Since the original description in 2011, the array of pectoral nerve blocks has evolved. The pectoral nerve (PECS) block in conjunction with general anesthesia can decrease an additional analgesic in perioperative period for breast cancer surgeries. Current literature on the PECS block has reported three several types (PECS I, PECS II, and serratus plane blocks). The PECS I block is the same as to the first injection in the PECS II block. The second injection in the PECS II block and the serratus plane block blocks intercostal nerves (Th2–6) and provides an analgesic for the breast cancer surgery. However, the PECS I block (or first injection in the PECS II block) has no analgesic, because both lateral and medial pectoralis nerve blocks are motor nerves. PECS block in previous reports, when added to opioid-based general anesthesia, may improve analgesia and decrease narcotic use for breast cancer surgery. Moreover, PECS block compares favorably with other regional techniques for selected types of surgery. A major limitation of the PECS block is that it cannot block the internal mammary region. Therefore, some studies have reported its ability to block the anterior branches of the intercostal nerve. PECS block is an effective analgesic tool for the anterolateral chest. In particular, the PECS block can provide more effective analgesia for breast cancer surgery.

Keywords: pectoral nerve (PECS) block, chest wall block, breast cancer surgery, perioperative pain management

Introduction

The pectoral nerve (PECS) block was first described by Blanco, and “PECS I block,” “PECS II block,” and “serratus plane block” have been reported to be able to provide a perioperative pain management procedure for several surgeries of the anterolateral chest since the first publication. Recently, the effective use of the PECS block has been unraveled. This review introduces the mechanism of the PECS block and advises how to use the PECS block effectively.

Anatomy Surrounding Pectoralis Muscles

Firstly, three muscles (pectoralis major, pectoralis minor, and the serratus anterior muscles) involved in the PECS block must be understood to perform the PECS block with accuracy (Fig. 1). The pectoralis major muscle originates from clavicular head (anterior surface of medial half of clavicle) and sternocostal head, which is usually thought to arise from the superior five ribs, variations to 6th and 7th rib, to lateral lip of intertubercular groove of the humerus. The pectoralis minor muscle originates from the 3rd to the 5th rib near their costal cartilages to medial border...
The lateral and medial pectoral nerves, which run between the pectoralis major and the pectoralis minor muscles. The serratus anterior muscle originates from the 1st to the 9th rib and inserts at the ventral surface of the medial border of the scapula and is innervated by the long thoracic nerve, which runs on the serratus anterior muscle.

The nerve tracts (lateral pectoral, medial pectoral, long thoracic, thoracodorsal, and intercostal nerves) involved in the PECS block must be also understood to perform the PECS block with accuracy (Fig. 2). Except for the intercostal nerves, all nerves are originated from the brachial plexus. In the brachial plexus, the lateral pectoralis nerve branches from the lateral cord and the inner pectoralis nerve branches from the internal cord. These pectoralis nerves, which pass into the pectoralis minor and run between the pectoralis major and pectoralis minor muscles, innervate the pectoralis major and minor muscles. The thoracodorsal nerve, which branches from the posterior cord and extends to the posterior axillary wall, is a motor nerve. The long thoracic nerve, which branches from the intercostal nerves (Th5–6) and passes between the pectoralis minor and serratus anterior muscles, is a motor nerve. The nerves supplying the pectoralis muscles are usually referred to as lateral and medial anterior thoracic nerves, and they arise from the lateral and medial cord of the plexus, respectively. The intercostal nerves pass through the intervertebral foramen and run between the parietal pleura and innermost intercostal muscle. They pass between the inner intercostal and innermost intercostal muscles. The lateral cutaneous nerve branches at the middle axillary line. The branches become the anterior cutaneous branches and supply the rectus abdominis muscle.

