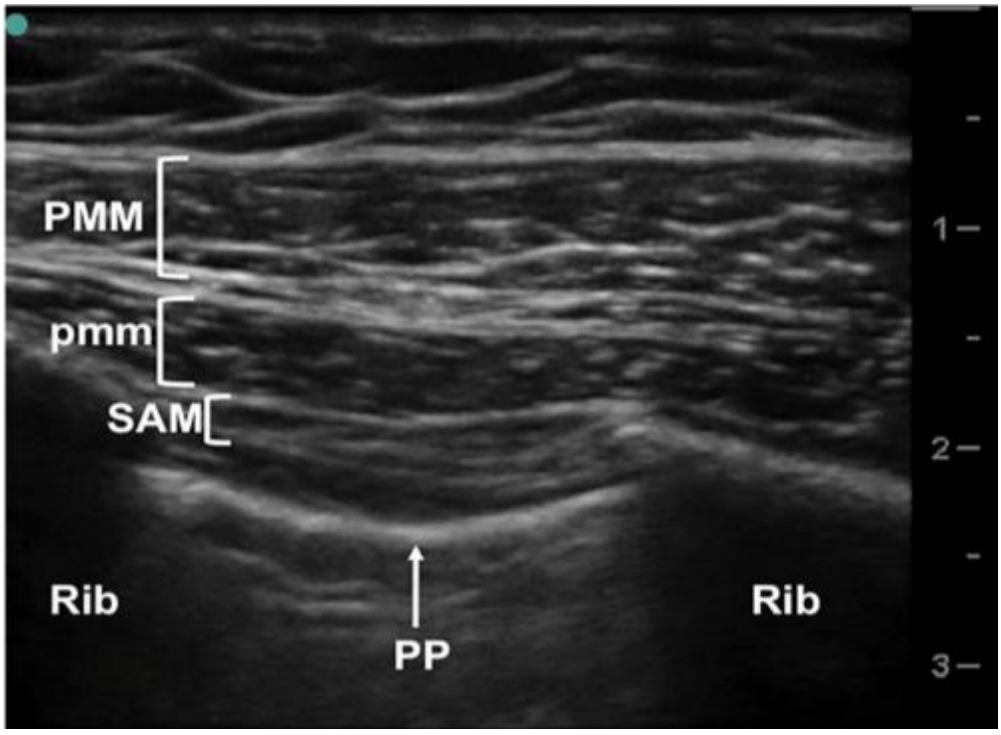

Figure (11): Ultrasound visualization for pectoral nerve block II. The pectoralis major muscle (PMM), pectoralis minor muscle (pmm), and serratus anterior muscle (SAM), and the parietal pleura (PP) is identified between the ribs **(14).**

Advantages of pectoral nerve block:

1. It differs from thoracic epidural and paravertebral blocks as it is not associated with sympathetic block.

2. It is seems to be simple, easy to learn and fast acting block, also it can be done before or after induction of general anesthesia **(17).**

Disadvantages of pectoral nerve block:

1. Accidental intravascular injection due to local anesthetic injection into pectoral branch of the thoracoacromial artery but can be avoided by proper visualization of anatomy especially the thoracoacromial artery **(9).**

2. In the PECS II block, pleural puncture is possible although the pleura is located deep to the SAM, but it is not far from the desired injection site, and so careful needle visualization should be done **(8).**

Erector Spinae Plane Block

Erector spinae plane (ESP) block is one of the newest techniques that have been described. It was first described by **Forero et al.** in 2016 for the treatment of chronic thoracic neuropathic pain and postoperative pain in thoracic surgery **(18).**

Anatomy:

The erector spinae muscle (ESM) is a complex formed by the spinalis, longissimus thoracis, and iliocostalis muscles that run vertically in the back. Erector spinae muscle run bilaterally from the skull to the pelvis and sacral region, and from the spinous to the transverse processes, extending to the ribs. The muscles change their size and profile during their craniocaudal course alongside the spine. As part of the "core" muscles, one of their main functions is to stabilize the spine. The erector spinae plane block is performed by depositing LA in the fascial plane, deeper than the ESM at the tip of the transverse process of the

vertebra (Fig 12 & 13) (19).

