Review

Medical Ultrasonography
2010, Vol. 12, no. 3, 223-227

Thoracic paravertebral blockade

Attila Bondár[1], Szilárd Szűcs[2], Gabriella Iohom[3]

[1] MD, Specialist in Anaesthesiology/Tutor in Regional Anaesthesia, Department of Anaesthesiology and Intensive Therapy, Semmelweis University, Budapest, Hungary
[2] MD, Research Fellow, Department of Anaesthesia and Intensive Care Medicine, Cork University Hospital, Cork, Ireland
[3] MD, PhD, Consultant Anaesthetist/Senior Lecturer, Department of Anaesthesia and Intensive Care Medicine, Cork University Hospital, Cork, Ireland

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

Rezumat

Blocajul paravertebral toracic este o tehnică simpla, uşor de învăţat şi cu o rată joasă a complicaţiilor. Această tehnică trebuie să fie considerată ca o alternativă sigură a analgeziei/anesteziei epidurale. În acest articol se vor revedea tehnicile de blocaj toracic paravertebral cu un interes special asupra ghidajului ecografic.

Cuvinte cheie: blocaj toracic paravertebral, anestezie regională, ecografie

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.

Received 15.06.2010 Accepted 20.06.2010
Med Ultrason
2010, Vol. 12, No 3, 223-227
Address for correspondence: Gabriella Iohom
Address: Department of Anesthesia, Cork University Hospital, Wilton, Cork, Ireland.
Tel.: +353214922135
Fax: +353214546434
Email: ghspielhaupter@mac.com

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 af-

ter exit from the intervertebral foramina, the dorsal rami become a posterior cutaneous branch to skin and muscles in the paravertebral region. At the angle of the ribs a lateral cutaneous branch arises. The main trunk of the intercostal nerve continues between the innermost intercostal muscle and the internal intercostal muscle and terminates as the anterior cutaneous branch [2].

Applied anatomy

Dermatomal innervation

Thoracic paravertebral blockade results in anaesthesia of the skin of the posterior, lateral and anterior aspect of the chest and abdomen (T1-T12).

Myotomal innervation

The main muscles innervated by the intercostal nerves are the erector spinae muscle, the innermost, internal and external intercostal muscles, the transversus abdominis muscle, the internal and external oblique muscles and the rectus abdominis muscle.

Osteotomal innervation

The intercostal nerves innervate the costotransverse joints, the ribs (1-12), the costosternal joints and the sternum.

Indications

Postoperative analgesia:

Thoracic surgery (thoracotomy, video-assisted thoracoscopy)

Breast surgery (benign conditions, breast cancer surgery, breast augmentation)

Cholecystectomy

Renal and ureteric surgery

Herniorrhaphy

Appendicectomy

Minimally invasive cardiac surgery

Surgical anaesthesia

Breast surgery

Herniorrhaphy

Chest wound exploration

Acute pain management

Acute postherpetic neuralgia

Fractured ribs

Chronic pain management

Benign and malignant neuralgia

Techniques of thoracic paravertebral blockade

The thoracic paravertebral block can be performed with the patient in sitting, lateral or prone position. It has been successfully performed in awake, sedated and 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).



Fig 1. Landmarks. C7 – 7th cervical , T1 – first thoracic, T2-second thoracic, T3-third thoracic vertebra. x-point of needle insertion for paravertebral block for mastectomy with axillary clearance

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 thoracoscopic surgery has also been reported [9].

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-

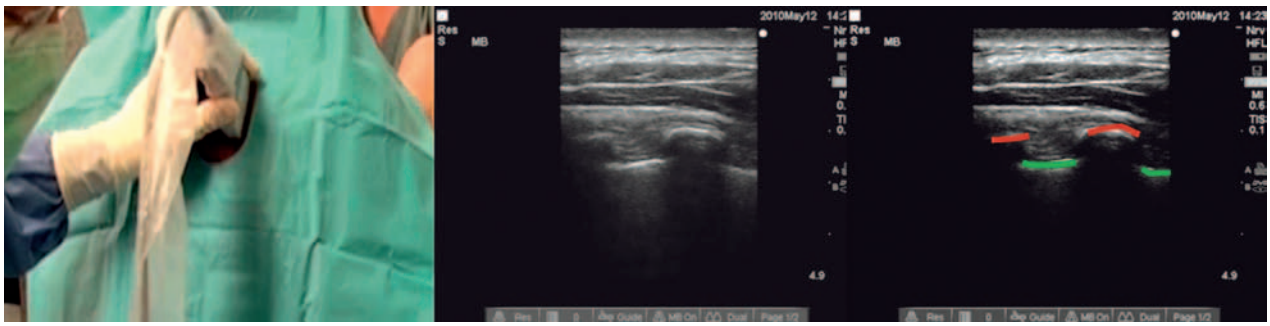


Fig 2. Scout scan. US probe in sagittal paramedian plane. Red line-transverse process. Green line-parietal pleura



