

Addition of transversus thoracic muscle plane block to pectoral nerves block provides more effective perioperative pain relief than pectoral nerves block alone for breast cancer surgery

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Abstract

Background. The pectoral nerves (PECS) block cannot block the most internal mammary region, whereas a transversus thoracic muscle plane (TTP) block can. The combination of PECS and TTP blocks may be suitable for anterior chest surgery. We studied patients undergoing mastectomy to assess whether the combination of PECS and TTP blocks provides better analgesia than PECS block alone.

Methods. Seventy adult female patients undergoing unilateral mastectomy under general anaesthesia were randomly allocated to receive either the combination of PECS and TTP blocks (PT group, $n=35$) or the PECS block only (C group, $n=35$). The primary outcome measure was visual analog scale pain score. Secondary outcomes were the sensory level loss confirmed by cold tests and additional analgesic drugs within 24 h after the operation.

Results. The visual analog scale pain scores were lower in the PT group than the C group. The use of postoperative additional analgesic drugs was also lower in the PT group than that in the C group. In the majority of patients in the PT group, sensory loss was confirmed in both the anterior and the lateral branches of thoracic nerves (Th2–6).

Conclusion. Compared with PECS block, the combination of PECS and TTP blocks provides effective perioperative pain relief for breast cancer surgery.

Clinical trial registration. University Hospital Medical Information Network (UMIN) ID number 000018299.

Key words: mastectomy; nerve block; analgesia; radical

Breast cancer is a common cancer, and the number of breast cancer operations is increasing.^{1–2} Nevertheless, we may not pay attention to the perioperative pain relief after breast cancer surgery because of the minimal invasiveness in comparison to other cancer surgeries. However, ~20% of patients who undergo breast surgery may have chronic post-mastectomy pain.³

The pectoral nerves (PECS) block provides analgesia of the lateral mammary region, the intercostobrachial and lateral

cutaneous branches of the intercostal nerves (Th2–6), the medial cutaneous nerve of the arm and forearm, and the long thoracic and thoracodorsal nerves.^{4–5} Therefore, the PECS block is reported to be effective for perioperative pain management of breast cancer surgeries.^{6–8} One major problem with the PECS block is that it cannot block the internal mammary region.

The ultrasound-guided transversus thoracic muscle plane (TTP) block can block multiple anterior branches of the

Editorial decision: December 10, 2016; **Accepted:** December 13, 2016

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Editor's key points

- The pectoral nerves (PECS) block, which is effective analgesia for mastectomy, cannot block the internal mammary region. Addition of transversus thoracic muscle plane (TTP) block may be beneficial.
- Postoperative analgesia effect was compared between the PECS block and PECS plus TTP blocks, in patients who underwent mastectomy under general anaesthesia.
- Compared with PECS block, the combination of PECS and TTP blocks provided more effective perioperative pain relief after mastectomy.

intercostal nerves (Th2–6), which dominate the internal mammary region.^{9,10} Therefore, a combination of the PECS block and the TTP block may be effective for acute postoperative analgesia in breast cancer surgery. The aim of this study was to compare the analgesic efficacy of the combination of PECS block and TTP block (PT group) for modified radical mastectomy surgery, compared with the PECS block only (C group).

Methods

Patients and design

This prospective study was approved by the Showa University Hospital Institutional Review Board (approval no. 1802) and was registered at the University Hospital Medical Information Network (UMIN ID no. 000018299). From July 2015 to January 2016, ASA physical status I and II female patients who had elective, unilateral, primary modified radical mastectomy surgery were recruited to participate in the study. All patients gave written informed consent to this study.

The exclusion criteria were an inability to cooperate, inability to communicate, allergy to levobupivacaine, and secondary surgery.

Anaesthesia and pre- and perioperative analgesia

General anaesthesia was induced with fentanyl 1–2 $\mu\text{g kg}^{-1}$ and propofol 1–2.5 mg kg^{-1} . Neuromuscular block was achieved with rocuronium 0.6–0.9 mg kg^{-1} , and the trachea was intubated. Anaesthesia was maintained with desflurane 4–6% in oxygen 40–60%, with remifentanyl 0.05–0.2 $\mu\text{g kg}^{-1} \text{min}^{-1}$. Rocuronium 0.1–0.2 mg kg^{-1} was given at the discretion of the anaesthetists. Additional boluses of fentanyl 50 μg were administered to maintain blood pressure or heart rate values within 30% of first vital signs when the patient entered the operating room. After induction of anaesthesia, ultrasound-guided nerve blocks were performed. The patients were randomly allocated to one of two groups. In one group (the C group), only the PECS block was performed, whereas in the other group (the PT group), PECS and TTP blocks were performed. The group allocation (PT group or C group) was concealed in sealed opaque envelopes that were opened after enrolment of the patients.

