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Review

# Update on Thoracic Paravertebral Blocks

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**A B S T R A C T**

*Thoracic paravertebral block was widely practised at the beginning of the 20$^{th}$ century. It has enjoyed a renaissance in the past decade. This form of afferent blockade is the technique of injecting local anaesthetic into the thoracic paravertebral space. Thoracic paravertebral analgesia is mostly indicated for unilateral surgical procedures of the thorax and abdomen. Compared to the other available regional techniques such as epidural, intercostal and interpleural, paravertebral blocks offer comparable or better analgesia with less side effects. Thoracic paravertebral blocks deserve greater consideration and investigation.*

***Key words**: anaesthetic techniques, regional, paravertebral, pain, post-operative*

## Introduction

Thoracotomy and upper abdominal surgery are associated with severe postoperative pain and marked impairment of respiratory function. Postoperative analgesia regimens often include regional anaesthetic technique because complete analgesia with a single agent or method may not be possible. The nociceptive pathways involved in pain following thoracic surgery are complex and incompletely understood. Chest wall pain is caused by retraction, resection, rib fracture, costovertebral joint disruption and intercostal nerve damage. Thoracic epidural analgesia (TEA) was considered by many to be the best method of pain relief after major thoracoabdominal surgery. Paravertebral block is an alternative technique that may offer comparable analgesic effectiveness and a better side-effect profile[1].

Thoracic paravertebral block (TPB) is the technique of injecting local anaesthetic adjacent to the thoracic vertebra close to where the spinal nerves emerge from the intervertebral foramina. It results in ipsilateral somatic and sympathetic nerve blockade in multiple contiguous thoracic dermatomes above and bellow the site of injection[2]. TPB was first performed in 1906 by Hugo Sellhaim of Leipzig and is thus amongst the oldest of local anaesthetic technique[3]. A surgical resident in Leipzig, Arthur Läwen, made a special study of this new technique. Kappis developed the technique in 1919 comparable to the one in nowadays use and produced surgical anaesthesia for abdominal surgery. It's popularity reached a peak in the 1920's and 1930's following which, during 1950's and 1960's publications about this technique almost completely disappeared. Eason and Wyatt stimulated renewed interest when they described the insertion of a catheter into the thoracic paravertebral space[4]. Sabanathan, Richardson and Lönnqvist are three researchers who recently have contributed to improving our understanding of this almost the forgotten technique[5,6].

## Anatomy

The thoracic paravertebral space (TPVS) is a wedge-shaped area between the heads and necks of the ribs. The posterior boundary is the superior costotransverse ligament and laterally, the posterior intercostal membrane. Anteriorly is the parietal pleura and medially is the postero-lateral aspect of the vertebra, the intervertebral disc and the intervertebral foramen[7]. The spinal nerves emerge from the dura, cross the epidural space encased within a dural cuff and enter the TPVS via the intervertebral foramina usually still within the dural cuff. Within the TPVS the segmental nerve divides into the dorsal and ventral branches (rami). The spinal nerves in the TPVS are lying freely among the fat and devoid of fascial sheath, which makes them susceptible to local anaesthetics. The endothoracic fascia divides the TPVS into two potential fascial compartments, the anterior

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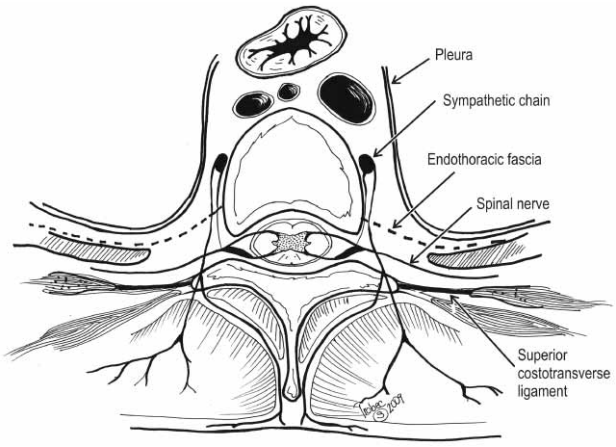


*Fig 1. Anatomy of the thoracic paravertebral space.*

extrapleural paravertebral compartment and the posterior subendothoracic paravertebral compartment[8]. The spinal nerves and vessels are located in the posterior compartment while the sympathetic trunk is located in the anterior paravertebral compartment (Figure 1).

