

UDC 618.19-009.624-089.5

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INTERFASCIAL THORACIC ANTERIOR AREA AND DORSAL NERVE BLOCKS

Due to the widespread access to ultrasonography, regional anaesthesia has become a safe method of post-operative pain management. It can be performed not only in orthopedic surgeries, but also in thoracic wall surgeries. One of the most frequent chest wall operations are breast surgeries. Although thoracic epidural anaesthesia and paravertebral blockades continue to be relevant, increasing number of one-day procedures demands an easier alternative with a lower number of side effects. To meet these expectations, in 2011 R. Blanco introduced pectoral nerve blocks. In PEC I block local anaesthetic is injected between the pectoral major and minor muscles. PECS II block extends analgesia to the axilla and consists of PECS I block and a second injection of local anesthetic between the pectoral minor and serratus anterior muscles. Another effective method of antero-lateral chest analgesia is serratus plane block, where LA is deposited in the interfascial plane above the serratus muscle. Above-mentioned procedures lead to a lower opioid consumption after chest surgery and, as a consequence, a shorter stay in PACU.

Key words: breast surgery, regional anaesthesia, PECS I block, PECS II block, serratus plane block, post-operative pain management.

Regional anaesthesia allows effective blocks to be performed not only to the limbs, but also to the thoracic wall nerves and dorsal branches of spinal nerves. The progress that has been made in this discipline over the last decade has been possible thanks to the widespread availability of ultrasonography, which has led to a renaissance in regional anaesthesia. Regional techniques have evolved to make anaesthesia increasingly effective.

In 2011 Rafael Blanco proposed a block that has no analogy with the other approaches (R. Blanco, 2011). It is only similar to the transversus abdominis plane block (TAP block), where the local anaesthetic is placed into the interfascial plane between an internal oblique muscle and a transverse abdominal muscle (A. Kumar, 2015). In an article published in the 2011 edition of *Anesthesia* the author described an easy alternative to the thoracic epidural anaesthesia and thoracic paravertebral blockade in the post-operative pain management after breast surgery.

Breast cancer is the most common cancer among women. In the United States it affects one in eighth of the female population. Effective pain control is a major challenge (R. Blanco et al., 2013). An increasing number of surgeries are being performed as a day procedures, making thoracic epidural anaesthesia or paravertebral blockade inadequate for these operations. Moreover, the side effects of these blocks could exceed the advantages. To solve this problem, the PECS blocks were introduced (R. Blanco et al. 2012; R. Sedra, 2015).

A PECS block derives its name from the word „pectoral“ – the local anaesthetic is deposited in the fascial plane between the pectoral minor and major muscles. In Blanco's study, the blockade was performed in approximately 50 patients, who required only minimal post-operative analgesia – a regular administration of paracetamol and dexamethasone (R. Blanco; 2011). The block is useful for reconstructive breast cancer surgery or subpectoral prosthesis. It is performed with a linear ultrasound probe placed in a position similar to that used to the infraclavicular plexus block. The needle is inserted on

the cephalad side of the probe just beneath the clavicle (M. Saleem, V. Irvine, 2014). First, the pectoral major muscle is identified. Then, between both pectoral muscles, the pectoral branch of thoraco-acromial artery is localised with a colour Doppler. The lateral pectoral nerve is located adjacent to the thoraco-acromial artery. The medial pectoral nerve is situated in the same interfascial space. In Blanco's study 50 ml of the local anaesthetic (LA) - 0,25% bupivacaine - was injected. In subsequent publications, the LA amount was limited to 10-20 ml. The location was suitable to leave a catheter and perform a continuous analgesia using 0,25% bupivacaine 5ml/h during for 7 days. Most of the patients with continuous analgesia did not require any opioids.