**Fig. 1. Knowledge of muscles involved in the pectoral nerve block.**

**Nomenclature**

Literature on the PECS block has been reported three types (PECS I, PECS II, and serratus plane block) (Table 1).\(^1\)\(^2\) Firstly, PECS I block reported in 2011 by Blanco.\(^1\) The PECS I block injects local anesthetic into the plane between the pectoralis major and the pectoralis minor at the 3rd rib. Secondly, Blanco reported PECS II block in 2012 to be more effective.\(^2\) The PECS II block inject local anesthetic at two parts (the first injection and the second injection). The first injection is equal to the PECS I block and the second injection in the PECS II block is the local anesthetic injected between the pectoralis minor and the serratus anterior at the 4th rib. Finally, Blanco reported the serratus plane block in 2013.\(^3\) The serratus plane block inject local anesthetic around the serratus anterior at the 5th rib.\(^4\)
The patient was made to lie in the supine position, and the patient’s head was turned away. A shoulder pillow was placed at the patient’s back and the upper limb was abducted. An anesthesiologist stood at the patient’s head and an ultrasound machine was placed under the patient’s arm. A high-frequency linear probe was attached vertically to the midpoint of the clavicle and advanced in that direction.

For the PECS I block (or the first injection of PECS II block), the probe was set to the anterior chest to confirm the location of the interfascial plane between the pectoralis major and the pectoralis minor muscles at the 3rd rib, and local anesthetic 10 mL was injected at the interfascial plane (Figs. 3 and 4).

For the PECS II block, two parts (the first and the second injection) were injected local anesthetic. The first injection was the same as PECS I block. The second injection was attached the probe at the anterior chest to confirm the location of the interfascial plane between the pectoralis minor and the serratus anterior muscle at the 4th rib on the anterior axillary line and local anesthetic 20 mL was injected at the interfascial plane (Fig. 4).

Finally, for the serratus plane block, the probe was attached at the anterior chest to confirm the location of the interfascial plane around the serratus anterior at the 5th ribs.

Table 1. Nomenclature of each pectoral nerve block

<table>
<thead>
<tr>
<th>Block nerves</th>
<th>Position</th>
<th>Injection site</th>
</tr>
</thead>
<tbody>
<tr>
<td>PECS I block of first injection</td>
<td>Supine</td>
<td>Interfascial plane between pectoralis major and minor muscle at 3rd rib</td>
</tr>
<tr>
<td>PECS II block</td>
<td>Supine</td>
<td>Interfascial plane between the pectoralis minor and the serratus anterior muscle at the 4th rib on the anterior axillary line</td>
</tr>
<tr>
<td>Serratus plane block</td>
<td>Supine</td>
<td>Around the serratus anterior muscle (or semi-lateral) at 5th ribs</td>
</tr>
<tr>
<td>PECS: pectoral nerve</td>
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</table>

Tecniques of PECS Block

The patient was made to lie in the supine position, and the patient’s head was turned away. A shoulder pillow was placed at the patient’s back and the upper limb was abducted. An anesthesiologist stood at the patient’s head and an ultrasound machine was placed under the patient’s arm. A high-frequency linear probe was attached vertically to the midpoint of the clavicle and advanced in that direction.

For the PECS I block (or the first injection of PECS II block), the probe was set to the anterior chest to confirm the location of the interfascial plane between the pectoralis major and the pectoralis minor muscles at the 3rd rib, and local anesthetic 10 mL was injected at the interfascial plane (Figs. 3 and 4).

For the PECS II block, two parts (the first and the second injection) were injected local anesthetic. The first injection was the same as PECS I block. The second injection was attached the probe at the anterior chest to confirm the location of the interfascial plane between the pectoralis minor and the serratus anterior muscles at the 4th rib on the anterior axillary line and local anesthetic 20 mL was injected at the interfascial plane (Fig. 4).

Finally, for the serratus plane block, the probe was attached at the anterior chest to confirm the location of the interfascial plane around the serratus anterior at the 5th ribs.

In some cases, it may be easier to administer this block when the patient is in the semi-lateral position.
Fig. 3. How to connect to the pectoral nerve block.

