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SCIENTIFIC ARTICLE

Axillary local anesthetic spread after the thoracic interfascial ultrasound block – a cadaveric and radiological evaluation



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Lymph node excision;
Ultrasonography

Abstract

Background: Oral opioid analgesics have been used for management of peri- and postoperative analgesia in patients undergoing axillary dissection. The axillary region is a difficult zone to block and does not have a specific regional anesthesia technique published that offers its adequate blockade.

Methods: After institutional review board approval, anatomic and radiological studies were conducted to determine the deposition and spread of methylene blue and local anesthetic injected respectively into the axilla via the thoracic inter-fascial plane. Magnetic Resonance Imaging studies were then conducted in 15 of 34 patients scheduled for unilateral breast surgery that entailed any of the following: axillary clearance, sentinel node biopsy, axillary node biopsy, or supernumerary breasts, to ascertain the deposition and time course of spread of solution within the thoracic interfascial plane in vivo.

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PALAVRAS-CHAVE

Anestesia por condução;
Axila;
Músculos intercostais;
Bloqueio do plexo braquial;
Nervos intercostais;
Excisão de linfonodo;
Ultrassonografia

Results: Radiological and cadaveric studies showed that the injection of local anesthetic and methylene blue via the thoracic inter-fascial plane, using ultrasound guide technique, results in reliable deposition into the axilla. In patients, the injection of the local anesthetic produced a reliable axillary sensory block. This finding was supported by Magnetic Resonance Imaging studies that showed hyper-intense signals in the axillary region.

Conclusions: These findings define the anatomic characteristics of the thoracic interfascial plane nerve block in the axillary region, and underline the clinical potential of this novel nerve block.

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Dispersão axilar de anestésico local após bloqueio interfascial torácico guiado por ultrassom - estudo radiológico e em cadáver

Resumo

Justificativa: Os analgésicos orais à base de opioides têm sido usados para o manejo da analgesia nos períodos peri e pós-operatório de pacientes submetidos à linfadenectomia axilar. A região axilar é uma zona difícil de bloquear e não há registro de uma técnica de anestesia regional específica que ofereça o seu bloqueio adequado.

Métodos: Após a aprovação do Conselho de Ética institucional, estudos anatômicos e radiológicos foram realizados para determinar a deposição e disseminação de azul de metileno e anestésico local, respectivamente injetados na axila via plano interfascial torácico. Exames de ressonância magnética foram então realizados em 15 de 34 pacientes programados para cirurgia de mama unilateral envolvendo qualquer um dos seguintes procedimentos: esvaziamento axilar, biópsia de linfonodo sentinela, biópsia de linfonodo axilar, ou mamas supranumerárias, para verificar a deposição e tempo de propagação da solução dentro do plano interfascial torácico *in vivo*.

Resultados: Estudos radiológicos e em cadáveres mostraram que a injeção de anestésico local e azul de metileno via plano interfascial torácico usando a técnica guiada por ultrassom resulta em deposição confiável na axila. Nos pacientes, a injeção de anestésico local produziu um bloqueio sensitivo axilar confiável. Esse achado foi corroborado por estudos de ressonância magnética que mostraram sinais hiperintensos na região axilar.

Conclusões: Esses achados definem as características anatômicas do bloqueio da região axilar e destacam o potencial clínico desses novos bloqueios.

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Introduction

Patients who undergo axillary surgery suffer variable post-operative discomfort and pain.¹ Until today, there has been no ultrasound-guided regional anesthesia technique that provides adequate blockade of the axillary compartment. Thoracic paravertebral block (TPVB) is the main regional anesthetic technique used in breast surgery,^{2,3} but it does not provide complete analgesia to the anterior and lateral chest wall due to innervations from the supraclavicular nerves (C4–C5), the lateral pectoral nerve [LPn] (C5–C6), medial pectoral nerve [MPn] (C8–T1) and medial brachio-cutaneous nerve [MBCn] (C8–T1).⁴ The chronic pain that occurs after axillary dissection (AD), often results from inadequate treatment of acute postoperative pain.^{5–7}

As described by Moore and Dalley,⁸ the axilla has 4 walls, 3 of which are muscular Fig. 1. The cutaneous sensory innervation of the axilla is supplied by the intercostobrachial nerves (ICBn) and medial brachio-cutaneous nerve (MBCn).

