Relationship between injectate volume and disposition in lumbar erector spinae plane block: a cadaveric study

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Introduction

Erector spinae plane (ESP) block has been reported to be an effective analgesic adjunct for lumbar spine surgery. Harbell et al. demonstrated that 20 mL of injectate at the L4 transverse process results in spread cranially to L2 and caudally to the L5 spinal level. It is unclear what influence other volumes might have on injectate disposition. We performed an radiographic and anatomic study with the aim of clarifying the influence of volume of injectate on (A) craniocaudal spread and (B) spread to the ventral rami or other relevant structures/locations when performed via a lumbar ESP block. Our hypothesis was that there would be a direct relationship between volume and craniocaudal spread in the lumbar region. We also sought to characterize the extent of dye spread in the paraspinal area when injected via a surgical infiltrative technique into the ES muscle.

Materials and Methods

IRB approval was not required for this study, as there was no use of human subjects. Ultrasound-guided ESP injections were performed on two fresh cadavers (prone position) using a solution of iopamidol radiographic contrast, indocyanine green dye, and saline. A curvilinear ultrasound transducer was placed in a parasagittal orientation off the midline of the spine and the sacrum and lumbar transverse processes identified. A 21 ga 100 mm block needle (Sonoplex, Pajunk Medical Systems, Norcross, GA) was then inserted in-plane from the cephalad aspect of the transducer until the tip was firmly apposed to the transverse process of L3, and 30 mL of solution injected in 10 mL increments. Fluoroscopic video recordings were obtained in real-time during each injection in order to characterize the dynamic spread of the injectate. On the contralateral side, a spine surgeon performed a standard surgical infiltration of the paraspinal musculature using 30 mL of the solution. The specimens were then dissected to expose tissue staining. Care was taken to document the precise disposition of the dye solution within and around the erector spinae muscle, the psoas major muscle, and the lumbar plexus.

Results/Case Report

Fluoroscopic and anatomic observations are summarized in Table 1. Extent of contrast spread on imaging is shown in Figure 1. Overall, there was a small but direct relationship between volume of injectate with ESP and craniocaudal spread (as determined by number of spinal levels) from 10 mL to 30 mL. Following 30 ml of injectate, the ventral surface of the erector spinae muscle was intensely stained from L1 to L4. There was no spread deep to the transverse processes, and there was no staining of
the epidural space, intervertebral foramina, psoas muscles or lumbar plexus. By comparison, there was faint and variable dye staining within the erector spinae muscle group following surgical infiltration, with no spread outside the fascial covering of the muscle (Figure 2).

Discussion

Under the conditions of our study, we observed a direct relationship between volume of injectate in lumbar ESP injections and extent of craniocaudal spread. 30 mL of volume resulted in spread to most of the lumbar spinal levels (L1-L4) suggesting that this may be a useful volume for analgesia following many lumbar spine procedures. This reinforces the findings of others who used 20 mL at the L4 level and found spread from L2-L5. (2) The degree of spread with 30 mL in the lumbar region (4 levels) is less than that the 6-9 levels seen following ESP injection in the thoracic region (previous thoracic cadaver model performed by the authors). This may be due to anatomic factors such the larger size of the lumbar vertebrae, and/or fluid dynamics related to the thicker and less compliant erector spinae muscle in the lumbar region. The scattered and faint dye staining of the muscle following surgical infiltration was limited to roughly the L3 level, which may have implications for postoperative pain control, although this remains speculative; a comparative clinical study of infiltration versus ESP block is indicated. Importantly, we observed no spread to the epidural space or lumbar plexus, a reassuring finding with a large (30 mL) volume of injectate in close proximity to the neuraxis and lumbar nerve roots. Further studies examining larger volumes of injectate may be useful to establish additional volume-disposition relationships.

References


Disclosures

Yes

Tables / Images
**L3 US-guided ESP**

- Injection 1, 10 mL (10 mL total)
- Injection 2, 10 mL (20 mL total)
- Injection 3, 10 mL (30 mL total)
- 2 min post-injection

<table>
<thead>
<tr>
<th>Injection</th>
<th>Transverse Process</th>
<th>Injection Volume (mL)</th>
<th>Cumulative Volume (mL)</th>
<th>Radiographic Spread (spinal levels)</th>
<th>Dye staining of ventral ES muscle?</th>
<th>Spread to PV space/ventral rami</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Right L3</td>
<td>10</td>
<td>10</td>
<td>L2-L3 (2 levels)</td>
<td>L1-L4</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Right L3</td>
<td>10</td>
<td>20</td>
<td>L1-L3 (3 levels)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Right L3</td>
<td>10</td>
<td>30</td>
<td>L1-L4 (4 levels)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Surgical infiltration of ES muscle</td>
<td>30</td>
<td>30</td>
<td>N/A</td>
<td>No (variable strands of intramuscular staining)</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 1. Radiographic and dye disposition observations with cumulative repeated injections at L3, as well as surgical infiltration of paraspinal muscles at and around L3. ES, erector spinae; PV, paravertebral