## Indications

Thoracic paravertebral blocks are particularly advocated for unilateral surgical procedures for example: thoracotomy, breast surgery and lung surgery. Continuous TPB either unilaterally or bilaterally has been useful in minimally invasive cardiac surgery to provide excellent analgesia while allowing early ambulation[9]. There is also a potential advantage of avoiding central neuraxial haemathoma with this technique. It was presented that TPB can resolve ST segment depression during general anaesthesia and thus is useful in treatment of angina pectoris[10]. There is some evidence that TPB because of the effect on the sympathetic chain may provide visceral analgesia also and thus may be useful for cholecystectomy and nephrectomy[11]. TPB provides excellent analgesia for rib fractures[12]. Paravertebral block is being utilised for chronic postherpetic neuralgia and other chronic pain syndromes. It can also be used for the treatment of hyperhydrosis.

## Contraindications

Infection at the site of needle insertion, empyema, tumor occupying the TPVS are some of the few contraindications. A coagulopathy, bleeding disorder or therapeutic anticoagulation are considered as relative contraindications for TPB. Some of the absolute contraindications for TEA are not such a problem with TPB. Because of the low potential for neurological damage, the presence of a coagulation disorder or the use of anticoagulants are relative rather than absolute contraindications. Paravertebral blocks can be safely performed in anaesthetized patients. Care is needed in the case of severe chest deformity or scoliosis to avoid injection into epidural or subarachnoidal space.

## Side Effects and Complications

Paravertebral blocks generally have a low incidence of side effects. In retrospectively reviewing this subject, the overall incidence of side effects or complications was less than 5%[13]. Accidental epidural or subarachnoidal injection is a rare event which indicates a faulty technique. Lönnqvist et al. evaluated complications after paravertebral blocks and observed the following frequency of complications: hypotension 4.6%, vascular puncture 3.8%, pleural puncture 1.1% and pneumothorax 0.5%[14]. In a patient who has already undergone thoracotomy a pulmonary haemorrhage developed after performance of percutaneous paravertebral block[15].

## Techniques

The standard technique of space location is by loss of resistance to air or saline. The patient can be positioned set up or lying in the lateral position. The proximal edge of the appropriate thoracic spinous process is palpated and a local anaesthetic skin wheal raised 2–3 cm lateral. Because of the angulation of the spinous processes of the thoracic spine, the transvers process contacted will belong to the vertebra below that of the spinous process. An 18 G Tuohy or 22 G spinal needle is inserted at 90 degrees to the skin until it touches the transverse process at a depth of 2.5–5 cm. The needle is then walked off the cranial or caudal edge according to preference, using loss of resistance to identify the TPVS as the needle penetrates the superior costotransverse ligament (Figure 2). This usually occurs 0.5–1 cm deep to the transverse process. The needle must be kept parallel with the midline to avoid puncturing the pleura laterally or the epidural space medially[16,17]. The TPVS can be identified by loss of resistance to air or saline, using a peripheral nerve stimulator to induce pulse synchronous muscle movement or pressure inversion[18]. This is the point at which

*Fig. 2. Loss of resistance technique.*

*Fig. 3. Radiographic appearance after injection of 10 mL of contrast medium through a paravertebral catheter.*

the inspiratory pressure in the erector spinae muscle which is higher than the expiratory pressure suddenly becomes lower (but still positive) as the needle enters the TPVS. If the pleural cavity is entered then both pressures become negative. The technique is repeated at each dermatomal level, using 3–5 mL of local anaesthetic *per* segment. If a single-shot technique is used, choose the dermatomal level at the mid point of the surgical field and inject 15 mL once the TPVS is identified. If a catheter is to be placed Tuohy needle 18 G is used, than catheter is inserted that 1–3 cm of distal end of the catheter lies within TPVS. Sabanathan described a method of surgical catheter placement under the direct vision for use in thoracotomy[19]. Fluoroscopy and contrast chest radiography are often used as supplementary methods to confirm the position of the catheter (Figure 3).

Contrast injected into the TPVS produces either a longitudinal or cloud – like spread localized to the paravertebral region as depicted on frontal chest radiograph.