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

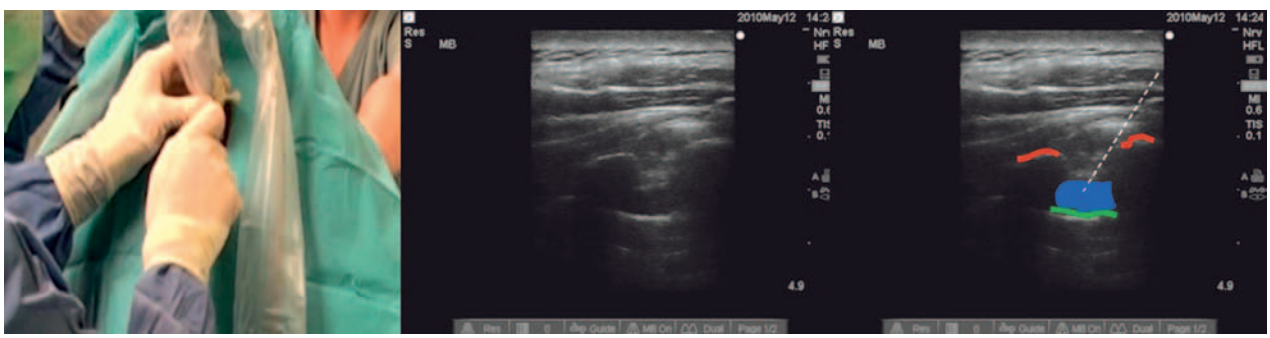


Fig 4. Single shot local anaesthetic injection. Red line-transverse process. Green line-anteriorly displaced pleura. White dotted line-shadow of Tuohy needle. Blue area-local anaesthetic solution

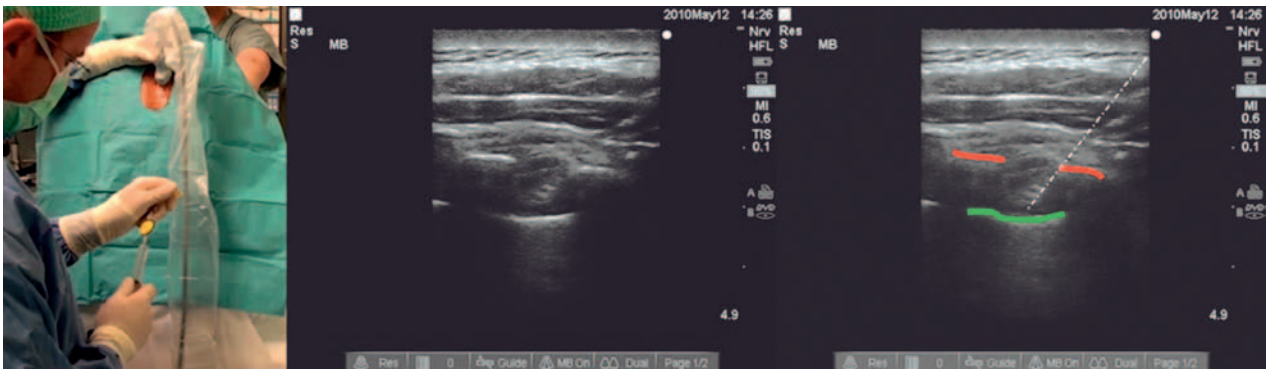


Fig 5. Catheter through needle technique. Red line-transverse process. Green line-pleura. White line-shadow of the catheter

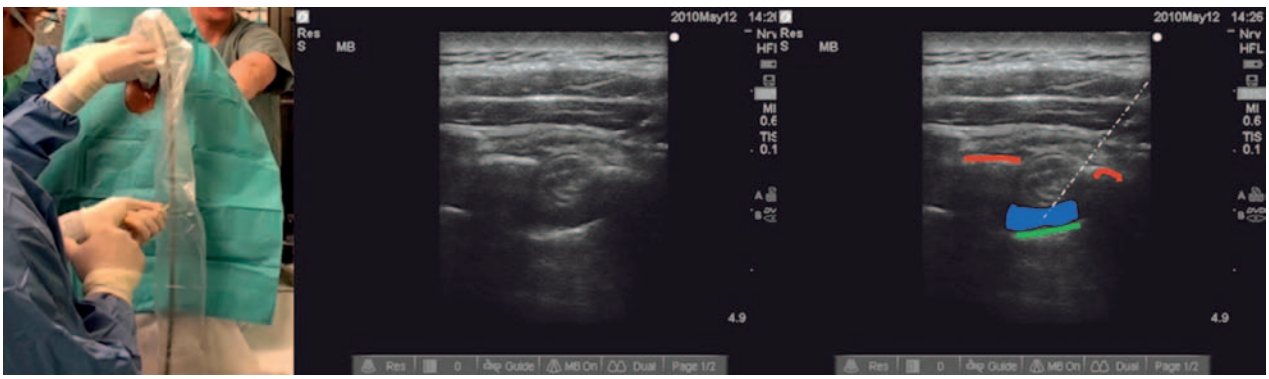


Fig 6. Local anaesthetic injection through the catheter. Red line-transverse process. Green line-pleura. White line-shadow of the catheter. Blue area-local anaesthetic solution

