Benefits of peripheral nerve blocks in breast surgery

Salem Bobaker

Moderator: S Jithoo

School of Clinical Medicine
Discipline of Anaesthesiology and Critical Care
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INTRODUCTION

Breast surgery is currently among the most common in-hospital surgical procedures being performed and includes aesthetic procedures, cancer surgery and reconstructive surgery. Some of these surgeries are associated with significant postoperative complications such as acute pain, chronic pain, and nausea and vomiting (PONV) in up to 50% of patients.\(^1\) These complications can lead to an increase in duration of hospital stay, patient dissatisfaction and increase in hospital and patient costs.\(^1, 2\) The introduction of peripheral nerve blocks for breast surgery such as thoracic paravertebral blocks (TPVB), pectoral nerve blocks 1 and 2, serratus plane blocks and erector spinae blocks has been shown to significantly improve patient outcomes and reduce these described surgical and aesthetic postoperative complications.\(^1-10\)

Aside from a decrease in pain and PONV, several studies\(^11-14\) have described other interesting benefits of peripheral nerve blocks compared to general anesthesia plus opioids alone for breast surgery. These include a role in attenuating perioperative immunosuppression and decreasing the rate of tumor metastases. Studies comparing the effect of GA+paravertebral and GA+opioid on plasma levels of protumerogenic factors (matrix metalloproteinases and cytokines) found a decrease in levels of these hormones in the perioperative period when using regional anaesthesia rather than opioid alone. Increases in IL-10 levels, (known to prevent the production of proinflammatory cytokines, and exhibit anti-tumour and anti-metastatic activity) were also found, as well as enhanced cytotoxicity of Natural Killer cells, when using regional anaesthesia for breast surgery compared to GA+opioids alone.\(^1, 11, 12, 13, 14\)
ANATOMY OF THE CHEST WALL AND BREAST

1. Skin: dermatomes extend from T1-T7 for chest wall and from T2-T6 for breast (mainly anterior branches of T4 - T6). Axilla is covered by T2 (intercostobrachial nerve).

2. Muscles of chest wall:
   a. **Pectoralis major and pectoralis minor**: both receive innervation through medial (C8-T1) and lateral pectoral (C5-7) nerves.
   b. **Serratus anterior**: runs from the 1st-8th rib, innervated by long thoracic nerve (C5-C7)
   c. **Latissimus dorsi muscle**: innervated by posterior cord of thoracodorsal nerve (C6-8)

![Anatomy of the Chest Wall and Breast](image)

Figure 2

NERVES SUPPLY OF THE BREAST AND ANTERIOR CHEST WALL

1. **Pectoral nerves**: originate from the brachial plexus at the levels of the cords and subdivide into medial and lateral pectoral nerves.
   a. **Lateral pectoral nerve**: originates from C5-7 roots of the brachial plexus. Runs between pectoralis major and minor muscles. Main innervation to pectoralis major muscle.
   b. **Medial pectoral nerve**: originates from C8-T1 of the brachial plexus. Runs deep to pectoralis minor. Supplies both pectoralis major and minor muscles.

2. **Spinal nerves (T2-T6)**: run between the intercostal muscles in plane and split into anterior and lateral branches.
   a. **Anterior branches**: penetrates the serratus anterior and intercostal muscle anteriorly, supply the medial part of the breast.
   b. **Lateral branches**: penetrates the serratus anterior and intercostal muscle at mid-axillary level and give off anterior and posterior cutaneous branches.

3. **Thoracodorsal nerve / long thoracic nerve**:
   a. **Thoracodorsal nerve**: originates from posterior cord of the brachial plexus (C6-8) and supplies Latissimus dorsi muscle by running deeply in posterior axillary wall.
   b. **Long thoracic nerve**: originates from (C5-7). Runs through the outer border or on the surface of the serratus anterior muscle, innervating it, and ending in the axilla
Figure 3

Figure 4
THORACIC PARAVERTEBRAL BLOCK

The thoracic paravertebral block is one of the commonly used regional techniques in breast surgery, providing surgical anesthesia and postoperative analgesia. It aids in decreasing postoperative analgesic requirements and postoperative nausea and vomiting up to three times compared to general anesthetic and opioid alone. This leads to enhanced recovery rates, greater patient satisfaction and decrease in hospital stay.\textsuperscript{1-3}

Furthermore, while it cannot prevent it, paravertebral blocks have been shown to significantly decrease the intensity of chronic pain (phantom breast pain, paresthesia, costobrachial neuralgia) which can affect 20–50 % of patients post breast surgery. As previously discussed, paravertebral blocks also play a role in attenuation of perioperative immunosuppression and the reduction of tumour metastasis.\textsuperscript{1,9}

Anatomy

The paravertebral space is a wedge shaped space that lies close to the vertebral body and consists of transverse process / intervertebral foramina medially, parietal pleura anteriorly, costo-transverse ligament posteriorly and heads of the ribs inferiorly and superiorly. Administration of local anesthetic into the thoracic paravertebral space results in a blockade of both ipsilateral sympathetic and somatic nerves at the level administered. It dose cover the dermatomes below and above that level due to cranio-caudal continuity of the paravertebral space.