In 2012 Blanco described a modification to the PECS block, which was named the PECS II block (R. Blanco et al., 2012). He analysed the anatomy of the breast innervation, which was essential for the use of ultrasonography. This modification was intended to extend analgesia to the axilla, which provides a better pain control after vast revisions, tumorectomies, mastectomies and sentinel node dissection (Abrahams et al., 2016; R. Sedra, 2015). To perform a PECS II block two needle approaches are needed. The first approach is a PECS I blockade with the insertion of 10 ml of the LA. The second puncture injects 20 ml of local anaesthetic between pectoral minor muscle and serratus muscle. This enables reaching so called “axillary door” and blocks the long thoracic nerve and I and II intercostal nerves (R. Blanco et al.; 2012). This approach also blocks the lateral branches of the intercostal nerves, which exit at the level of the mid-axillary line to innervate the mammary gland and the skin from T2 to T6.

ANATOMY

The pectoral muscles are mainly innervated by the lateral and medial pectoral nerves, which arise from the brachial plexus (R. Blanco et al., 2012). The lateral pectoral nerve arises from C5, C6 and C7 and is separated from the lateral cord of brachial plexus. It runs between the major and minor pectoral muscles in close proximity to the pectoral branch to the thoracoacromial

artery. It innervates two-thirds of the pectoral major muscle. Medial pectoral nerve arises from C8-T1 and is separated from the medial cord of brachial plexus, running under pectoral minor muscle piercing it and the clavipectoral fascia and innervates the lower third of pectoral major muscle. It is possible that the medial pectoral nerve runs along the lateral border of the pectoral minor muscle.

A second group of nerves are the thoracic intercostal nerves from T2 to T6 (H. Ueshima et al., 2016), which run in a plane between the intercostal nerves to the sternum. The anterior divisions of these nerves pierce through the intercostal muscles, intercostal membrane and pectoral major muscle crossing the internal mammary artery and supply the medial side of breast. Lateral branches of intercostal nerves pierce intercostal muscles and the serratus anterior muscle in the mid-axillary line, giving off anterior and posterior terminal branches. The lateral branch of the intercostal nerve T2 continues as an intercostobrachial nerve to the axillary area.

A third group of nerves are the long thoracic and thoracodorsal nerves. The long thoracic nerve arises from C5-C7, enters the axilla runs along the serratus anterior muscle. Once damaged during the radical mastectomy or axillary clearance, a winging scapula can be produced, especially when the arm is lifted forward. Damage to the long thoracic nerve has also been described during the plexus brachialis blockade from the interscalene approach, when the needle was inserted through the middle scalene muscle.

The thoracodorsal nerve is a branch of the posterior trunk of the brachial plexus. It runs along the thoracodorsal artery and innervates the latissimus dorsi muscle (the posterior axilla wall). The nerve lies very deep and can be damaged during the breast reconstruction using serratus anterior flaps.

The clavipectoral fascia lies on the anterior surface of pectoral minor nerve and on the lateral border of the muscle converts to Gerdy ligament (the suspensory ligament of axilla). It enables maintaining the concave shape of the axilla.