Fig. 4. Ultrasound Images of the pectoral nerve (PECS) block. (A, B) Pre-injection, post-injection of PECS I block (or first injection in the PECS block). (C, D) Pre-injection, post-injection of second injection in the PECS block. (E, F) Pre-injection, post-injection of serratus plane block. (White arrow: needle trajectory and white dotted line: spread of local anesthetic.)

PMM: pectoralis major muscle; PmM: pectoralis minor muscle; SAM: serratus anterior muscle LDM: latissimus dorsi muscle.
To provide longer-lasting analgesia, continuous block has been made. Both the PECS block and continuous continuous local anaesthetic infusion could provide better analgesia over 24 h than the PECS block only. Adjuvant of dexmedetomidine added to PECS block could also provide an effective analgesia within the first 48 h after the block. \(^{17,18}\)

### Analgesia

The second injection in the PECS II block and the serratus plane block, which can block intercostal nerves (Th2–6) in the PECS block, is the main peripheral nerve block related to the analgesic of PECS block. \(^2,19\) Although the PECS I block (or the first injection in the PECS II block) can also block intercostal nerves (Th2–6), the injection volume of more than 0.4 mL/kg is needed. The injection volume of less than 0.4 mL/kg may block only the lateral and medial pectoralis nerve blocks, which are motor nerves. \(^1,20,21\)

Considering the above, each PECS block was performed for each surgery (Table 2).

### Breast Cancer Surgery

#### Lumpectomy and Partial Mastectomy

Need analgesia for lumpectomy and partial mastectomy is a subcutaneous breast tissue, and blocking of anterior and lateral cutaneous branches of upper thoracic nerves related the incised wound is needed. \(^22,23\)

#### Modified Radical Mastectomy and Total Mastectomy

In addition to need analgesia for lumpectomy and partial mastectomy, modified radical and total mastectomy which were injured pectoralis major muscle result in partial denervation and perioperative myofascial pain. \(^24\) To relieve the myofascial pain, blocking the lateral and medial pectoralis nerve blocks are needed.

Also, for axillary dissection or sentinel node biopsy in conjunction with radical mastectomy and total mastectomy, blocking the intercostobrachial nerve (lateral cutaneous branch of T2), thoracodorsal nerve (C6–8) and long thoracic nerve (C5–7) are needed.

#### Reconstructive Breast Surgery

Reconstructive breast surgery, which restores a natural breast appearance, is frequently performed after breast cancer surgery.

Insertion of tissue expanders for the reconstructive surgery is inserted between the psoas major muscle and the psoas minor muscle. Therefore, the lateral and medial pectoralis nerves must be blocked.

Breast reconstruction with deep inferior epigastric perforator flap is needed to block the anterior branches of T10–L1 in addition to the anterior and lateral cutaneous branches of upper thoracic nerves, and the lateral and medial pectoralis nerves. Breast reconstruction with latissimus flap is needed to add blocking of the posterior branches of T10–L1.

### Cardiac Surgery

Cardiac surgery is needed to block the anterior and lateral branches of intercostal nerves (T2–6). \(^12,25\)

Table 2 shows that adding of blocking anterior branches of intercostal nerves (T2–6) to the PECS block was essential to provide effective analgesia.

### Anterior Branches of Intercostal Nerves (Th2–6)

Although the PECS block can improve postoperative pain, the only PECS block has been reported to unable to provide anterior chest pain relief completely, and to increase the quality of recovery. \(^26\) Therefore, in addition to the PECS block, a block for the anterior branches of intercostal nerves was needed. Some studies have reported the other blocks, such as the transversus thoracic abdominis plane (TTP) block and the parasternal intercostal nerve (PSI) block, to block the anterior branches of the intercostal nerves (Th2–6). \(^27-32\) Especially, the addition of TTP block to PECS block can provide an effective pain management for breast cancer surgery within the first 48 h after surgery. \(^15\) Blocking anterior branches of intercostal nerves to the PECS block may provide more effective perioperative pain relief for anterior chest surgery than a PECS block alone. \(^15\)