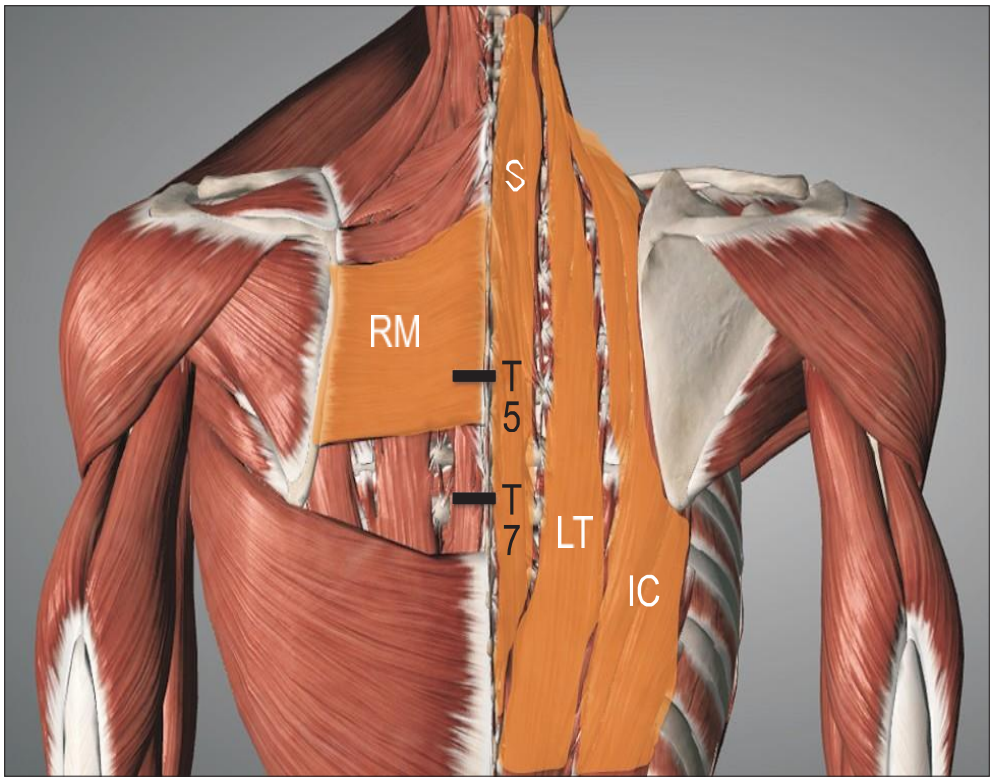

Figure (12): Anatomy of the erector spinae muscle. RM: Rhomboid major muscle, S: Spinalis, LT: longissimus thoracis, and IC: iliocostalis **(19).**

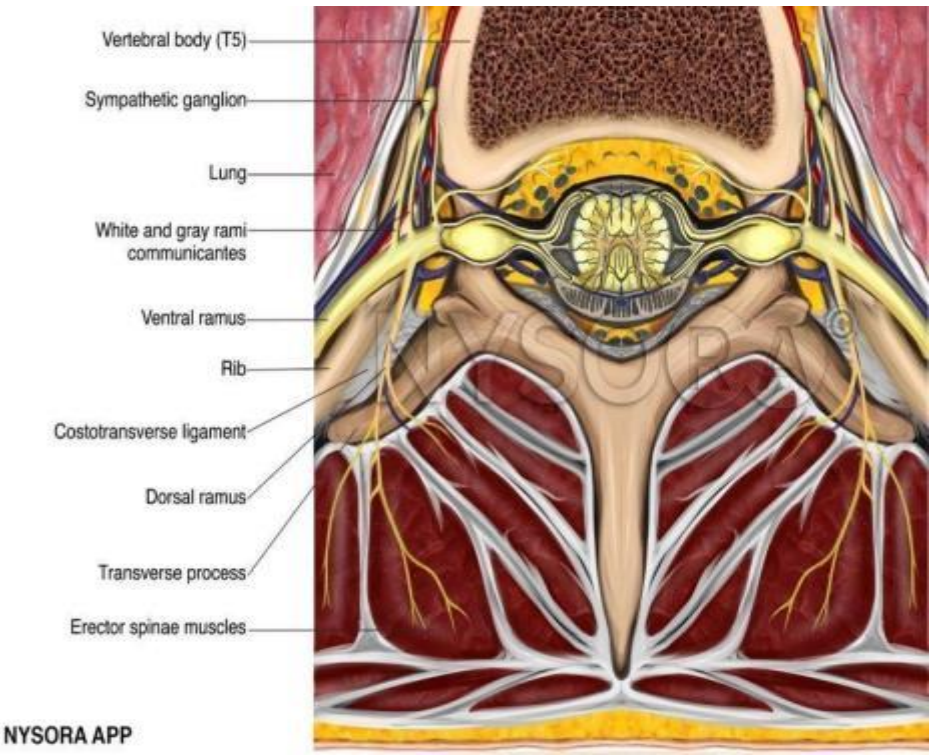

Figure (13): Transverse plane: Anatomy of erector spinae muscle at the level of T5 vertebrae (19).