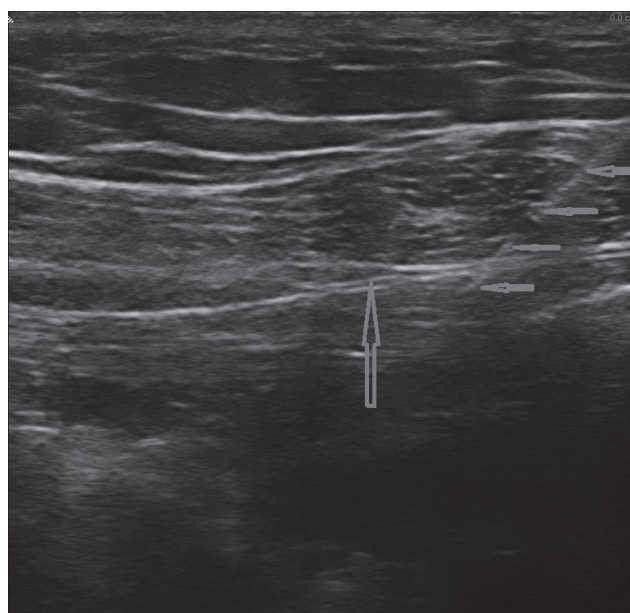
Sonoanatomy and block technique

PECS 1 block

The patient is positioned supine with the arm put on the side or abducted and externally rotated. Blanco described an approach when the probe is located at the level of the coracoid process. Perez has modified the probe placement to the lateral one-third of the clavicle (M. F. Pérez et al.; 2013). The needle is inserted medial-to-lateral in the “in-plane” position to minimize the possibility of the bone or vascular structure damage. The following structures must be identified: subcutaneous tissue, pectoral major muscle, pectoral minor muscle, axillary artery, axillary vein and pleura (E.D. Bolin et al., 2015). Between both pectoral muscles there is the thoracoacromial artery and the lateral pectoral nerve. 10-20 ml of 0,125-0,25 % bupivacaine or ropivacaine is injected. This block does not affect the anterior branches of the intercostal nerves (picture 1).

PECS 2 block

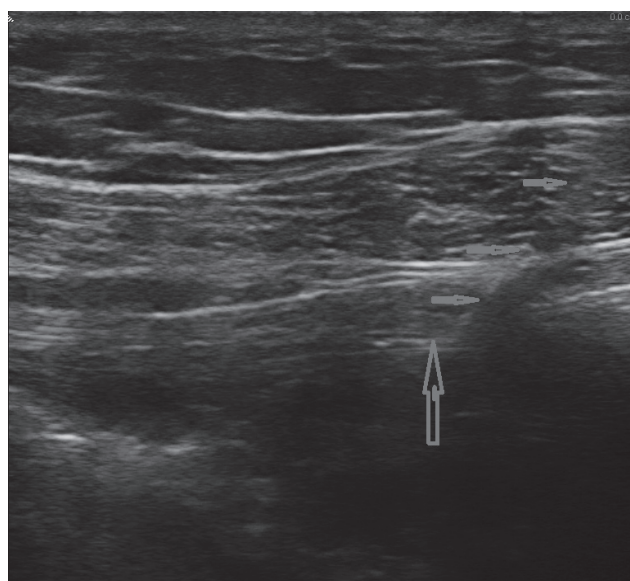
The initial part is similar to a PECS 1 block (Abhijit S. Nair et al., 2015). Then the probe is moved laterally and distally until the third rib (J.S. Kim et al., 2016) and the lateral border of the pectoral minor muscle are identified. On the third rib, continuation of the Gerdy ligament is visualized along with serratus anterior muscle, which lays beneath the ligament and



Picture 1 - PECS I block. The plane between pectoral muscles is visible. The tip of needle is so deep into pectoral minor muscle and should be remove some millimetres. LA injection should be given exactly into plane between pectoral muscles.

Red arrow – fascial plane between pectoral muscles.

covers the ribs (E.D. Bolin et al., 2015). The parietal pleura is located at the depth of serratus muscle between the ribs. The needle is inserted “in-plane”, medially to laterally and 20 ml of long lasting local anaesthetic is administrated. During the withdrawal of the needle additional 10 ml of local anaesthetic can be injected into the interfascial plane between two pectoral muscles. Thanks to this method, the long thoracic nerve, thoracodorsal nerve and intercostal nerves II-IV are blocked. In the PEC 2 block the LA spreads along the chest wall until the level of T8 (picture 2).