Ultrasound-guided peripheral nerve block

For ultrasound-guided peripheral nerve block, we used a 20-gauge Tuohy needle and a 12L-RS linear probe of the LOGIQ e Premium ultrasound system (GE Healthcare Japan, Tokyo, Japan). The precordium was firmly cleaned with chlorhexidine.

For the PECS block, levobupivacaine 0.15%, 10 ml was injected between the pectoralis major and pectoralis minor at the third rib and 25 ml above the serratus anterior muscle. For the TTP block, levobupivacaine 0.15%, 15 ml was injected between the transversus thoracic muscle and the internal intercostal muscle between the fourth and the fifth ribs connecting at the sternum (Fig. 1).

The local anaesthetics were prepared by another anaesthetist who did not perform the peripheral nerve blocks.

At the end of the surgery, acetaminophen 1 g was infused i.v. After the patient responded to verbal command, the trachea was extubated and the patient transferred to the recovery room. When the exit criteria became >8 points on the Aldrete score, the patient was moved to the ward. In the postoperative ward, the patient's blood pressure, heart rate, and oxygen saturation were monitored. When the patient complained of pain, pentazocine 15 mg was injected i.v. at 8 h intervals, regardless of the degree of pain. If the patient complained of additional pain, acetaminophen 1 g was given i.v. at 8 h intervals. If both these were not able to control the pain, attending anaesthetists were consulted. The patient was prescribed continuous administration of fentanyl. If the patient experienced nausea and vomiting, metoclopramide 10 mg was injected.

The postoperative pain score was assessed using a visual analog scale (VAS, 0–100 mm; 0=no pain and 100=worst severe pain). The VAS pain score was obtained at 1, 2, 4, 6, 12, and 24 h after surgery at rest. In addition, it was obtained at 12 and 24 h after surgery, during abduction of the shoulder. The sensory level was assessed using a cold test (+, normal sensation; –, decreased cold sensation and loss of cold sensation compared with the sensation at unaffected areas).

The primary outcome measure of the study was the postoperative pain score. The secondary outcome measures included the number of patients who required additional pentazocine i.v., metoclopramide, and the sensory level of block. The sensory level was checked when all patients awoke completely after the operation.

Statistical analysis

JMP® Pro software version 12.2.0 (SAS Institute, Cary, NC, USA) was used to test the normality of the data. The measured data were compared using Student's unpaired t-test, whereas non-parametric data were compared using the Mann–Whitney