Technique

1. Blind techniques: Either awake or asleep technique (no evidence of preference). Needle is inserted at the level of T4 spine, about 2.5 cm lateral to the midline. Needle inserted perpendicular to skin, advance until you come in contact with transverse process then redirect the needle 10 degrees cephalad, and further advance from 1 to 1.5 cm using loss of resistance technique.

2. Ultrasound techniques: By using ultrasound, it is easier to identify the depth and location of the transverse process and the paravertebral space. Pleura and distribution of the local anesthetic during the injection can be identified.
Volume and continuous infusion

Single injection of 15 - 20 ml of local anesthetic (0.5% bupivacaine) can block 3 dermatomes for somatic innervation and block up to 8 dermatomes of sympathetic innervation. Or multiple injections of 3–5 ml of local anesthetic at multiple levels of thoracic paravertebral spaces and alternate spaces are recommended to minimize the toxicity. A single injection of this volume of local anesthetic will provide analgesia for approximately 4 hours and decrease opioids consumption to 24 hours.

Continuous infusion with an indwelling catheter may be done to avoid multi-level injections. 8–10 ml of 0.5% bupivacaine can be initially loaded, and maintained with 6 to 10 ml of 0.2% bupivacaine.

Advantages of thoracic paravertebral blocks

1. Provides excellent pain control specifically in the first 24 to 72 hours.
2. Insertion of catheter allows continues infusion of local anesthetic.
3. Decrease in postoperative complications such as nausea and vomiting, acute pain, chronic pain, immunosuppression and decreasing cancer reoccurrence risk.
4. When used in combination with lateral pectoral nerves blocks, superior pain control is achieved, with significantly lower anesthetic and analgesic requirements.

Disadvantages and complications

1. Risk of pneumothorax  0.5 %
2. Spinal cord injury
3. Conversion to total spinal or epidural anesthesia
4. Failure rate 6.8 – 10 %.
5. Vascular puncture 3.8 %.
6. Hypotension 4.6 %.
7. Pleural puncture 1.1 %
8. Dose not covers the axilla and brachial plexus branches (medial and lateral pectoral nerves)
9. May need multiple levels of injections for optimal anesthetic.
PECTORAL NERVE BLOCK

The pectoral nerve block is considered a fascial plane block at the thoracic area. Done under ultrasound guidance, it can be used for analgesia in the perioperative period for chest and breast surgery. There are two components of this block – PECS 1 and PECS 2

PECS 1

Injection of local anesthetic (10ml) between pectoralis major and minor muscles at the level of the 3rd rib. This blocks the medial and lateral pectoral nerves.

Indications
Any operation involving pectoralis major muscle e.g. insertion of breast expanders of the, pacemakers and cardiac defibrillator, anterior approach thoracotomy, shoulder surgery at deltidoid-pectoral groove.
Ultrasound technique PECS 1

**Technique**

<table>
<thead>
<tr>
<th>Positioning</th>
<th>Supine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe</td>
<td>High frequency linear probe 38 mm, 6-13 MHz</td>
</tr>
<tr>
<td>Depth</td>
<td>Usually 1-3 cm</td>
</tr>
<tr>
<td>Needle</td>
<td>22G regional block needle, 50-100mm</td>
</tr>
<tr>
<td>Needle approach</td>
<td>In-plane</td>
</tr>
<tr>
<td>Injection</td>
<td>0.15 to 0.2 mls/kg of 0.25% of levobupivacaine. A minimum volume recommended is 10mls. (Figure 4)</td>
</tr>
</tbody>
</table>

**Probe position and sonography for Pecs 1**

- Place the probe inferior to the clavicle (Figure 3)
- Identify the pectoralis muscles with the axillary artery and axillary vein on sonography. The brachial plexus should be visible underneath. (Pectoralis major is the most superficial, pectoralis minor lies underneath (Fig 4).
- Look for a vascular branch moving between the pectoral muscles from medial to lateral. This is the lateral pectoral branch of the thoraco-acromial artery.
- The author prefers to rotate the probe so that it is oblique to the spine and medial to the coracoid process. In this way, it will also be in a position suitable for Pecs II block (Fig 5). This is the original description for this block.

![Figure 3: Pecs I block- probe and needle placement](image)

The needle can be introduced in-plane cephalic to inferior (Fig 3) or if you have rotated your probe it will be a medial to lateral approach. Use hydrolocation with saline or local anaesthetic to identify and open the space between the pectoralis muscles. It may be preferable to use saline for hydrolocation so as to not waste any local anaesthetic.