Mechanism of action of the erector spinae plane block:

The mechanism of action is not fully understood, there are three likely mechanisms by which ESP injection of local anesthetic may produce analgesia. The first is that local anesthetic penetrates anteriorly into the paravertebral and epidural space containing spinal nerves, dorsal and ventral rami, through fenestrations in the connective tissues that span adjacent transverse processes and ribs. Second, the dorsal rami are blocked as they ascend through the lake of local anesthetic deposited in the ESP. Third, because the ESP is contiguous laterally with the plane deep to serratus anterior muscle and superficial to the ribs and intercostal muscles, local anesthetic spreading laterally within this plane can potentially reach and anesthetize lateral cutaneous nerve branches **(20).**

Indications of Erector spinae plane block:

The ESP block is an effective analgesic technique in a variety of clinical scenarios. It can be utilized successfully in the treatment of acute and chronic pain. Likewise, it has also been effective for analgesia at the cervical, thoracic, and abdominal levels. Likewise, studies indicate that it can provide adequate analgesia in the upper or lower limbs if it is performed at the high thoracic and lumbar levels, respectively **(21).**

Contraindications of Erector spinae plane block:

- Infection at the site of injection in the paraspinal region or patient refusal, are absolute contraindications for performing an ESP block.

- Anticoagulation may be a relative contraindication to ESP block, although there are no specific guidelines **(21).**

Technique of Erector spinae plane block:

The position of the patient for the realization of the block includes: sitting, lying on the side, or lying prone. The technique can be performed with the patient awake or under the effects of general anesthesia. Although cases of blind puncture or under fluoroscopy have been described, the technique is usually guided by ultrasound. Usually, a high-frequency linear ultrasound transducer is used to block the thoracic level, and a convex transducer is used to block the lumbar level **(22).**

Following intravenous access, application of appropriate monitors, and skin disinfection, the probe is placed in a transverse orientation to identify the spinous process. Once the level is identified, the probe is moved 3 cm laterally until the transverse process is identified. The probe should be rotated 90 degrees on the transverse process by placing it in a parasagittal plane. Three muscles must be identified as superficial to the hyperechoic transverse process shadow, and they include the trapezius, rhomboid major, and erector spinae **(Fig.14).** These three muscles are visualized at the level of the fifth thoracic vertebra (standard level for a thoracic block); however, the rhomboid major muscle disappears at the level of the seventh thoracic vertebra (in lower blocks) **(21).**

A 22-gauge block needle is inserted in-plane to the ultrasound transducer in a cranial-to-caudal direction. The transverse process is contacted gently with the needle tip and a test injection with 0.5–1 ml normal saline is performed to confirm correct placement in the ESP. This is signaled by

a linear pattern of fluid spread in both cranial and caudal directions that separates and lifts the erector spinae muscle off the transverse process then 20 mL of 0.25% bupivacaine is deposited with frequent aspiration in the fascial plane, deeper than ESM at the tip of the transverse process of the vertebra **(Fig.15).** Moreover, the block can be administered by a single shot or with a catheter insertion for continuous infusion **(23).**