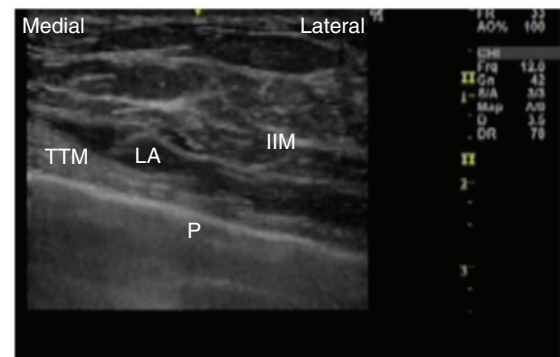
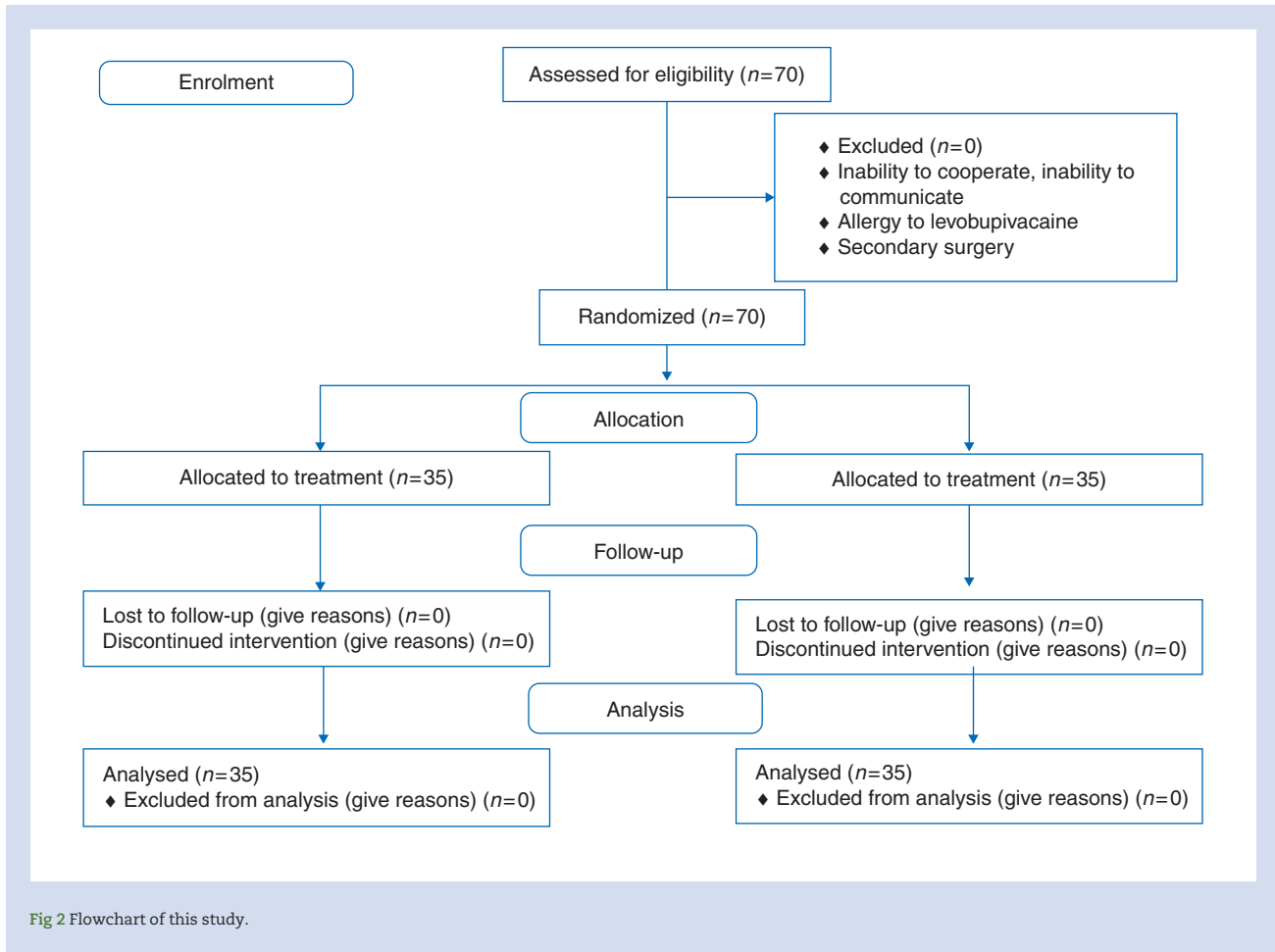


Fig 1 Ultrasound appearance of 15 ml of local anaesthetic solution filling the transversus thoracic muscle plane. IIM, internal intercostal muscle; LA, local anaesthetic; NT, needle tip; P, pleura; TTM, transversus thoracic muscle.



U-test and χ^2 test for the difference between the two groups. All VAS pain scores data for the primary outcome were compared using the Mann-Witney U-test for pairwise comparisons. The number of patients who received pentazocine or metoclopramide for the secondary outcome were compared by using Fisher’s exact test. In addition, the upper and lower sensory levels of block were compared using Student’s unpaired t-test.

According to a pre-established analysis plan with the C group ($n=8$), the sample size was calculated. Taking the postoperative VAS scores at 1 h at movement with an SD of 40 mm, for 30 mm difference in the VAS score decrease at an α error of 5% and a β error of 0.2, a total sample size of 60 patients would be required (30 in each group). Considering this fact, we planned to enrol 70 patients.

Results

All 70 patients were included in this study (Fig. 2). Patients’ characteristics and other factors were comparable between groups (Table 1). Compared with the C group, the VAS pain scores of the PT group were lower at all time points both at rest and during movement (Figs 3 and 4). The number of patients who required pentazocine was significantly lower in the PT group (20 patients) than in the C group (33 patients; $P=0.0003$; Table 2). No patient required acetaminophen or continuous administration of fentanyl. There was no significant difference in the use of metoclopramide (five patients in the PT group and two patients in the C group; $P=0.2$; Table 2). The sensory loss is shown in Table 3. There was no significant difference between

Table 1 Patient characteristics and other factors. Data are expressed as the median (range)

	PT group (n=35)	C group (n=35)
Age (yr)	52 (46–61)	48 (43–66)
BMI (kg m^{-2})	20.6 (19.3–24.7)	20.7 (19.6–22.1)
ASA classification (I/II)	25/10	22/13
Duration of anaesthesia (min)	140 (100–180)	115 (100–170)
Duration of surgery (min)	100 (65–140)	80 (65–125)
Fentanyl (μg)	150 (100–200)	200 (200–200)
Remifentanyl (mg)	0.25 (0.2–0.3)	0.2 (0.2–0.4)

the groups in the sensory loss of the lateral cutaneous branches of the intercostal nerves (Th2–6), whereas the PT group had a more effective sensory loss than the C group in the region of the anterior branches of the intercostal nerves (Th2–6).