In the present report, we will discuss three thoracic interfascial ultrasound-guided approaches.^{9–13} These techniques have been recently described, with encouraging effects on blockade of the neural afferents of the chest wall, in spite of the few samples reported.^{8–11} However, the detailed anatomic characteristics and the spread of LA in these interfascial ultrasound-guided blocks have not yet been determined. We hypothesize that LA injection into the interfascial plane of the antero-lateral chest wall will produce enough spread into the axillary fascia, due the inter-fascial connection of the muscles that form the axillary wall. This may help in reducing acute postoperative pain in patients undergoing axillary dissection and may become an alternative to other techniques used to provide analgesia after breast surgery. We consider these inter-fascial blocks easy techniques: they are superficial blocks and the echo-anatomy is simple to understand.^{9–11,13–17}

The Pec's block,¹⁴ appears to be particularly useful for patients who have breast expanders placed during

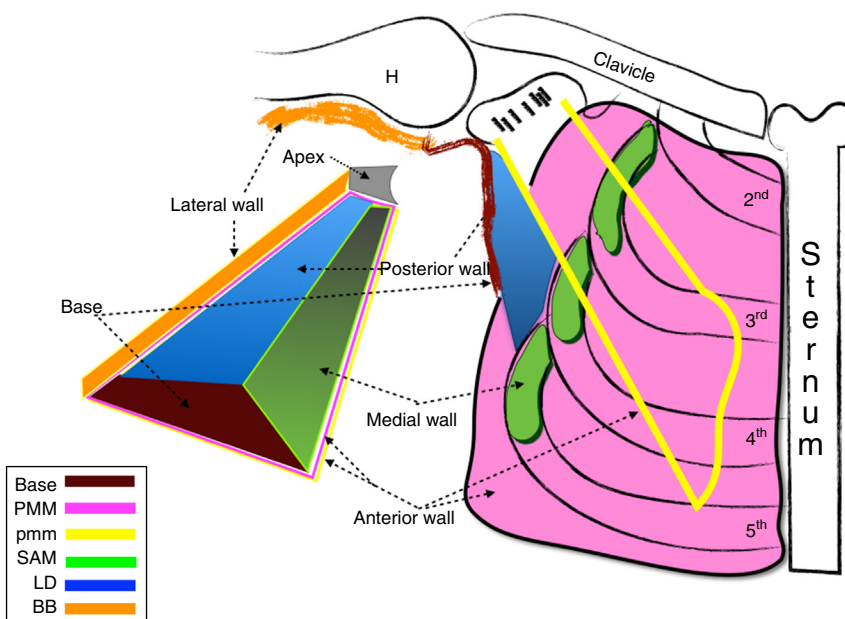


Figure 1 The boundaries of the axilla. PMM, Pectoralis major muscle; pmm, pectoralis minor muscle; SAM, serratus anterior muscle; LD, latissimus dorsi; BB, biceps brachii muscle; H, Humerus.

reconstructive breast cancer surgery or subpectoral prostheses.¹³

The Serratus-Intercostal Fascial Block (SIFB) anterior approach,¹⁵ involves injecting the LA between the Serratus Anterior muscle and the External Intercostal muscle. The efficacy of the SIFB technique has been reported by findings described in two observational studies in patient under no reconstructive breast surgery.^{11,15}

We conducted a cadaveric dissection and radiological study, with the goal of characterizing the SIFB injection, as well as evaluating the spread of local anesthetic agents injected via this interfascial plane.

Methods

Thirty four consecutive patients, scheduled for axillary surgery, were recruited to take part in the radiological study, 33 females and 1 male. The age range was 18–80 years of age. Institutional review board approval and written consents were obtained before conducting the ultrasound thoracic interfascial blocks and MRI studies in 5 of 34 patients. The time period was September 2013 through May 2014.

The inclusion criteria were: patients scheduled for axillary clearance, sentinel node biopsy, axillary node biopsy, axillary supernumerary breasts or melanoma excisions.

Exclusion criteria included patients unable or unwilling to cooperate in this study, known allergy to LA and/or to opioids, bleeding disorders, on anticoagulants, significant liver or renal disease, diabetes, history of drug or alcohol abuse, pain patients receiving chronic analgesics or corticosteroids.

Intravenous (IV) access was established, routine monitoring (EKG, non-invasive blood pressure, oxygen saturation) was used. All patients were given midazolam 1–2 mg IV before the block. The patients received a preoperative,

ipsilateral SIFB, anterior approach single-injection referred to as the thoracic interfascial ultrasound block (Fig. 2).

The ultrasound blocks were performed in the Radiology Department, before surgery using a Locoplex (Vygon; Ecouen, France) block needle (17 degree, 25 gauge, 100 mm) and a Mindray M7 (Mindray Medical; Madrid, Spain) ultrasound machine with a high-frequency probe (6–13 MHz). The total amount of local anesthetic was injected under real-time ultrasound visualization.

Decreased temperature sensation in the T1–T3 dermatomes was determined as an indication of successful block of the axilla. An unbiased observer evaluated the extent of blockade. The fine and gross touch were evaluated by using a cotton wool and pin prick, respectively.

The patients were then transferred to the operating room and general anesthesia was induced with target injection control (TCI) of Propofol and Remifentanyl (depending on the patient's age and physical condition). Laryngeal mask airways appropriate for weight were inserted.