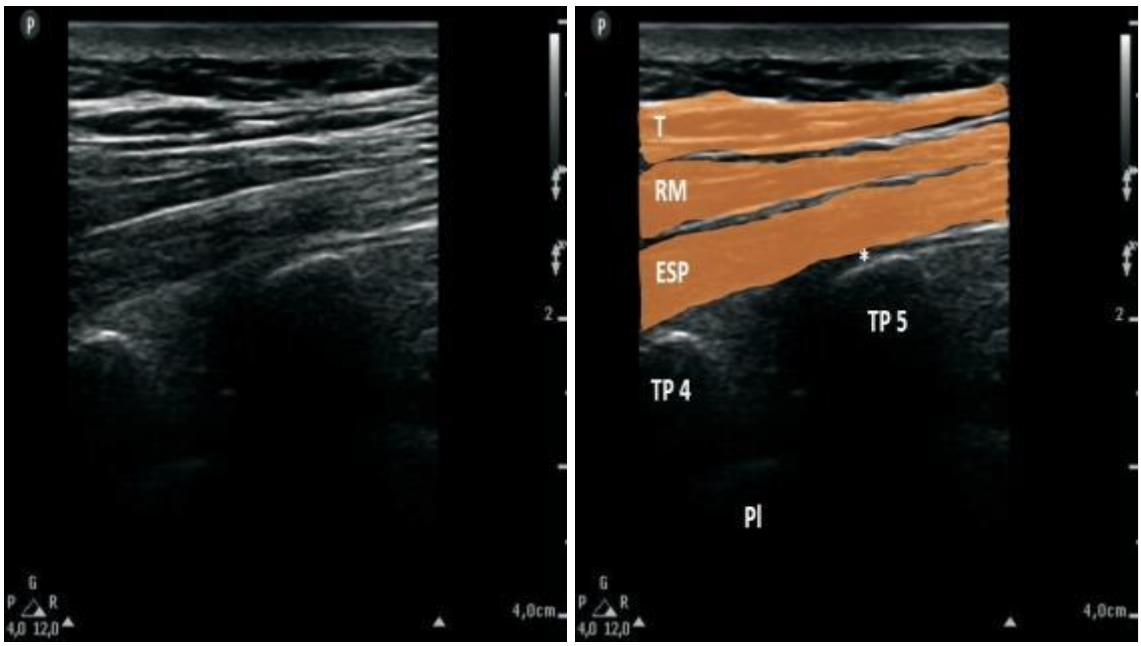

Figure (14): Sonoanatomy of the erector spinae block at T5 level. TP: transverse process, T: trapezius, RM: Rhomboid major, ES: erector spinae, Pl: Pleura. *Needle tip place **(21).**

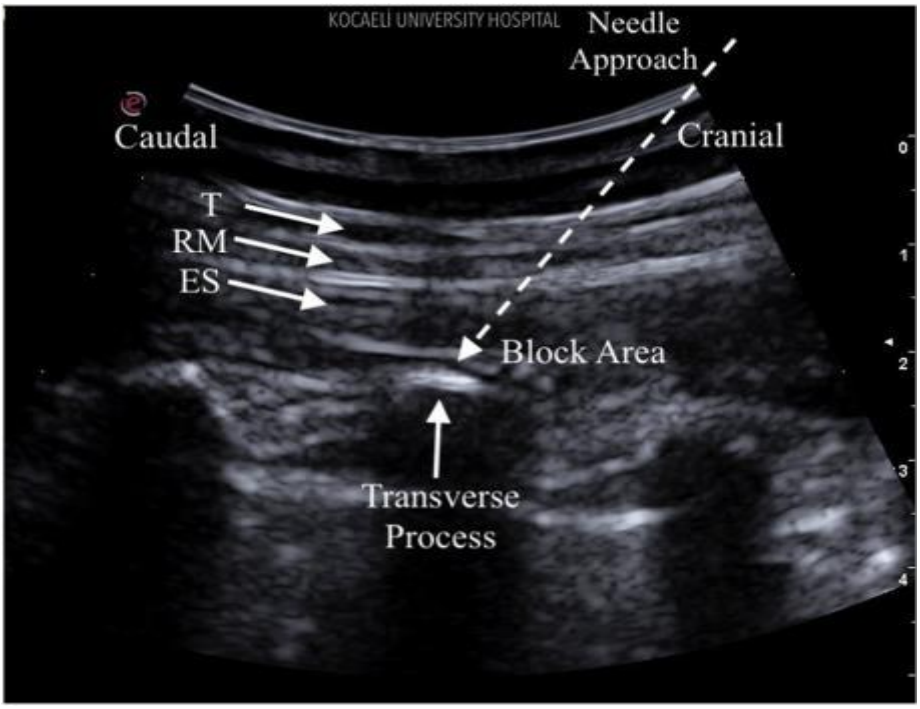

Figure (15): Ultrasound image of erector spinae block. T: Trapezius, RM: Rhomboid major, ES: erector spinae (23).

Advantages:

1. It is an easy technique to perform as the transverse process is an easily visualized landmark and provides a backstop to prevent inadvertently advancing the needle too far **(18).**

2. The technique has a low risk of complications because important structures such as main vessels and pleura whose injury can cause serious complications, are far from the target of blockage **(24).**

3. Inserting a catheter for continuous infusion can be done readily **(18).**

Disadvantages:

As with any other regional technique the following complications can occur: peripheral nerve injury, local anesthetic toxicity, infection and failure of block **(25).**

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