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. Argueably, 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 ar 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 boli or repeated boli. To minimize the risk of infection, asepsis must be strictly

observed. During the catheter insertion technique we follow the same steps as for the single shot technique: anatomical landmarks are identified and marked, the transducer is positioned, the paravertebral space is identified, the 18-gauge Touhy needle is inserted in plane and advanced in cephalad direction, the superior costotransverse ligament is punctured and local anaesthetic solution is injected deep to the ligament. Depositing 3-5 ml of local anaesthetic solution in the paravertebral space allows easier passage of the catheter (fig 4). The catheter is inserted through the Touhy needle to a distance of 2-3 cm beyond the needle tip (fig 5). The needle is then carefully removed and the catheter well secured. Anterior displacement of the pleura following injection through the catheter is also observed (fig 6).

Another technique of ultrasound-guided continuous thoracic paravertebral blockade using an intercostal approach was recently described in the literature [12].

Complications of the thoracic paravertebral blockade are rare and include pneumothorax, nerve injury, epidural blockade, spinal blockade and systemic toxicity.

Current trends

There is a perceived resurgence of paravertebral blocks in recent years. A meta-analysis by Davies demonstarated its superiority over epidural analgesia following thoracotomy, i.e. comparable pain relief with better side-effect profile [13]. An interesting concept is the potential of regional anaesthesia and analgesia to reduce the risk of recurrence after breast cancer surgery [14]. A prospective multicentre trial enrolling 1100 patients over five years is under way to test the hypothesis that patients randomized to paravertebral or high-thoracic epidural analgesia combined with sedation or light anaesthesia have lower local or metastatic recurrence rate compared to those who receive intraoperative volatile anaesthesia and postoperative systemic opioid analgesia [15]. It is conceivable that ultrasound guidance will further enhance the performance of paravertebral blockade.

Conclusion

The practice of peripheral nerve blockade using ultrasound guidance has increased dramatically over the past few years, as a result of advances in technique, equipment (high resolution ultrasound images) and training. We described a simple and easy-to-learn ultrasound-guided technique with low incidence of complications - a safe alternative to thoracic epidural blockade.

References

1. Karmakar MK. Thoracic paravertebral block. Anesthesiology 2001; 95:771–780.
2. Barrett J, Harmon D, Loughnane F, Finucane B, Shorten G. Peripheral nerve blocks and peri-operative pain relief. 1st ed. Philadelphia, PA: W.B. Saunders Company; 2004.
3. Eason MJ, Wyatt R. Paravertebral thoracic block-a reappraisal. Anaesthesia 1979; 34:638–642.
4. Shaw WM, Hollis NY. Medial approach for paravertebral somatic nerve block. JAMA 1952; 148:742–744.
5. Tenicela R, Pollan SB. Paravertebral-peridural block technique: A unilateral thoracic block. Clin J Pain 1990; 6:227–234.
6. Richardson J, Cheema SP, Hawkins J, Sabanathan S. Thoracic paravertebral space location: A new method using pressure measurement. Anaesthesia 1996; 51:137–139.
7. Lang SA. The use of a nerve stimulator for thoracic paravertebral block. Anesthesiology 2002; 97:521.
8. Downs CS, Cooper MG. Continuous extrapleural intercostals nerve block for post thoracotomy analgesia in children. Anaesth Intensive Care 1997; 25:390-397.
9. Soni AK, Conacher ID, Waller DA, Hilton CJ. Video-assisted thoracoscopic placement of paravertebral catheters: A technique for postoparative analgesia for bilateral thoracoscopic surgery. Br J Anaesth 1994; 72:462–464.
10. Lonnquist PA, MacKenzie J, Soni AK, Conacher ID. Paravertebral blockade: Failure rate and complications. Anaesthesia 1995; 50:813–815.
11. O Riain SC, Donnell BO, Cuffe T, Harmon DC, Fraher JP, Shorten G. Thoracic paravertebral block using real-time ultrasound guidance. Anesth Analg 2010; 110:248–251.
12. Ben-Ari A, Moreno M, Chelly JE, Bigeleisen PE. Ultrasound-guided paravertebral block using an intercostal approach. Anesth Analg 2009; 109:1691–1694.
13. Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy – a systematic review and meta-analysis of randomized trials. Br J Anaesth 2006; 94:418–26.
14. Exadaktylos AK, Buggy DJ, Moriarty DC, Mascha E, Sessler DI. Can anesthetic technique for primary breast cancer surgery affect recurrence or metastasis? Anesthesiology 2006; 105:660–4.
15. Sessler DI, Ben-Eliyahu S, Mascha EJ, Parat MO, Buggy DJ. Can regional analgesia reduce the risk of recurrence after breast cancer? Methodology of a multicenter randomized trial. Contemp Clin Trials 2008; 29:517–26.