Controlled ventilation was maintained aiming at an end-tidal CO₂ pressure between 35–40 mm/Hg. The patient's vital signs remained within 20% of baseline values throughout the operation. Anesthesia was maintained with Propofol and Remifentanyl TCI and an oxygen/air mix with a fraction of inspired oxygen (FiO₂) of 40%. Bispectral Index values were maintained between 40 and 60. Remifentanyl 5–10 mcg/kg bolus doses were given whenever mean arterial blood pressure or heart rate exceeded 20% of preoperative baseline values. All patients were treated with Ondansetron 4 mg IV, 30 min before the end of the procedure, to prevent PONV.

After emerging from anesthesia, the patients were transferred to the post anesthesia care unit (PACU) for a 24 h observation period. Analgesia was provided with patient-controlled analgesia (PCA) with Morphine 1 mg/mL, set at boluses of 1 mg with a lockout period of 10 min. Maximum Morphine consumption at 4 h was set at 24 mg. In addition,

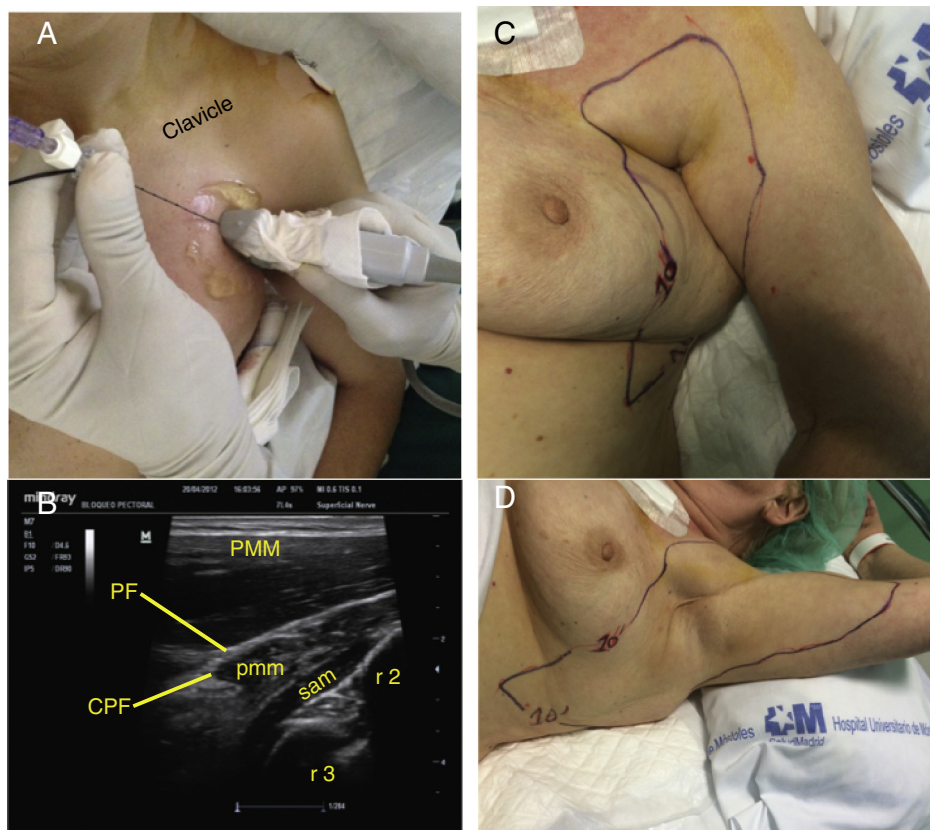


Figure 2 Ultrasound-Guided Anterior-Approach SIFP Block prior to undergoing tumorectomy in the outer quadrant and sentinel node biopsy. (A) Image shows probe placement and needle insertion. (B) Ultrasound image of the anterior thoracic wall shows the pectoralis major muscle (PMM), pectoralis minor muscle (pmm), serratus anterior muscle (SAM), clavipectoral fascia (CPF), pectoral fascia (PF) and the ribs (r). (C, D) Shows the area of sensory loss in the anterior lateral chest wall 10 min following the injection of local anesthetic between the SAM and external intercostal muscle.

the patients were given IV Acetaminophen 1 g and Ketoprofen 25 mg every 8 h. Nausea lasting more than 10 min or vomiting was treated with 4 mg Ondansetron. Morphine consumption, as well as administration of antiemetic medication and incidence of adverse effects (nausea, vomiting, pruritus, sedation, headache, and hypotension) was recorded.