Discussion

We have shown that compared with PECS block, the combination of PECS block and TTP blocks provides effective perioperative pain relief for breast cancer surgery.

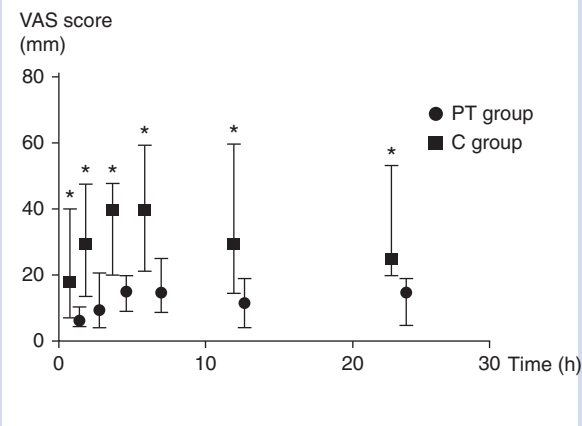


Fig 3 Postoperative visual analog scale (VAS) scores (in millimetres) at 1, 2, 4, 6, 12 and 24h at rest. Data are expressed as the median (range). * $P < 0.0001$.

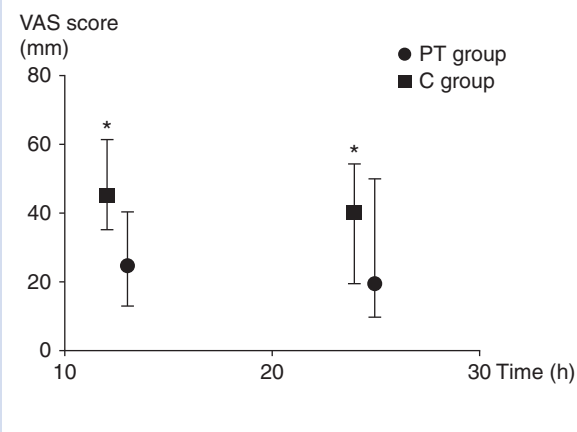


Fig 4 Postoperative visual analog scale (VAS) scores (in millimetres) at 12 and 24h during movement. Data are expressed as the median (range). * $P < 0.0001$.

Conventional regional anaesthesia for breast cancer surgery is a thoracic epidural anaesthesia or a thoracic paravertebral nerve block.^{11–13} Epidural anaesthesia may provide strong pain relief but may not be suitable for patients receiving anticoagulant therapy. The thoracic paravertebral nerve block has been increasingly performed using ultrasound guidance, but it can be technically difficult because of the deep injection site.¹⁴ In addition, the thoracic paravertebral nerve block may sometimes suppress pain at the axillary region, because the local anaesthetic may not spread to the cervical region. Compared with these regional anaesthesia methods, the injection points of the PECS block and TTP block are shallower.

This study has some limitations. There were a few failures to assess sensory function. The sensory level was assessed using a cold test. The anaesthetist who performed the sensory level

Table 2 The numbers of patients who received additional pentazocine 15 mg i.v. and metoclopramide 10 mg i.v. within 24 h after surgery

	PT group (n=35)	C group (n=35)	P-value
Pentazocine 15 mg	20	33	0.0003
Metoclopramide 10 mg i.v.	2	5	0.2

Table 3 The sensory level checks using a cold test. The data express the numbers of patients

	PT group (n=35)	C group (n=35)	P-value
Lateral			
T2	30	31	0.7
T3	35	35	–
T4	35	35	–
T5	35	35	–
T6	32	30	0.7
Anterior			
T2	33	0	<0.0001
T3	33	0	–
T4	35	2	–
T5	35	2	–
T6	30	0	<0.0001

checks was a specialist and was accustomed to performing the sensory level checks, but they should have performed the sensory level checks using more reliable pin-prick test.

Also, there may have been no difference in the sensory level between the two groups at 12 or 24 h after surgery. The absorption of the TTP block may be slower than for other forms of regional anaesthesia, such as epidural anaesthesia, because the transversus thoracic muscle is a rough muscle and local anaesthetic flows to the intramuscular. Therefore, the effect of TTP block must remain until 24 h after surgery. In addition, acute postoperative pain relief may prevent the development of chronic pain.¹⁵

Conclusion

Compared with PECS block, the combination of PECS block and TTP block provides effective perioperative pain relief for breast cancer surgery.

Authors' contributions

Study design/planning and data analysis: H.U., H.O.

Study conduct: N.T., E.H.

Writing the manuscript: H.U.

Revision of the manuscript: all authors.

Declaration of interest

None declared.

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Handling editor: Takashi Asai