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CORRESPONDENCE

The electrophysiological principles of the electrical stimulation test in the epidural compartment

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To the Editor,

I commend Margarido *et al.*[1] on their recent paper in which they evaluated the ability of the epidural stimulation test (EST) to predict local anesthetic consumption. The authors verified that the EST is "an efficient tool to confirm the epidural catheter placement in the epidural space." Nevertheless, the finding that the EST cannot predict local anesthetic consumption is not surprising since it shows epidural analgesia acting in a compartment phenomenon, as would be expected.

As shown in the original article that appeared in the *Journal* 15 years ago, the fundamental objective of the EST is to confirm catheter tip placement in the epidural space.[2] When the catheter tip is in the epidural space, currents $\geq$ 1 mA are needed to elicit muscle twitches, whereas motor responses observed at $<$ 1 mA or just above 1 mA are usually indicative of placement in the subarachnoid or subdural space or even migration out of the epidural space but still proximal to a nerve root.[3,4] Regardless, there is no electrophysiological basis to suggest that threshold current itself can predict amount of local anesthetic needed. Volume, concentration, spread of local anesthetic, and epidural opioids all affect analgesia at the corresponding spinal level, but they do not intensify the threshold current provided the current is within the range associated with the epidural compartment (e.g., 1-10 mA).

The primary mechanism of the EST relies on stimulation of the nerve root rather than the spinal cord, and the test facilitates predicting the spinal level of the catheter within the epidural compartment. A lower current may be indicative of proximity to the nerve root and may therefore suggest that a lower volume of local anesthetic is needed; however, it is important to account for the fact that effective epidural analgesia typically requires bilateral coverage and that lower volumes may result in unilateral block.[5] As such, although only one side of the nerve root is stimulated with low current, a set volume of local anesthetic would still be required to ensure circumferential spread to cover the opposite side of the nerve root within the compartment. Otherwise, there is the risk of a unilateral epidural block when applying only a small volume of local anesthetic when the threshold current is low. Beyond this clarification, it is important to remind the reader of the significance of the electrophysiological mechanism of the EST and of the importance to evaluate the test accordingly and appropriately.

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Conflict of interest/other associations Dr. Tsui has a patent-licensing agreement with Pajunk.

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Reply

We thank Dr. Tsui for his comments on our publication. We agree that epidural anesthesia is a compartmental phenomenon and, assuming sufficient volume of the injectate has been used, that the local anesthetic solution will most often spread evenly over a segment of the spine regardless of the position of the epidural catheter. In many cases, however, the epidural spread will be uneven and lead to asymmetric blocks. Some of these cases are successfully managed by withdrawing/mobilizing a small segment of the epidural catheter, which suggests that the tip of the catheter may sit at times in an unfavourable location and result in uneven spread of the anesthetic solution.

Assuming the catheter is in the lumbar epidural space, the response to the electrical stimulation test is a unilateral twitch on the lower limbs. It is our clinical impression that the side responding to the electrical stimulation becomes a "dependent" side for the epidural block, especially in the context of a continuous infusion over the course of hours. A "dependent" side observed in epidural anesthesia is commonly associated with gravity, whereby the decubitus of a given patient dictates a denser block on the dependent side. Although usually not clinically relevant to determine an asymmetric sensory block, increased motor block and prolonged recovery times may be observed on the dependent side. On the other hand, the "dependent" side phenomenon determined by the position of the catheter seems independent from gravity and very significant at times. This was the rationale behind our hypothesis. Unfortunately, in our study, we did not find a correlation between the results of the electrostimulation of the catheter and the presence of asymmetric analgesia or local anesthetic consumption. Nevertheless, we did not assess motor block and regression of anesthesia; therefore, we cannot elaborate further.

The response to the electrical stimulation of the epidural catheter reveals not only its presence in the epidural space and the level of the spine at which it is located, as highlighted by Dr. Tsui, but also whether the tip of the catheter sits on the right or left of the epidural space. Although we agree with Dr. Tsui that the basic idea behind the electrical stimulation of the epidural catheter is to identify the appropriate placement of the epidural catheter in the epidural space, it is our impression that other clinically relevant information could be gained from this elegant test. Our hypothesis was an attempt to explore the test further.

Competing interests None declared.

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