Postoperative analgesia data was collected using a visual analog scale (VAS), as well as during painful restricted movement of the shoulder, as well as Fig. 3 classified into three grades (restricted, fair, and free) every 4 h starting from the arrival of the patient at PACU, and lasting throughout the 24 h study period. Initial pain assessment in the PACU by visual analog scale (VAS; 0 = no pain, 10 = worst pain imaginable) was zero. Data was collected by an unbiased observer who was not otherwise involved in the study. Patients were monitored throughout their hospital stay for complications related to SIFB (pneumothorax, external mammary artery lesion), and for signs of LA toxicity as well as pain in the site of injection. After 24 h of post-operative period and free of surgical or anesthetic complications, the patients were discharged home. Patients were given oral Acetaminophen 1 g plus Ketoprofen 25 mg every 8 h, and Tramadol 50 mg every 4 h to use at home.

After receiving approval from the local ethics committee and written consent from the cadavers' families, as part of a donation program from the "Universidad Autónoma de

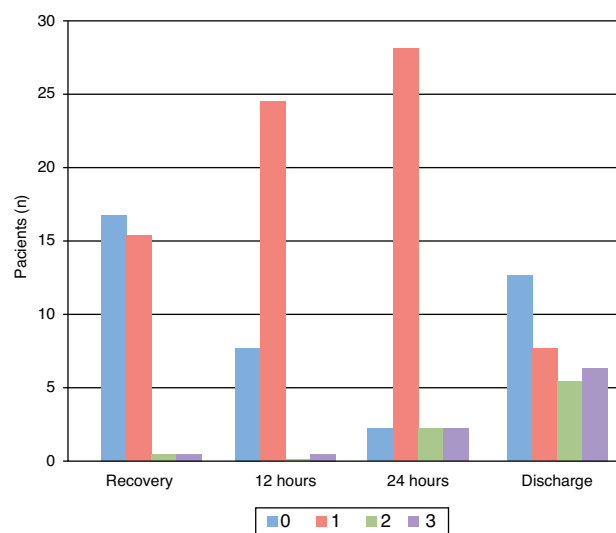


Figure 3 VAS score (0–3) during arm abduction for the composite of 34 patients receiving SIFB anterior approach nerve block after axillary surgery throughout their hospitalization. Most patients rated pain level of 0–1 even during arm abduction. No patient rated pain >3.

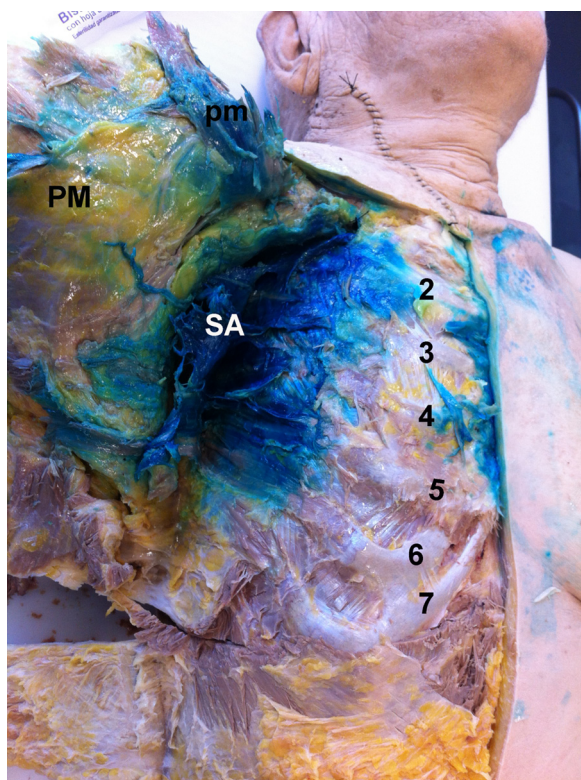


Figure 4 Anatomic dissection of the anterolateral chest wall. Following injection of methylene blue, the dye penetrated into the axilla. (A) Injection between the serratus anterior muscle (SA) and external intercostal muscle (anterior-approach SIFB). Pectoralis major muscle (PM), pectoralis minor muscle (pm), ordinal numbers corresponding the consecutives ribs.

Madrid'', the nine cadavers were embalmed according to classical technique and were maintained at room temperature for 24h prior to the injections and dissections. The cadavers were placed in the supine position, with the arm in abduction, to perform the SIFB anterior-approach. Twenty mL of methylene blue (0.2% diluted in distillate water) were injected, using a block needle (17 degree, 25 gauge, 100mm) and ultrasound machine with a high-frequency probe. The total amount of contrast dye was injected under real-time ultrasound visualization. All needle placements were made by the same investigator, proficient and experienced in performing the thoracic ultrasound-guided regional anesthesia. Assistance was provided for injection of the solution. The axillary spread of the dye (macroscopic view) was evaluated, and dissection was performed by 2 investigators, with experience in cadaveric dissection, between 15 and 30 min after dye injection (Fig. 4).