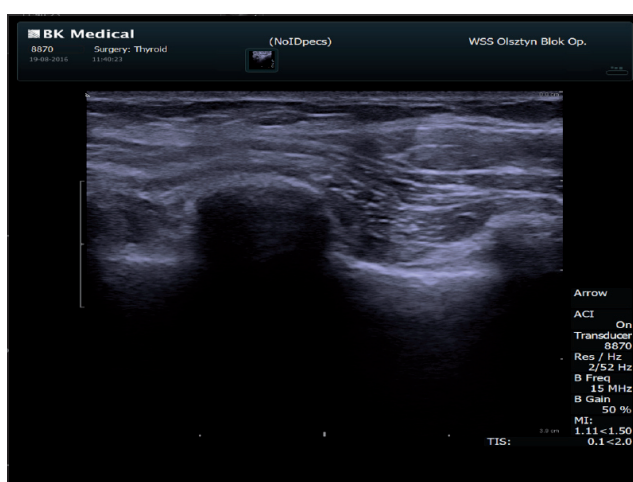
Picture 2 - PECS II block. The end-point of the needle is between pectoral minor muscle and serratus anterior muscle.

Red arrow – fascial plane between two muscles.

Blue arrow - the shaft of the needle

SERRATUS PLANE BLOCK

A serratus plane block provides an exact analgesia of the thoracic wall by blocking the lateral branches of intercostal nerves (M.P. Sebastia, 2014; H. Otake, 2015; J.S. Kim et al., 2016). The blockade is performed in the supine position. We visualize the V rib at the mid-axillary line, latissimus dorsi muscle (more superficially and laterally), teres major muscle (above) and serratus anterior muscle. The needle should be inserted to a depth of about 2 cm. The local anaesthetic is injected into the interfascial plane above the serratus muscle or beneath this muscle. According to Blanco placing the LA above the muscle provides a faster sensory blockade of the hemi thorax (R. Blanco et al., 2013). The thoracodorsal artery can serve as a landmark to identify the localization. Superficial placement of LA is one of the advantages of this technique (P.A.-de la Torre et al., 2015; S. Tighe et al., 2013) (picture 3).



Picture 3 - Sonoanatomy by Serratus Plane Block. The probe is placed in the middle axillary line in the short axis. Blue arrows -the plane between two muscles

ERECTOR SPINAE PLANE BLOCK (ESPB).

Erector spinae plane block was first described in 2016 (Mauricio Forero et al., 2016), when it was used to overcome a neuropathic pain. A high-frequency linear ultrasound transducer was located in a longitudinal orientation, 3 cm lateral to the T5 spinal process. The trapezius, rhomboid major and erector spinae muscles were identified and the local anesthetic was administered in a cephalad-to-caudad direction in the interfascial plane between the rhomboid major and erector spinae major muscles in the amount of 20 ml. The other landmark is the transverse process at lower levels, as rhomboid major muscle has its inferior border at T6. The local anesthetic should be inserted close to the midline at the tip of the transverse processes to avoid the intercostal muscles, which could be a barrier to the spread of the local anesthetic. According to the authors – the erector spinae plane block is less invasive and safer comparing to the paravertebral and interpleural blocks and more dedicated to the posterior side of the chest wall than PEC blocks and serratus plane blocks. Furthermore, this plane permits an extensive cranio-caudal spread and coverage of multiple dermatomes due to the longitudinal extension of the erector spinae muscle. On the other hand, deep ESPB is similar to the retrolaminar block (Takeshi

Murouchi, 2016), where the local anesthetic is inserted either on lamina or on the transverse process. The efficacy and using of the two techniques require more studies.

PRACTICAL USE

A PECS I block can be an effective method for postoperative analgesia for mastectomies, breast augmentation, breast reconstruction, CRTD implantation (Fujiwara et al., 2014), or vascular port implantation. PEC II indications are similar to a PEC I's plus mastectomy with axillary clearance, sentinel node dissection and anterior thoracotomy.

A serratus-plane block is useful as an additional analgesia in breast surgery, multiple rib fractures (N.P. Kunhabdulla et al., 2014) (picture 4) and breast reconstructive surgeries involving the latissimus dorsi muscle (Abhijit S. Nair et al., 2015). It is also used as anterolateral chest chronic pain treatment (Fujiwara S. et al., 2015) after radiotherapy and minimal invasive cardiac surgeries (MIDCAB – minimal invasive direct coronary artery by-pass).

