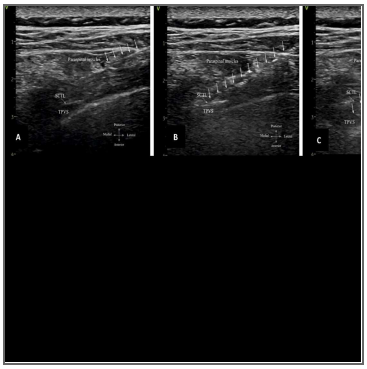

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Waveform characteristics in thoracic paravertebral space: a prospective observational study

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ABSTRACT

Background: With increased use of thoracic paravertebral block (TPVB) in thoracic surgery, many faced the challenge of locating the thoracic paravertebral space (TPVS) ultrasonographically. This observational study aimed to investigate the waveform characteristics and pressure value within the TPVS in Anesthetized patients with controlled ventilation.

Methods: Fifty patients scheduled for elective lung surgery were enrolled. After conduction of Anesthesia, all patients underwent TPVB at T4/5 and T6/7 using transverse, in-plane ultrasound guidance. A pressure transducer system with a desktop monitor was connected to the needle hub to measure pressure values and waveform characteristics in three locations: the paraspinal muscles, immediately behind the superior costotransverse ligament, and within the TPVS. Next, 15 mL of 0.33% bupivacaine was injected into each desired TPVS. After completion of the surgery, the extent of dermatomal blockade and the pain score was assessed in all patients.

Results: Ninety-eight typical regular respiratory waveforms with a mean pressure of ≤ 25 mmHg were detected in the TPVS of fifty patients. The sensitivity of the combined ultrasound and pressure waveform measurement technique to identify the TPVS was 95.45% (95% confidence interval, 84.527–99.445) . Nontypical respiratory waveforms were present in two patients. Factors interfering with the TPVS waveform characteristics were previous thoracic surgery and chronic pleural inflammation.

Conclusion: Monitoring of the pressure value and waveform characteristics is a simple and reliable strategy to identify the needle tip in the TPVS. The appearance of the respiratory waveform ensures that the end of the needle aperture is within the TPVS.

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Protocol for the study: Waveform characteristics in thoracic p...

1 Fifty patients scheduled for elective lung surgery (open thoracotomy and video-assisted thoracoscopic surgery) were recruited during 9th February 2021 to 18thMay 2021.

2 Anesthesiology residents or fellows at Ramathibodi Hospital obtained preoperative information and provided informed consent. The inclusion criteria were an age of 18 to 80 years and an American Society of Anesthesiologists (ASA) physical status of I to III. The exclusion criteria were no provision of informed consent, refusal to receive TPVB, a body mass index of > 35 kg/m^2, significant thoracic kyphoscoliosis, coagulopathy (platelet count of <100,000 per mL or international normalized ratio of >1.4), allergies or contraindications to medications used in the study protocol, and refusal to participate or withdrawal of consent at any stage of the study.

3 All enrolled patients were fasted for at least 8 hours before surgery. Standard ASA monitoring was
performed throughout the surgery. Anesthesia was induced using propofol (2.0–2.5 mg/kg), fentanyl (1–2 mcg/kg), and cisatracurium (0.15–0.2 mg/kg) intravenously.

4 First, the tip of the needle was identified in the paraspinal muscles. Second, the needle tip was advanced immediately posterior to the superior costotransverse ligament (SCTL) and confirmed by a 1.0-mL normal saline injection. Third, the needle tip was located in the TPVS and confirmed by a 0.5- to 3.0-mL saline injection, which widened the TPVS and caused anterior displacement of the pleura.

5 The operator identified the first rib and then counted downward until the fourth rib was reached. The probe was then moved inward to locate the fourth transverse process. The ultrasound probe was then dragged downward to locate the fifth transverse process and identify the location of the TPVS between T4 and T5, labelling the site with an indelible pen. The ultrasound probe was moved further downward to locate the sixth and seventh transverse processes and the TPVS was marked between T6 and T7.

6 An echogenic needle (SonoTAP; Pajunk GmbH Medizintechnologie, Geisingen, Germany) was connected to a pressure transducer system (TruWave PX260; Edwards Lifesciences, Irvine, CA, USA) via a three-way stopcock (Discofix 3SC; B. Braun, Melsungen, Germany) and a 36-inch noncompliant pressure tubing (Edwards Lifesciences). The pressure transducer was connected to a desktop monitor (IntelliVue MP70; Philips, Amsterdam, Netherlands) and levelled at the spinous process. The needle was then inserted at the skin approximately 3 cm from the midline and advanced laterally to medially under in-plane ultrasound visualization. The pressure values and characteristics of the thoracic paravertebral waveform were recorded along the needle trajectory in three steps.

7 The operator then slowly injected 15 mL 0.33% bupivacaine into each desired TPVS. The collected
waveforms were classified into three patterns (A, B, and C) according to our pilot study and based on previous trials. The “A” waveform was defined as a smooth and regular sine wave resembling the respiratory pattern with a mean value of ≤ 25 mmHg; the “B” waveform was defined as an irregular coarse, wavy line with a mean value of ≤ 40 mmHg; and the “C” waveform was defined as a tense, straight line with a mean value of > 40 mmHg.