Anesthetic regional ultrasound-guided techniques

Serratus-Intercostal Fascial Ultrasound-Guided Block (SIFB), anterior approach

With the patient in the supine position, a linear probe is positioned below the external third of the clavicle (Fig. 2)

to identify, in the surface plane, the pectoralis muscles, the toracho-achromial artery and the cephalic vein that lie between them. In the deep plane, the SAM is identified, resting on the ribs. The needle is then introduced in-plane from medial to lateral, and its tip is placed between the SAM and the External Intercostal muscle at level of second rib. Twenty mL of Levobupivacaine 0.25% + Epinephrine 1:200,000 were injected under direct ultrasound visualization in real time, fragmenting the total volume, aspirating every 3 mL to reduce the risk of intravascular injection and minimizing the patient discomfort on hydrodissection (Fig. 2A).

Study 1: determination of injectate spread during SIFB using MRI

The aim of this study was to determine the axillary spread of the injectate within the SIFB anterior approach. Our image study consisted of a MRI done immediately after LA injection. Our radiologist used MRI sequences to show T2-weighted, fat-suppressed images, making axial and coronal thoracic sections from the supraclavicular regions to the inframammary crease. The same radiologist, proficient in thoracic MRI, analyzed the images and issued a report of the spread of the LA injectate in the interfascial thoracic planes (Fig. 5A and B).

Study 2: Validation of Ultrasound-Guided SIFB in a cadaver model

The aim of this study was to validate the described ultrasound-guided regional technique, by demonstrating that they resulted in the deposition of dye within the lateral thoracic interfascial planes reaching the axilla. An ultrasound-guided SIFB anterior approach was performed on nine embalmed cadavers (Fig. 4).

Results

Patient data and the type of surgery are showed in Table 1. We demonstrate that LA reaches the axilla if injected into the interfascial planes of the medial axillary wall. In our opinion, the radiological findings support the correlation between MRI images and territories blocked. Thirty two patients of the SIFB groups reported a VAS=0 at rest. Pain with arm abduction was also very low during hospitalization (Fig. 3). No patient from this groups needed a rescue Remifentanyl bolus in the intraoperative period or Morphine in PACU. 32/34 patients classified the anesthesia technique used as excellent and 2/34 as good.

Study 1: Validation of Ultrasound-Guided SIFB techniques using MRI

In five patients our study, the imaging studies (T2 weighed, fat-subtraction, axial and coronal views) clearly showed the presence of a hyperintense signal (corresponding with the LA) between the interfascial planes in the anterior and lateral chest wall. The LA was noted to spread into the axilla,

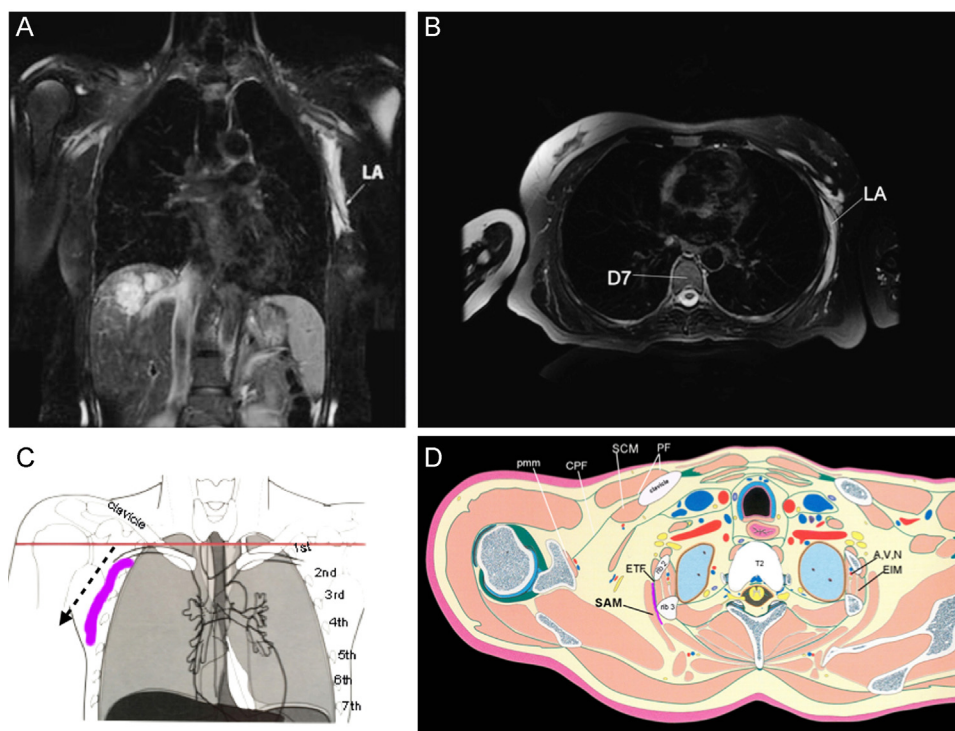


Figure 5 (A) MRI T2 – weighed fat-substraction sequence: axial and sagittal sections through the chest wall immediately after injection of local anesthetic. (A, B) Axial and sagittal views show spread of the local anesthetic between the anterior serratus muscle and external intercostal muscle after an anterior-approach SIFP. (C) Diagram shows dotted line needle direction and local anesthetic spread (purple). (D) Sagittal view of the chest wall (T3) show the local anesthetic between serratus anterior muscle (SAM) and external intercostal muscle (EIM), subclaviam muscle (SCM), pectoral fascia (PF), thoracic external fascia (ETF), pectoral minor muscle (pmm), arteria, vein and intercostal nerve (A, V, N).