## Mechanism of Analgesia

The mechanism of action of paravertebral analgesia is by direct penetration of local anaesthetic into the spinal nerve, its dorsal ramus, the rami communicantes and the sympathetic chain anteriorly[20]. TPB can produce a very dense afferent blockade of sensory information. TPB differs in one specific way from neuroaxial blocks[21]. Although neuroaxial blocks cause almost complete blockade of the mainly efferent sympathetic transmission from the spinal cord, such blocks are not able to block transmission within the sympathetic chain. TPB, on the other hand, will cause not only dense somatic afferent blockade, but will also, due to the anatomy of the paravertebral space, completely block transmission within the sympathetic chain[21]. A thoracic paravertebral injection can spread to the contiguous spaces above and below, the epidural space medially and the intercostal space laterally[22,23]. A contradictive studies about the spread of local anaesthetics in TPVS were published. After single paravertebral injection of local anaesthetic a large ipsilateral somatosensory and sympathetic block occurred[24,25]. In the novel studies it has been recommended that single-bolus technique may be better supplanted by a reversion to the multiple-level injection technique[26,27]. There is controversy about epidural spread and its contribution to the extension of TPB. Epidural spread has been shown to occur after 70% of percutaneous paravertebral injections[28]. It was demonstrated that a thoracic paravertebral injection can result in contralateral paravertebral spread anterior to the vertebral bodies through the anterior paravertebral compartment[29]. In summary thoracic paravertebral injection can spread to the contiguous spaces above and below, the epidural space medially and the intercostal space laterally, and anteriorly to the contralateral paravertebral space.The use of clonidine and fentanyl as adjunctive analgesics for TPB improved postoperative pain relief[30,31].

## Comparative Studies

TPB has enjoyed a renaissance in recent years. The studies which compared TPB with TEA found no difference in analgesia. In the study of Richardson et al. was found that TPB (bupivacaine) was superior in terms of analgesia, pulmonary functions, neuroendocrine stress responses, side effects and postoperative respiratory morbidity compared to TEA (bupivacaine)[6].

In the study of Casati and co-workers was shown that continuous thoracic paravertebral analgesia is as effective as epidural blockade in controlling a post-thoracotomy pain, but is associated with less haemodynamic effects[32].

In patients undergoing minimally invasive direct coronary artery bypass surgery TEA and TPB were compared. The quality of analgesia was comparable within the groups. TPB is technically easier than TEA and may be safer than TEA because no complication were seen in the TPB group[9].

In a prospective, randomized comparison of continuous thoracic epidural and paravertebral bupivacane infusion was shown that, TEA is as effective as TPB for pain management in patients with unilateral fractured ribs[33].

Karmakar showed that continuous thoracic paravertebral infusion of bupivacaine is a simple and effective method of providing pain relief in patients with unilateral multiple fractured ribs[34].

In the study which compared interpleural and paravertebral analgesia in thoracic surgery was found that bupivacaine administered paraveretebrally produced greater preservation of lung function and less confused patients than bupivacaine administered interpleurally[35].

Single-injection thoracic paravertebral block performed preoperatively reduced pain score after thoracoscopic surgery in a clinically significant fashion[36].

The study of a continuous paravertebral infusion of bupivacaine for the management of post-thoracotomy

pain in 20 infants showed no major complications relating to the technique and analgesia was satisfied[37].

Two recent systematic reviews have confirmed the efficacy of paravertebral blockade for post-thoracotomy analgesia[1,38]. Davies et al. compared TPB with TEA and confirmed that the quality of analgesia was equivalent but there were fewer side effects and complications with TPB[1]. The Prospect group looked at all randomized trials where regional technique was used (epidural, paravertebral, intrathecal, intercostals and interpleural). Again, on the balance of equivalent or superior analgesia and less adverse events, TPB is recommended for post-thoracotomy analgesia[38].

## Conclusions

Over the past decade enthusiasm for a TPB in patients undergoing thoracic surgery has increased[39]. Systematic reviews found no difference in analgesia with TPB techniques when compared with TEA regimens. Important side effects such as hypotension, urinary retention, nausea and vomiting, were less frequent with TPB than with TEA. Compared to the other available regional techniques such as intercostals and interpleurals TPB offers better quality, longer duration of analgesia and less side effects.

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## NOVI POGLED NA TORAKALNI PARAVERTEBRALNI BLOK

## SAŽETAK

Torakalni paravertebralni blok je bio u širokoj primjeni već početkom dvadesetog stoljeća, međutim možemo reći da svoju renesansu doživljava tijekom prošlog desetljeća. Ovaj oblik regionalne anestezije je oblik aferentne blokade koji se izvodi primjenom lokalnog anestetika u torakalni paravertebralni prostor. Torakalna paravertebralna analgezija je opravdana za unilateralne operacije toraksa i abdomena. U usporedbi s drugim tehnikama regionalne anestezije gdje se anestetik primjenjuje epiduralno, interkostalno i intrapleuralno ova tehnika osigurava jednaku ako ne i kvalitetniju analgeziju s manje mogućih komplikacija. Tehnika paravertebralnog torakalnog bloka sigurno zauzima vrijedno mjesto u anesteziološkim tehnikama i zahtijeva daljnja istraživanja.