Initially, few cases of opioid reduction in these blocks were published. In 2015 G.M. Bashandy (G.M. Bashandy et al., 2015) with colleagues published a PEC II prospective randomized trial, in which 120 patients underwent a modified unilateral radical mastectomy. They were divided into two groups – with and without the block. In patients with a PEC II block the opioid consumption was reduced during the first 12 hours after surgery, there was a 50% reduction of fentanyl use during the operation, a shorter stay in a post-anaesthesia care unit and a generally shorter stay in the hospital.

S.S. Wahba compared thoracic paravertebral block (PVB) versus a PEC II block in the radical mastectomies (S.S. Wahba et al., 2013). The PEC II block required lower opioid consumption



Picture 4 - Continuous Serratus Plane Block with Certa Catheter (Ferrosand™, Denmark) by polytrauma. The block end-point of the needle is performed for the patient with ribs multiple fractures (II-XI). Additionally, the patient had spine injury with the fractures of left transverse process of vertebrae Th II -Th10 and multiple fractures of pelvis bones. Thoracic paravertebral block or thoracic epidural analgesia were contraindicated due to thoracic vertebrae fractures. Lumbar spine was intact. Lumbar epidural analgesia was performed for treatment of pelvic pain

during the first 24 hours after the surgery. After the PEC II block also pain intensity was also lower during the first 12 hours compared to PVB. The PONV was comparable between the two groups. The authors suggest that a PEC II block can be an alternative to a paravertebral block. It is a safe, effective chest wall block method with fewer contraindications connected with antithrombotic therapy compared to epidural thoracic analgesia and, unlike PVB, PEC II also provides a contralateral sympathetic chain block.

In 2016, Abrahams published a review of several truncal block methods (M. Abrahams et al., 2016). It was noted that current publications recommend thoracic cage blocks with an “A” grade of recommendation and Ib-III level of evidence.

All of the cited studies described these blockades as an intra- and postoperative analgesia, which was accompanied by general anaesthesia (A. Amir et al., 2016). There are only few examples of using them as the only one method of anaesthesia (H. Murata et al., 2015).

COMPLICATIONS

Few complications of the block have been described (A.J. Louw, 2014). The thoraco-acromial artery should be localized to avoid a vascular LA administration. In the PEC II block the needle must be visualized to avoid pleura puncture. The chest wall blockades are performed with a large volume of local anaesthetic, so the maximal doses should be followed, taking into account the age and a general condition of the patient to prevent any toxic reactions.

SUMMARY

Chest wall blockades are an easy and effective method of pain management, characterized by a low risk of side effects and complications. They require a several points of needle placement and a frequent needle orientation to view the desired localization. In these types of blocks, the local anaesthetic reaches nerves from the interfascial plane. Thanks to the superficial site of these spaces, high frequency ultrasound probes can be used, which provides a better image resolution. An increasing number of new compartments of local anaesthetic placement have been introduced, which is a step toward presenting a new generation of blockades based on ultrasound guidance. Upcoming, prospective, randomized and controlled trials may show a clinical evidence of their efficacy in breast and chest wall surgeries.

Chest wall blockade: PEC I, PEC II and serratus-plane block are performed using ultrasonography in breast operations, multiple rib fractures and other chest wall procedures. In this paper, block techniques and the anatomy and sonoanatomy of the breast area are described. Moreover, the indications, complications and future perspectives of the blocks are discussed.

Erector spine block is new block and further studies are needed to assess an efficacy of this interesting method in the acute and chronic pain management.

Research transparency

Research did not have a sponsorship. The authors are absolutely responsible for presenting the release script for publication.

Declaration about financial and other relations

All authors took part in elaboration of article conception

and writing the script. The release script was approved by all authors. The authors did not get the honorary for the article.