Table 1 Patients characteristic (n = 34).

Patient characteristics (n = 34)	
Female/male	33/1
Age	46 (22–68)
BMI	24 (18–35)
ASA I/II/III	2/30/2
Surgical procedure	
Axillary biposy	4
Reintervention of axillary lymph none clearance	2
Melanoma	1
Lumpectomy with centinele node	23
Mastectomy with axillary clearance	4

Data are present as absolute number or medians with 25th to 75th interquartile range ASA indicates American Society of Anesthesiologist. BMI, body mass index.

covering the intercostobrachial nerve territories, and the Medial Brachio-Cutaneous nerve (MBCn) in 34/34 patients.

In patients who received the SIFB-anterior approach, the LA spread into the interfascial plane of the lateral chest wall reaching the axilla. The patients were monitored during the performance of these blocks and for 24h after for signs of local anesthetic toxicity. We used Eco-Doppler images in real time to avoid intravascular injection. There were

no recognized symptoms and signs of this complication on any patient. We did not observe Long Thoracic nerve (LTn) palsy in any of the patients. Brachial plexus motor deficit was not seen in any patient. The MBCn and the Intercostobrachial nerve territories were blocked in all patients, reaching the upper third of the medial arm. All patients referred discomfort after needle to bone contact and when the LA hydrodissection started.

Study 2: Validation of Ultrasound-Guided SIFB techniques in a cadaver

Anatomic dissection of the 9 embalmed cadavers (as described above) showed the spread of dye into the serratus intercostal fascial plane, reaching the axilla (Fig. 4).

In the SIFB anterior approach, the methylene blue was found into the axilla in all cadavers. The ICBn, MCBn and the intercostal territories from T1 to T3 were stained. We also observed the contrast reaching the posterior axillary line.

Discussion

This radiological and cadaveric study evaluated and demonstrated the feasibility of using ultrasound-guided approaches to block the axillary region, through the interfascial planes between the muscles of the medial axillary

wall. Our findings show that the SIFB anterior approach injections provide a potential space into which LA can be deposited to achieve sensory blockade of the IBCn and MBCn. These studies also indicate that it is possible to inject LA into the SIFB in vivo using ultrasound-guided techniques. These findings show that the medial chest wall offers an easy means to reach the axillary region due the communication or permeability of the thoracic interfascial planes.

The axillary compartment is a difficult region to block. Despite the thoracic para-vertebral block (TPVB) being the gold standard technique for breast surgery, we have been using these new interfascial thoracic ultrasound-guide blocks. We described here to achieve analgesia after breast and axillary surgery with good results.^{9,11,15-17} Pre-precisional LA infiltration reduces pain during the initial hours after breast and axilla operations, and therefore this has become a standard procedure in our unit.^{5,6} Campbell et al. in their study concluded the LA infiltration during breast surgery has a marked opioid sparing effect, with significant patient benefits, reducing nursing workload and drug costs.¹⁹ Sidiropoulou et al.²⁰ in their study, evaluated the analgesic efficacy and morphine consumption of the two techniques after mastectomy, concluding that the continuous wound infiltration of local anesthetics is an effective alternative to paravertebral analgesia after mastectomy with axillary dissection. These new thoracic ultrasound guide interfascial blocks may have some similar aspects to local wound infiltration, but they use less LA, and a catheter can also be placed before the surgery without causing interference with the surgical field and thus reducing postoperative pain for an extended period of time.¹⁶

Oral opioid analgesics have traditionally been used to provide peri- and postoperative analgesia in patients who undergo axillary dissection. Previous studies evaluated the effects of peri- and postoperative administration of LA. The results obtained by Rawlani²¹ in his double-blind, randomized, prospective study, supports the efficacy of a postoperative local anesthetic pain pump in reducing pain, narcotic use, and postoperative nausea and vomiting in women undergoing breast reduction. Scott²² compared the efficacy of continuous axillary administration of bupivacaine versus standard surgical treatment or placebo in patients undergoing axillary lymph node dissection. The patients treated with a continuous infusion of bupivacaine experienced significantly lower pain scores. The postoperative opioid analgesic requirements also were significantly decreased in the bupivacaine group. The use of continuous administration of bupivacaine after axillary lymph node dissection significantly decreases pain and opioid analgesic requirements, with concomitant decreases in nausea and sedation. This study provides encouraging evidence of the therapeutic benefits of continuous infusion of local anesthesia and may represent a valuable adjunct for surgical patients who require axillary lymph node dissection (ALND), including those with breast cancer and melanoma. Strazisar⁵ observed that wound infusion in the LA group (vs. the standard opioid-based analgesia group) resulted in a greater reduction of acute pain and enabled reduced opioid consumption; they also noted a trend toward reduction of chronic pain in the LA group. Fajardo et al.¹⁶ published the interpectoral fascia infusion of Levobupivacaine 0.125%