### Compared With Other Regional Anesthesia

Compared with only general anesthesia, a combination of general anesthesia and a PECS II block has been reported to be a more effective analgesic for breast cancer surgeries during the perioperative period. \(^3,33,34\)
<table>
<thead>
<tr>
<th>Block region</th>
<th>Cutaneous and subcutaneous innervation</th>
<th>Muscle innervation (myofascial pain)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Intercostal nerves</td>
<td>Cervical plexus</td>
</tr>
<tr>
<td></td>
<td>Intercostobrachial nerve (T2)</td>
<td>Lateral pectoral nerve (C5–7)</td>
</tr>
<tr>
<td></td>
<td>Lateral cutaneous branches</td>
<td>Medial pectoral nerve (C7–T1)</td>
</tr>
<tr>
<td></td>
<td>Anterior cutaneous branches</td>
<td>Thoracodorsal nerve (C6–8)</td>
</tr>
<tr>
<td></td>
<td>Supraclavicular nerves</td>
<td>Long thoracic nerve (C5–7)</td>
</tr>
<tr>
<td>Block region</td>
<td>Axilla and medial upper arm</td>
<td>Lumpectomy and partial mastectomy</td>
</tr>
<tr>
<td></td>
<td>Lateral half of breast</td>
<td>Axillary dissection or sentinel node biopsy</td>
</tr>
<tr>
<td></td>
<td>Medial half of breast</td>
<td>Modified radical mastectomy and total mastectomy</td>
</tr>
<tr>
<td></td>
<td>Cranial portion of the breast</td>
<td>Axillary dissection or sentinel node biopsy</td>
</tr>
<tr>
<td></td>
<td>Pectoralis major muscle</td>
<td>Pectoralis minor and major muscle</td>
</tr>
<tr>
<td></td>
<td>Pectoralis major muscle</td>
<td>Latissimus dorsi muscle</td>
</tr>
<tr>
<td></td>
<td>Latissimus dorsi muscle</td>
<td>Serratus anterior muscle</td>
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<td></td>
<td>Serratus anterior muscle</td>
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<thead>
<tr>
<th>Type of surgery and blocking nerves</th>
<th>Nerve block</th>
</tr>
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<tbody>
<tr>
<td>Lumpectomy and partial mastectomy</td>
<td>PECS I block or first injection of PECS II block</td>
</tr>
<tr>
<td>Modified radical mastectomy and total mastectomy</td>
<td>PECS II block</td>
</tr>
<tr>
<td>Axillary dissection or sentinel node biopsy</td>
<td>Serratus plane block</td>
</tr>
</tbody>
</table>

**Table 2.** Play of the pectoral nerve block for anterior chest surgery

PECS: pectoral nerve.
There are a few papers concerning regional anesthesia. As for radical mastectomy, the PECS block was a more effective perioperative analgesic compared with the thoracic paravertebral nerve block because the PECS block can relieve pain at the axillary region even though the thoracic paravertebral nerve block cannot relieve pain at this region.\(^\text{39}\) Additionally, the serratus plane block has been reported to be more effective for postoperative analgesia after thoracotomy compared with thoracic epidural analgesia.\(^\text{37}\) However, the serratus plane block has also been reported to be inferior to the thoracic paravertebral block.\(^\text{36}\) The serratus plane block may not be able to provide an effective analgesic for radical mastectomies with axillary evacuation. Otherwise, the PECS I block (or first injection in the PECS II block) may be an analgesic for breast cancer surgeries.\(^\text{13}\) Also, these blocks are injected local anesthetic at the shallower site compared with the paravertebral nerve block and epidural anesthesia. Therefore, some complication after these blocks may be managed promptly.\(^\text{37}\) The PECS II block and the serratus plane block can be the more effective blocks in perioperative period compared with the thoracic paravertebral nerve block and safer blocks of analgesia in perioperative period compared with the thoracic epidural analgesia. As for the efficacy of chronic pain for the PECS II block and the serrates plane block, some additional research will be needed.\(^\text{38}\)

