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Ultrasound Guided Paravertebral Block: Analysis of CT Images of Injectate Spread Using Transverse and Parasagittal Approaches

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Introduction

The current understanding of the paravertebral anatomy has improved through cadaveric and radiologic studies. This anatomical space is rather complex; It is bordered anteriorly by the parietal pleura, laterally by the compression of pleura against rib, posteriorly by the superior costotransverse ligament, and medially by the vertebrae, intervertebral discs and intervertebral foramen containing nerve roots as they exit their respective dural cuffs (1,2). This wedge-shaped space is further sub-divided by the endothoracic fascia into two compartments: the extra-pleural (anterior) and sub-endothoracic (posterior) compartments (3).

To-date, there are nine published ultrasound-guided techniques, each describing a variation of the transverse or para-sagittal oblique approaches. Institutionally, we have 15 years of experience performing the US-guided paravertebral block (PVB) using both transverse and parasagittal approaches with seemingly indistinguishable outcomes. As part of an IRB approved quality improvement (QI) project, an independent study was designed to assess the reliability of injectate deposition into the paravertebral space using both ultrasound-guided approaches. We used data obtained from this independent QI project to retrospectively compare the transverse and parasagittal oblique ultrasound approaches to the PVB. The CT-guided block was conducted using a separate protocol and therefore analyzed independently. Our primary goal was to elucidate the differences, if any, in local anesthetic spread into the PV space and neighboring anatomic structures using the aforementioned different techniques .

Materials and Methods

Using data obtained from the IRB approved QI project, we conducted a retrospective analysis of CT images obtained from patients undergoing CT-guided hepatic or renal microwave ablation (MWA) in the interventional radiology (IR) suite from July 2021 to December 2021. The exclusion criteria were procedure refusal, lack of consent, inability to communicate, relevant medication allergies, and contraindications to PVB per ASRA neuraxial guidelines. This procedural group allowed the index QI project to capitalize on pre-established procedural protocols involving radio contrast and CT imaging; the study did not require additional CT time and radiation exposure since the paravertebral space is incidentally imaged during the MW ablative procedure.

The US-guided PVBs were conducted using 20 mL of 0.5% Ropivicaine or 0.5% Bupivicaine with 1:400,000 Epinephrine and 2-3.5mL of Isovue®-300 (61% Iopamidol) per injection. Safety measures (monitoring, incremental injection, light sedation, rescue medications) were in accordance with current safe practices as described by ASRA. Following a chlorhexidine skin preparation, real time ultrasound guided approach into the PV space was done using a GE Logic ultrasound with a 8-12 MHz linear transducer. Blocks were performed at the T8-9 level for liver MWA and T11-12 level for renal MWA in the prone position. The needling track was topicalized using a 25G 3” needle, subsequently a 22G 8cm Pajunk faceted needle was advanced into the PV space. The needle orientation for the parasagittal oblique and transverse approach was cephalad to caudad and lateral to medial, respectively. Technical approaches (transverse vs parasagittal) were documented. Both the transverse and parasagittal oblique techniques are previously well described in the literature.

A few CT guided PVBs were conducted by our interventional radiologists using a varied protocol. A needle was advanced, in a lateral to medial direction, into the PV space under CT guidance, 1ml of contrast was injected followed by 20ml of a solution of 0.25% Ropivicaine, 0.25% Bupivicaine, 1:400,000 dilution of epinephrine, and 2mg of dexamethasone. Although not part of our analysis, the CT-guided results are included as a point of interest given the differing contrast spread patterns compared with those using US-guidance.

Results/Case Report

We analyzed 27 ultrasound guided paravertebral blocks using transverse and parasagittal oblique approaches (20 and 7 blocks respectively). Additionally, we analyzed 5 CT-guided PVBs conducted by our interventional radiologists. For each respective block we looked at the frequency of spread to various anatomic locations including the 1) anterior extra pleural paravertebral compartment 2) posterior subendothoracic paravertebral compartment, 3) intercostal space 4) epidural space, 5) inter pleural space 6) erector spinae plane/muscle and 7) dermatomal spread. Data obtained from Ultrasound guided procedures and CT-guided procedures are outlined in Figures 1 and 2 respectively.

Discussion

In this preliminary analysis, we found that ~85-90% of US-guided PVBs have local anesthetic spread into the extrapleural paravertebral compartment between the pleura and endothoracic fascia. There was less localization into the posterior subendothoracic compartment, for both US-guided approaches (~30-40%). It seems that the frequency of local anesthetic spread to the posterior compartment of the PV space is highest when done under CT guidance by our interventional radiologists. We are cautious to make extrapolations from comparing across the ultrasound-guided blocks and the CT-guided blocks as varied protocols were used across both arms in this retrospective analysis. It seems, however, that our current strategy of injecting behind the ultrasonographic costotransverse ligament leads to spread selectively into the deeper extra pleural paravertebral compartment. This could also explain why few ultrasound guided PVBs require vasoactive support and few PVBs result in epidural spread as it was reported more routinely (17%) on landmark PVBs. Notably, 100% of our CT guided PVBs required vasoactive support presumably due to epidural spread.

Surprisingly, this analysis suggests that injectate spread to extra-paravertebral space compartments occurs unpredictably and perhaps not infrequently. It remains unknown whether this unintended spread is clinically significant. The clinical impact of potentially permeable fascial layers to local anesthetic within and abutting the PV space remains unclear. However, ESP literature and a 2021 RCT conducted by Swathi Et al. supports the notion of clinical relevance of that possible permeability(4). Given the wide use of this block and the associated complex anatomy, further studies are warranted looking at differences in analgesia by correlating local anesthetic spread into each subcompartment to a sensory examination, OME consumption and VAS score.

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Disclosures

No

Tables / Images

Figure 1: Differential Spread of Local Anesthetic using US-guided approaches

	Extrapleural Paravertebral Compartment (%)	Posterior Subendothoracic Paravertebral Compartment (%)	Intercostal Space (%)	Epidural Space (%)	Interpleural Space (%)	Erector Spinae Plane/Muscle (%)	Spinal levels covered Avg (SD)
US-Guided Transverse n=20	90% (18/20)	35% (7/20)	5% (1/20)	0%	5% (1/20)	25% (5/20)	2.35 (1.23)
US-Guided Sagittal Paramedian n=7	85% (6/7)	43% (3/7)	0%	0%	0%	57% 4/7	2 (0.92)

Figure 2: Spread of local anesthetic in CT-guided PVB

	Extrapleural Paravertebral Compartment (%)	Posterior Subendothoracic Paravertebral Compartment (%)	Intercostal Space (%)	Epidural Space (%)	Interpleural Space (%)	Erector Spinae Plane/Muscle (%)
CT-Guided n=3	100% (5/5)	100% (5/5)	0%	100% (5/5)	0%	0%