(5 mL.h⁻¹) in patients undergoing mastectomy and axillary clearance and found good analgesia and less opioid consumption. Diéguez et al.¹¹ in January 2013, published (article in Spanish) the LA infiltration on the mid-axillary line in a patient for breast surgery. Diéguez¹¹ in her study demonstrated the effectiveness of the ultrasound-guided injection of LA between serratus anterior muscle (SAM) and external intercostal muscle (EIM) named BRILMA (in Spanish: intercostal branch nerves in the midaxillary line block) in an observational study in 30 patients scheduled for non-reconstructive breast and axilla dissection. Diéguez¹¹ found that injecting 15 mL Levobupivacaine 0.25% (3 mL in each intercostal space) provides adequate intraoperative and postoperative analgesia. Blanco et al., in 2013²³ performed the Serratus block at 2 different levels in four healthy volunteers'. The first was superficial to the SAM, similar to Pec's block II,¹¹ technique published in 2012. This approach aims to block at least the pectoral nerves, the intercostobrachial and the intercostals branches.

On September 2012, Fajardo published a descriptive, observational study in 44 women scheduled for breast surgery,¹⁵ on which he combined the block of the lateral and anterior cutaneous branches of the intercostal nerves. The objective of this study was to evaluate extension of LA through MRI, after the ultrasound-guided injection of LA between SAM and EIM. It was observed that, in most patients, the LA spread to the axilla and under the lateral and posterior chest wall, between T2 and T7 dermatomes, result comparable with Blanco et al.²³ We believe that LA injection between the SAM and EIM is more advantageous than injections superficial to the SAM because it may avoid transitory palsy of the LTN and likely achieve more distal dermatomal spread. The LA injection between the Pectoral Minor Muscle (pmm) and SAM (Pec's block II) has a good spread too, but the spread beyond T3 is erratic because the axillary fatty tissue may limit the LA spread. In our clinical practice, we abandoned this block in breast surgery because the patients referred pain at level of the nipple-areola complex.

The Pec's II block¹² achieves suitable axillary dissemination. Nevertheless, we did not evaluate this technique due to it being a more complex technique to perform than SIFB despite a greater axillary spread. The fascial space between the pectoralis minor and serratus anterior muscles is not always easy to find, especially in the elderly patients. Contrary to the Pec's block II, we intentionally injected the LA below the SAM for two reasons: to achieve greater spread within the serratus-intercostal plane and thus blocking the second and third intercostal nerves (ICBn), while avoiding the possibility of transitory palsy of the LTN, leading to a winged scapula than can be mistaken with a surgical lesion of this nerve.

The serratus interfascial plane (SIFB) is a small, poorly distensible neurovascular space between the SAM and EIM containing the perforating lateral intercostal cutaneous branches of the intercostal nerves.

The SIFB's poor distensibility, along with the respiratory movements, allows the LA to be extensively dispersed within this plane.

We would like to unify concepts in order to avoid confusing our readers. We use the term SIFB^{9,15,17,24} instead BRILMA¹¹ because for anglo readers it is easier to understand, but the interfascial plane injection is the same. The

SAM has several anatomical relationship in the chest wall, the same way the transversus abdominis muscle in the lateral abdominal wall, keeps an anatomical relationship with the internal oblique muscle. The SAM, in the lateral chest wall, attaches to the ribs and gets in contact with the EIM, being covered by the PMM, pmm and latissimus dorsi, and later gets enmeshed with the external oblique muscle in the antero-inferior thoracic wall. Therefore the name "serratus anterior plane" would be incorrect, since it does not describe the specific interfascial plane where the local anesthetic gets deposited.

Wahba²⁵ evaluated the thoracic paravertebral block (TPVB) versus pectoral nerve block in regard to morphine consumption and analgesic efficacy after modified radical mastectomy.

It was concluded that 24 h morphine consumption was significantly lower in Pec's block group, and lower pain scores in the first 12 h in comparison with TPVB after mastectomy. This result are contradictory, not corresponding with other published results.^{2,18,26} Based on the current evidence nowadays, the TPVB is the gold standard technique for breast surgery, despite the encouraging results of these new interfascial thoracic block.^{2,18} Based on our experience, the Pec's II block does not provide adequate analgesia for mastectomy and the LA hardly reaches beyond the level of T3–T4. We believe that Pec's II block is a good technique for axillary surgery, not for mastectomy.