**Complications**

As there are some branches of thoracodorsal artery through the interfascial plane pass between the pectoralis major muscle (PMM) and the pectoralis minor muscle (PmM), and the PmM and serratus anterior muscle, artery puncture and hematoma after these blocks may be one of high frequent risk. However, previous study showed that frequency of artery puncture and hematoma was less than 2.0%.\(^\text{37}\) Also, the total volume used for these blocks may be high volume was caused local anesthetic systemic toxicity (LAST). There are no papers, which investigated a local anesthetic concentration after these blocks. The local anesthetic concentration after the other trunk nerve blocks such quadratus lumborum block and transversus abdominis plane block showed that arterial ropivacaine levels measured using high-performance liquid chromatography with carbamazepine after administration of total 150 mg of ropivacaine for an adult (more than 50 kg). The ropivacaine concentration was less than 2.2 µg/mL, which represented the arterial and venous threshold values of systemic toxicity.\(^\text{39,40}\) Therefore, administration of 150 mg of ropivacaine for the trunk block may be safe. Total volume and concentration should be controlled not exceed 3 mg/kg (weight) of long-acting local anesthetic such as ropivacaine and levobupivacaine.

The concentration peak of the long-acting local anesthetic such as ropivacaine and levobupivacaine, which was injected for trunk nerve block, was observed between 30 and 60 min after these blocks was administered.\(^\text{39}\) We must pay attention to the patient for an hour after these blocks.

To prevent these complications, we must perform a pre-scan before a block accurately, and avoid puncturing artery around the blocks and injecting local anesthetic in the blood vessel.

**Discussion**

PECS block for breast surgery is showed to provide effective analgesia in perioperative period. However, the use of PECS block for each breast cancer is different. In addition, other nerve block such as intercostobrachial nerve (T2) and supraclavicular nerves must be performed to provide effective analgesia for breast surgery. Therefore, we must confirm the type of each breast surgery. To provide blocking of the cutaneous and subcutaneous innervation, blocking of anterior and lateral pectoralis nerves, intercostobrachial nerve (T2) and supraclavicular nerves must be performed depending on the incised site. To provide blocking of the myofascial pain, blocking of lateral and medical pectoralis nerve must be performed. Also, breast reconstruction with flap must block spinal nerve depending on the flap site.

After breast cancer surgery, contraction of pectoralis major and minor muscles in addition to postoperative pain management continuous to the difficulty of movement of the upper limb, and lead to decrease the quality of daily life. Single injection of PECS I block (the first injection in the PECS II block) could block both the lateral and medial pectoralis nerve blocks and prevent contraction of pectoralis major and minor muscles in the postoperative period.\(^\text{41,42}\) Therefore, PECS I block (the first injection in the PECS II block) may play a major role after the breast cancer surgery because of contraction prevention of pectoralis major and minor muscles.

In the future, the PECS block must play a central role for the efficacy of chronic pain for breast surgery. Therefore, we must confirm the type of breast surgery. To provide blocking of the cutaneous and subcutaneous innervation, blocking of anterior and lateral pectoralis nerves, intercostobrachial nerve (T2) and supraclavicular nerves must be performed depending on the incised site. To provide blocking of the myofascial pain, blocking of lateral and medical pectoralis nerve must be performed. Also, breast reconstruction with flap must block spinal nerve depending on the flap site.
role in perioperative pain management for the breast cancer surgery.

Conclusion

Current research continues to clarify the capabilities of the PECS block. We now understand that PECS block in conjunction with general anesthesia can decrease an additional analgesic in perioperative period for breast cancer surgeries, compared with using general anesthesia exclusively and using general anesthesia alongside other regional anesthesia.

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