



## Comment on “Comparison between the coronal diameters of the cervical spinal canal and spinal cord measured using computed tomography and magnetic resonance imaging in Korean patients”

Dear Editor,

We have read the article with interest titled “Comparison between the coronal diameters of the cervical spinal canal and spinal cord measured using computed tomography and magnetic resonance imaging in Korean patients” by Lee et al. [1]. Although cervical epidural steroid injection is a very useful procedure for cervical pain, it can cause serious side effects, such as spinal cord infarction or direct spinal cord injury. Unlike similar studies investigating how to reduce the risk of cervical interlaminar epidural block based on sagittal images [2], the present study that analyzes coronal plane images was impressive. We deeply appreciate the authors’ efforts to reduce the risk of cervical interlaminar epidural block and introduce new perspectives on this procedure. However, we have a few concerns regarding this article.

The first thing that we would like to point out is that the authors described the fluoroscopic images taken during cervical interlaminar epidural injection as the posteroanterior (PA) view. However, if fluoroscopic images are taken in the prone position of patients during this process, the X-ray tube (source) is placed at the bottom of the patient (chest side) while the image intensifier (detector) is located at the top (back side) [3,4]. Modern fluoroscopic systems are usually equipped with an X-ray generator placed on the bottom, and the detector placed on the top to minimize radiation exposure to physicians. Therefore, unless the X-ray generator of the C-arm machine was rotated by 180 degrees, i.e., inverted for some specific reason, the images obtained in this study would correspond to the anteroposterior view and not the PA view.

Second, the midline (or median) and paramedian approaches are two of the most commonly introduced cervical interlaminar epidural block procedures. These approaches target the posterior epidural space between the dura anteriorly and ligamentum flavum posteriorly. Since the posterior epidural space is the largest, and thus the safest, at the C7-T1 level of the cervical region, the most widely used method is to place a needle at this point [5]. As the authors described, the spinal cord is very unlikely to be present at the lateral 1/5 area of the spinal canal. Also, we do agree with the assertion that the cord-to-canal diameter ratio is the lowest at the T1 level, resulting in a low chance of direct injury to the spinal cord in this area. However, the posterior epidural space is a triangular-shaped structure that has diagonally placed ligamentum flavum on two sides and dura on the third side. Therefore, the distance between the ligamentum flavum

and dura becomes shorter the further we move from the midline centered on the spinous process, suggesting an increased risk of dural puncture. Although direct injury to the spinal cord could be avoided when the process is performed in accordance with the methodology followed in the present article, the possibility of dural puncture that may cause postdural puncture headache or high-level spinal block due to intrathecal injection is unavoidable. In addition, when the needle is inserted too laterally, it is difficult to assess whether the needle is positioned correctly on the fluoroscopic images because the needle has to be inserted deeper than the spinolaminar line to position the needle tip in the correct epidural space in the lateral view. There is no reliable method to identify the epidural space other than the loss of resistance technique that increases the risk involved in the procedure. Consequently, the methods suggested by Lee et al. [1] may not be safe to implement without sufficient verification and warrants attention and research.

Third, the authors described the measurement method in the present article as follows: “the spinal canal diameter was measured as the distance between the innermost border of the left and right pedicles at each upper pedicular level on transverse computed tomography (CT) images.” However, it is questionable whether the transverse diameter measured in the present article could indeed represent the actual spinal canal diameter. In addition, the authors described this diameter as the “diameter of the epidural space.” However, this may not correspond to the actual diameter of the epidural space because the ligamentum flavum that is attached to the bone is hard to see in fluoroscopy or CT, especially in the cervical spine.

Fourth, although the diameter of the spinal cord and spinal canal could be measured using magnetic resonance imaging (MRI), the reason behind measuring them separately on CT and MRI is unclear. Because the CT and MRI axial images in a patient do not exactly match, there is a limit to measuring the ratio of the spinal cord and the spinal canal diameter based on the unmatched images. Also, if CT and MRI dates were different and the dates were apart, there is a significant risk of postural or degenerative changes. It should be noted that small changes in the measurement can have a large effect on the ratio of the spinal canal diameter and spinal cord diameter reported in this study.

Fifth, when we perform the cervical interlaminar epidural injections, the needle moves from the posterior to the anterior direction of the patient. Hence, the anterior to the posterior (longitudinal) length of the spinal canal is significantly more important than the width (transverse length) that is measured in this article.

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## Response to “Comment on Comparison between the coronal diameters of the cervical spinal canal and spinal cord measured using computed tomography and magnetic resonance imaging in Korean patients”

We would like to thank you for your interest and appreciate your evaluation of our study [1]. The purpose of this study was to attempt to predict the location of the cervical cord on C-arm anteroposterior (AP) images since this critical structure cannot be visualized.

We agree that the AP view is used in C-arm images and acknowledge the error you have detected in our explanation.

Although it is true that the posterior epidural space is triangular

and punctures near the midline can prevent cord injury, this is possible only in people with normal anatomy that do not have, for example, a ligamentum flavum defect. As described in previous studies, the rate of fusion defects of the ligamentum flavum in the cervical spine range from 51% to 74% [2]. Therefore, moving the puncture point from midline to the far lateral position could reduce the risk of cord injury. While performing a cervical epidural block from the far lateral position of the interlaminar foramen, the operator must proceed with caution if any loss of resistance is felt, just as with the midline approach. However, as the puncture point is made laterally, the thickness of the ligamentum flavum is thinner and thus even more careful attention is needed in the event of any loss of resistance. Even when using the loss-of-resistance technique, it is considered safer to carefully check the loss of resistance while advancing the needle gradually rather than continuously. The needle tip position is then confirmed in the contralateral oblique view rather than in the lateral view [3].

In our study, the spinal canal diameter, also referred to as the epidural space diameter, was defined as the distance between the innermost border of the left and right pedicle. We agree that the thickness of the ligamentum flavum is included in the diameter of the epidural space. However, considering the anatomy of the cervical spine [4], the ligamentum flavum at this point is extremely thin and is more likely to affect the AP diameter than the transverse diameter of the epidural space.

Furthermore, as mentioned in the limitations of our study, while the computer tomography and magnetic resonance imaging axial images may not exactly match, we have determined this difference to be insignificant as the images were taken at 1-mm intervals.

Finally, we wholeheartedly agree that we must keep in mind that cervical interlaminar blocks progress in the AP direction; however, as previously mentioned, the perspectives presented in this study are clearly valuable.

Thanks again for your thoughtful recommendations.

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