Thoracic paravertebral blockade

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Abstract
Thoracic paravertebral blockade is a simple and easy-to-learn technique with a low incidence of complications. It should be considered as a safe alternative to thoracic epidural analgesia/anaesthesia. We reviewed the techniques of thoracic paravertebral blockade with special interest to ultrasound guidance.

Keywords: thoracic paravertebral blockade, regional anaesthesia, ultrasonography

Introduction
Thoracic paravertebral blockade is the technique of injecting local anaesthetic adjacent to the thoracic vertebra close to where the spinal nerves emerge from the intervertebral foramina. This results in ipsilateral somatic and sympathetic nerve blockade in multiple dermatomes above and below the site of injection [1]. This blockade is most commonly used for postoperative analgesia in patients undergoing unilateral breast or thoracic surgery, but it is also effective for surgical anaesthesia and it provides adequate pain relief in acute and chronic pain conditions. It has also been described in neonates and children. A catheter may be inserted in order to extend the benefit of the block beyond the pharmacologic properties of the local anaesthetic used.

Anatomy
The thoracic paravertebral space (TPVS) is a wedge-shaped space that lies on either side of the vertebral column. The boundaries of the space are posteriorly the superior costotransverse ligament; anterolaterally the parietal pleura and medially the vertebral body, the intervertebral disc and the intervertebral foramen. The TPVS contains fatty tissue, within which lies the intercostal (spinal) nerve, the dorsal ramus, the intercostal vessels, the rami communicantes and the sympathetic chain. It communicates medially with the epidural space and laterally with the intercostal space. The inferior limit of this space occurs at the origin of the psoas major muscle and the superior limit extends into the cervical region [1].

The intercostal (spinal) nerves comprise the ventral rami of T1 to T11 and T12 (subcostal nerve). Shortly a-
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anaesthetized patients. The latter has been reserved, however, for children only. The classical technique involves eliciting loss of resistance [3]. At the appropriate dermatome the 8-10 cm spinal/Touhy needle is inserted 2.5-3 cm lateral to the spinous process (fig 1) and advanced perpendicular to the skin to contact the transverse process (2-4 cm).

\[\text{Pressure measurement technique} \]

When bone is encountered the needle is walked above the transverse process and advanced gradually until a loss of resistance to air/saline is felt (1-1.5 cm). Two variations of the classical technique have also been described: the medial approach and the “paravertebral-peridural block” [4,5]. A “pressure measurement technique” was also advocated to localize the TPVS. Pressure in the erector spinae muscle is higher during inspiration than during expiration. Once the TPVS is entered, there is a sudden lowering of pressure leading to “pressure inversion” [6]. A nerve stimulator in a supramaximal mode (5 mA) can also be used to identify the paravertebral space and perform the paravertebral blockade [7]. The motor endpoint sought in this case is contraction of the intercostal muscles.

Thoracic paravertebral catheters can be placed under direct vision by the surgeon during thoracic surgery [8]. Video-assisted placement of a paravertebral catheter during thoracosopic surgery has also been reported [9].

\[\text{Sonoanatomy} \]

Using the traditional approach, locating the paravertebral space can be technically difficult because it requires location of the transverse process by blind needle placement and has a failure rate that varies from 6.8 to 10% [1]. Failure to identify the transverse process results in several needle reorientations causing pain and increases the potential risk of pneumothorax (0.5%) [10].
The sonographic anatomy of the TPVS was recently described in a cadaver and clinical study [11]. The use of ultrasound offers the advantage of visualizing the boundaries of the TPVS (fig 2) and sometimes its structures. The 38 mm broadband linear array transducer (5-10 MHz) is placed at a point 2.5 cm lateral to the tip of the spinous process in a vertical orientation, obtaining a sagittal paramedian view of the paravertebral space (fig 2). The transverse processes are identified as two dark lines, the parietal pleura as a bright structure running deep to the adjacent transverse processes, distinct from the deeper lung tissue. The superior costotransverse ligament can sometimes be seen as a collection of homogenous linear echogenic bands alternating with echo poor areas running from one transverse process to the next. The ultrasound technique also offers the capability to visualize the needle (fig 3), the spread of local anaesthetic solution (fig 4) and the placement of a catheter in the paravertebral space under direct vision (fig 5). The ultimate aim is to deposit the local anaesthetic solution and place the catheter tip between the superior costotransverse ligament and the parietal pleura. Local anaesthetic deposition translates into an anterior displacement of the parietal pleura on the ultrasound image (fig 6).

Ultrasound guidance has many potential advantages compared to blind techniques: visualization of the ana-

Fig 2. Scout scan. US probe in sagittal paramedian plane. Red line-transverse process. Green line-parietal pleura

Fig 3. Needle in plane approach. Red line-transverse process. Green line-parietal pleura. White dotted line-shadow of Tuohy needle

tomical structures, needle shaft, needle tip, catheter, local anaesthetic spread and possibly shorter performance time, shorter onset time, longer block duration, lower local anaesthetic volume, lower failure and complication rates, less patient discomfort. However, large scale randomized clinical trials are still missing.

**Single shot in plane needle insertion technique**

The desired thoracic vertebral level is identified by palpating and counting down from vertebra prominens (C7). The spine of the scapula may also be used as landmark (T3) (fig 1). Standard monitoring is applied and asepsis observed. The transducer is placed at a point 2.5 cm lateral to the tip of the spinous process in a vertical orientation. The paravertebral space and its structures are identified (fig 2). The midpoint of the transducer is aligned midway between the two transverse processes, local anaesthesia infiltrated at its lower border and a 18-gauge Tuohy needle (G20 or G22 spinal needles are also suitable for single shot technique) is inserted in an in plane approach in a cephalad orientation. The needle is advanced under direct vision to puncture the superior costotransverse ligament. Local anaesthetic solution is then injected between the ligament and the parietal pleura (fig 3). The parietal pleura is typically displaced anteriorly by the local anaesthetic solution (fig 4). It can be technically difficult to track the needle as it is advanced, due to the acute angle the needle must take to enter between the two transverse processes. Arguably, in some patients, there may be a role for using the curvilinear ultrasound probe. Tissue movement and hydrolocalization may facilitate locating the needle.

A single shot technique using bupivacaine, levobupivacaine or ropivacaine can provide analgesia for up to 18 hours.

**Catheter technique – in plane approach**

When prolonged analgesia (up to 72 hours) is desirable, an indwelling catheter may be inserted. Local anaesthetic solution can be administered via continuous infusion, patient controlled bolus or repeated bolus. To minimize the risk of infection, asepsis must be strictly
We described a simple and easy-to-learn ultrasound-guided technique with low incidence of complications - a safe alternative to thoracic epidural blockade.

**References**