The SIPB lateral approach was recently evaluated as a method to achieve analgesia after breast surgery, breast brachithrapy, chest drain tube.^{9,11,15,17,24} To improve this technique we use a long needle to advance it through the SIFP with the lateral approach and utilize hydrodissection, to place the LA as distal as possible. The ribs are important ultrasound landmarks to avoid pleural or lung puncture. The use of sedation analgesia relieves patient discomfort due the SAM puncture, ribs periosteum contact and hydrodissection of the interfascial plane. To perform SIFB-lateral approach, we prefer placing the patient in the lateral decubitus position or place a pillow under the chest because the soft tissue will drop down and the distance between the skin and the ribs is shortened. Also, resting the hand holding the probe on the lateral chest wall will make the technique more stable.

To improve these blocks, now we use fine and sharp needles for "single shots" and Tuohy needles to place continuous catheters.

This thoracic interfascial ultrasound block is a simple technique and relatively quick to perform since they are superficial and sonographically easy to understand, and they have a reproducible sonoanatomy in the vast majority of patients, and may be performed in patients under general anesthesia. Although these novel blocks are techniques performed usually by anesthesiologists, nurse anesthetists with training in regional block and surgeons would feel comfortable to perform such blocks.

They may also provide additional options when circumstances are unfavorable to perform a TPVB (such as coagulopathy, intolerance of sympathectomy or inability to position a patient properly). In addition, these can be targeted to unilateral or segmental surgery and can cover several dermatomes and the axilla with one injection. They may also very easily be performed as continuous peripheral nerve blocks with catheters, when extended analgesia

is required. In our experience and from discussions with our surgeons, these blocks do not interfere with the surgical field because the LA is placed between interfascial planes. These blocks may open new doors to investigation regarding the recurrence of breast cancer and the incidence of chronic pain after breast surgery.²⁷ Today, we do not have enough clinical data to compare these techniques with other techniques used in patients undergoing breast surgery.

We consider that these new blocks may have the following indications, according to our experience: the Pec's I block may be used in subpectoral prosthesis surgery with or without axillary approach, as well as for axillary surgery, remembering that it is also necessary to block the intercostal nerves, hence this block should not be used as the only anesthetic technique. The SIFB anterior approach can be used for non-reconstructive breast surgery and in combination with Pec's I block in patients undergoing reconstructive surgery, and for subpectoral prosthesis to block the lateral intercostal branches and the pectoral nerves. The SIFB lateral approach can be used for mastectomy, lumpectomy as well axillary clearance, and may be an alternative for latissimus dorsi flaps. The LA placed in this plane will diffuse through the intercostal muscles, thus blocking the anterior and lateral intercostal branches, producing sensory loss of the whole breast and diffusing anteriorly and posteriorly under the ribcage, reaching the posterior axillary line.

Even though our results are encouraging, we deemed it unnecessary to submit a large number of patients to an invasive investigation, for a small sample could bear out our theory. This study might open a new door to the analgesia of the axilla. We also did not explore the minimum amount of LA required to block the intercostal nerves that supply the breast and axilla. Despite using embalmed cadavers, the same level of adequate spread was demonstrated "in vivo" by using MRI. This is a descriptive study, further investigation is warranted.

Conclusions

This study represents, in our opinion, the first detailed depiction of the anatomic characteristics of interfascial thoracic blocks to achieve sensory block of the axilla (Interpectoral Fascia Plane (IPFP) and SIFB blocks).

These novel techniques may become widely used analgesic alternatives in axilla surgery given their low rate of complications and the characteristic single-puncture technique that allows simultaneous blockade of numerous dermatomes. Additional benefits of these techniques include applicability to the outpatient setting and to patients who have undergone a neuraxial block, may be safely practiced in a patient under general anesthesia, and the time consumed to block, 5–10 min, does not affect surgical time.

These blocks also might reduce the incidence of chronic pain after axillary dissection,^{5,6,28,29} the likelihood of tumor recurrence, decreasing noxious stimuli, as well as to attenuate the surgical stress response.^{29,30} Studies have shown that breast cancer patients who received the combination of a nerve block plus general anesthesia for their breast cancer surgery, had less cancer recurrence than those who received only general anesthesia.^{31–33} Moreover, patients

who received a nerve block, needed less post-operative pain relief from opioid drugs. We are waiting for a result of the observational studies and randomized controlled clinical trials, that are needed to confirm whether the thoracic interfascial block techniques are appropriate for routine clinical practice, and to determine the minimum amount of LA³⁴ required for blockade as well as the serum local anesthetic concentrations.

Conflicts of interest

The authors declare no conflicts of interest.

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