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ТҰЖЫРЫМ

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ФАСЦИАЛДЫАРАЛЫҚ КЕУДЕ БӨЛІМІ МЕН ДОРСАЛЬДЫ НЕРВІЛЕРДІҢ БЛОКАДАЛЫҚ АНЕСТЕЗИЯСЫ

УДЗ қолжетімді болуына орай жергілікті анестезия отадан кейінгі ауырсынуды басуда қауіпсіз әдіс болып отыр. Оны тек ортопедиялық ота жасау кезінде ғана емес, кеуде клеткасына ота жасау кезінде де пайдалануға болады. Оталардың аса жиі түрі бұл сүт бездеріне жасалатын оталар болып отыр. Торакальды хирургияда эпидуральды анестезия мен паравертебральды

блокадалардың әлі де қажет болуына қарамастан, біркүндік процедуралар санының артуы жанама әсері аз болатын жеңіл балама жолдарды керек етіп отыр. Осы мақсатта 2011 жылы Р. Бланко пекторальды блокадалық анестезияны ұсынды. **PECS I** блокадасында жергілікті анестезия шағын және үлкен пекторальды бұлшықет арасына салынады. **PECS II** блокадасының анальгезиясы қолтық астын қамтиды және **PECS I** блокадасынан құралған, екінші рет жергілікті анестезия пекторальды шағын және алдыңғы тісті бұлшықет арасына салынады. Кеуде анальгезиясының басқа тиімді әдісі ретінде алдыңғы латеральды баспалдақты жазық блокатор саналады, онда ЖА баспалдақты бұлшықеттен жоғары фасциальдыаралық жазықтықты қамтиды. Жоғарыда көрсетілген процедуралар анағұрлым төмен опиодты шығын келтіреді, соның нәтижесінде отадан кейін палатада болу мерзімін азайтады.

Негізі сөздер: сүт бездеріне жасалған ота; жергілікті анестезия; PECS I блокадасы; PECS II блокадасы; баспалдақты жазықты блокада; отадан кейінгі ауырсынуды басу.

РЕЗЮМЕ

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БЛОКАДНАЯ АНЕСТЕЗИЯ МЕЖФАЦИАЛЬНОГО ГРУДНОГО ОТДЕЛА И ДОРСАЛЬНЫХ НЕРВ

В связи с широким доступом к УЗИ, местная анестезия стала безопасным методом для купирования постоперационной боли. Ее можно использовать не только при ортопедических операциях, а также при операциях на грудную клетку. Одним из самых частых видов операций являются операции на молочные железы. Несмотря на то, что эпидуральная анестезия и паравертебральные блокады в торакальной хирургии продолжают оставаться востребованными, увеличивающееся количество однодневных процедур требуют более легкую альтернативу с меньшим числом побочных эффектов. С этой целью, в 2011 Р. Бланко представил пекторальную блокадную анестезию. В блокаде PECS I, местная анестезия вводится между малой и большой пекторальными мышцами. Блокада PECS II расширяет анальгезию до подмышечной впадины, и состоит из блокады PECS I, а также второго введения местной анестезии между пекторальной малой и передней зубчатой мышцами. Другим эффективным методом переднелатеральной грудной анальгезии является лестничный плоский блокатор, где МА откладывается в межфасциальной плоскости выше лестничной мышцы. Процедуры, описанные выше, приводят к более низкому опиоидным затратам, и в результате к более короткому пребыванию в послеоперационной палате.

Ключевые слова: операция на молочных железах; местная анестезия; Блокада PECS I; Блокада PECS II; Лестничная плоская блокада; Купирование постоперационной боли.

For reverence: Tuyakov B., Stepien Z., Onichimowski D., Mayzner-Zawadzka E. Interfascial thoracic anterior area and dorsal nerve blocks // *Medicine (Almaty).* – 2017. – No 4 (178). – P. 234-238

Article received 24.03.2017

Article accepted for publication 10.04.2017