**Figure 6**

**PECS 2**

Injection of local anesthetic (15-20 ml) between serratus anterior and pectoralis minor muscles where intercosto-brachial and intercostal nerves are running.
Indications
As for PECS 1 as well as for more extensive mastectomies (radical and modified radical mastectomies) with axillary clearance, or reconstruction involving serratus anterior or latissimus flaps.

Ultrasound technique PECS

Technique

<table>
<thead>
<tr>
<th>Positioning</th>
<th>Supine preferably with arm abducted to 90 degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe</td>
<td>High frequency linear probe 38 mm, 6-13 MHz</td>
</tr>
<tr>
<td>Depth</td>
<td>Usually 1-5 cm</td>
</tr>
<tr>
<td>Needle</td>
<td>22G regional block needle, 50-100mm</td>
</tr>
<tr>
<td>Needle approach</td>
<td>In-plane</td>
</tr>
<tr>
<td>Injection</td>
<td>0.15 to 0.2 mls/kg of 0.25% of levobupivacaine. One third of total volume is given at point 1 (between pectoral muscles) and two thirds at point 2 (between pectoralis minor and serratus anterior where it lies over the 4th rib). The minimum volumes recommended are 10mls at point 1 and 15mls at point 2 (Figure 7)</td>
</tr>
</tbody>
</table>

Probe position and sonography for Pecs II

- Start as for Pecs I with the probe at the mid clavicular level and angled inferolaterally (Fig 5)
- Identify pectoralis minor and serratus anterior on sonography. This may require moving the probe laterally from your Pecs I probe position.
- Locate the 2nd rib immediately under the axillary artery then count the 3rd rib.
- Move the probe laterally to identify the 4th rib (Fig 6).
- At this position, 10mls of local anaesthetic can be deposited between pectoralis major and minor (Pecs I) then the needle advanced to deposit 15-20mls of local anaesthetic between pectoralis minor and serratus anterior (Pecs II)

Figure 7
Figure 8

Advantages of PECS blocks 1-6:
1. Less invasive techniques
2. Simple to perform
3. Good analgesia
4. Added analgesia for muscle spasm from reconstructive surgery
ERECTOR SPINAES PLANE BLOCK

The erector spinae block is an ultrasound-guided myofascial plane block where 30 ml of local anesthetic is injected below the erector spinae muscle at the level of T4, 5 transverse processes. This results in unilateral blockade of both somatic and sensory innervation at multiple dermatomal levels through local anesthetic mediated blockade of the ventral and dorsal rami of the spinal nerve roots.

Figure 9

Advantages of Erector Spinae block
1. Higher safety margin than TPVB
2. Single injection (30 ml) enough for coverage in comparison with TPVB
3. Easier to perform, can do unilateral or bilateral blocks
4. Not inferior to TPVB in terms of analgesia

Mechanisms of action
- Spread occurs
  - Laterally (into intercostal space)
  - Anteriorly (into paravertebral space)
- Sympathetic chain
  - Viscera
- Dorsal ramus
  - Back
- Ventral ramus
  - Lateral cutaneous branches
  - Anterior cutaneous branches
Ultrasound guided technique of Erector Spinae block

Figure 10
<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Study Type</th>
<th>Surgery/Indication</th>
<th>Block Type</th>
<th>N</th>
<th>Injectate</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanco et al., 2013</td>
<td>Volunteer study</td>
<td>–</td>
<td>Serratus plane</td>
<td>4</td>
<td>0.4 mL/kg levobupivacaine 0.125% and gadolinium</td>
<td>Mean duration of paresthesia in the intercostal nerve distribution T2-T9, was 752 minutes injection superficial to serratus anterior</td>
</tr>
<tr>
<td>Wahba and Kamal, 2014</td>
<td>Randomized controlled trial</td>
<td>Mastectomy</td>
<td>Pecs II versus PVB</td>
<td>60</td>
<td>0.25% levobupivacaine: 15-20 mL T4 PVB, 10 mL Pecs I block</td>
<td>Pecs blocks reduced postoperative morphine consumption (first 24 h) and pain scores (first 12 h) in comparison with PVB following mastectomy</td>
</tr>
<tr>
<td>Fujiwara et al., 2014</td>
<td>Case report</td>
<td>Insertion of cardiac resynchronization device</td>
<td>Intercostal at first and second interspace, Pecs I block</td>
<td>1</td>
<td>0.375% ropivacaine: 4 mL intercostal block, 10 mL Pecs I block</td>
<td>Surgery performed under intercostal/ Pecs I blocks and dexmedetomidine</td>
</tr>
<tr>
<td>Kunhabdulla et al., 2014</td>
<td>Case report</td>
<td>Analgesia for rib fracture</td>
<td>Serratus plane</td>
<td>1</td>
<td>20 mL bolus 0.125% bupivacaine, then infusion of 0.0625% bupivacaine at</td>
<td>Effective analgesia to enable physiotherapy and ambulation</td>
</tr>
<tr>
<td>Madabushi et al., 2015</td>
<td>Case report</td>
<td>Analgesia for thoracotomy</td>
<td>Serratus plane</td>
<td>1</td>
<td>6 mL bolus 1% lignocaine, then infusion of bupivacaine 0.1% at 7 mL/h</td>
<td>Improvement in pain and ventilation</td>
</tr>
<tr>
<td>Murata et al., 2015</td>
<td>Case report</td>
<td>Breast surgery</td>
<td>Pecs II</td>
<td>2</td>
<td>35 mL 0.2% ropivacaine (mastectomy); 45 mL 0.2% ropivacaine (lumpectomy)</td>
<td>Mastectomy performed under Pecs II block and supplemental infiltration</td>
</tr>
<tr>
<td>Ueshima, 2015</td>
<td>Case report</td>
<td>Segmental breast resection</td>
<td>TTP combined with Pecs II</td>
<td>1</td>
<td>0.15% levobupivacaine: 15 mL TTP, 10 mL Pecs I, 20 mL Pecs II</td>
<td>Surgery performed under TTP and Pecs II blocks</td>
</tr>
<tr>
<td>Bashandy and Abbas, 2015</td>
<td>Randomized controlled trial</td>
<td>Mastectomy</td>
<td>Pecs II</td>
<td>120</td>
<td>0.25% bupivacaine: 10 mL Pecs I, 20 mL Pecs II</td>
<td>Lower visual analog scale pain scores and opioid requirements in the Pecs group compared to control group</td>
</tr>
<tr>
<td>Kulhari, 2016</td>
<td>Randomized controlled trial</td>
<td>Radical mastectomy</td>
<td>Pecs II versus PVB</td>
<td>40</td>
<td>25 mL 0.5 % ropivacaine</td>
<td>Duration of analgesia increased in Pec’s block compared to PVB group (4.9 versus 3.3 hours)</td>
</tr>
<tr>
<td>Hetta, 2016</td>
<td>Randomized controlled trial</td>
<td>Radical mastectomy</td>
<td>Serratus plane</td>
<td>64</td>
<td>30 mL 0.25 % bupivacaine, Serratus plane: 15 mL 0.25% bupivacaine, PVB</td>
<td>Increased opioid consumption in the serratus plane compared to PVB group</td>
</tr>
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</table>
CONCLUSION

Peripheral nerve blocks play an important role in pain control in the perioperative period for breast surgery and help to minimize the complications of surgery and general anesthetic e.g. nausea and vomiting and chronic pain. It may also play a role in attenuation of perioperative immunosuppression and decreasing cancer reoccurring. 1-7

Thoracic paravertebral blocks offer a good quality and duration of anesthesia and analgesia in breast surgery, and provides superior analgesia to general anesthesia plus opioids alone. However it is an invasive technique with a risk of complications e.g. pneumothorax, spinal cord injury, conversion to spinal/epidural anesthesia.

PECS's blocks and erector spinae muscle blocks are newer ultrasound-guided peripheral nerve blocks used for variety of breast procedures. They are good alternative options, providing excellent analgesia (comparable to that achieved by paravertebral blocks) but with higher safety margins. 1, 5, 6,9,10
REFERENCES


5. Dr. Teresa Parras and Dr. Rafael Blanco PECS BLOCKS. ATOTW 346 – PECS BLOCKS (31st Jan 2017) www.wfsahq.org/resources/anaesthesia-tutorial-of-the-week


11. Deegan, CA, Murray, ; Doran P , Moriarty, Denis ; Sessler, Daniel ; Mascha, Kavanagh, Brian P, Buggy, Donal J. Aesthetic Technique and the Cytokine and Matrix Metalloproteinase Response to Primary Breast Cancer Surgery Regional Anaesthesia and Pain Medicine: November 2010 - Volume 35 - Issue 6 - p 490-495.


17. 3-Liang Li 1 *, Ben-LongYu 2, Chen-FangHung ,Paravertebral Block Plus Thoracic Wall Block versus Paravertebral Block Alone for Analgesia of Modified Radical Mastectomy: A Retrospective Cohort Study

19. SQM Tighe, Michelle D Greene, Nirmal Rajadurai, Paravertebral block, Continuing Education in Anesthesia and Critical Care & pain, volume 10, Issue 5, 1 October 2010 BJA.

Figures:
1. Reference 14.
2, 3, 4, 6, 7 & 8 reference number 5
5. LSORA: Paravertebral block (US guided) tutorial YouTube
9 & 10 The ESP (erector spinae plane) Block – Our current understanding, Vicente Roques Escolar YouTube.