Pain Medicine Case Reports

ISSN 2768-5152

Volume 7, Number 2, pp. 93-96

Comparison of Magnetic Resonance Imaging and Intraprocedural Cervical Epidural Depth: A Case Series

Steven Kim, MD[1], Kimberly Fazio, MD[1], Vladimir Suric, MD[2], Gustaf Van Acker III, MD, PhD[3], and Chong Kim, MD[3]

Background: Cervical epidural depth is assessed intraprocedurally using loss-of-resistance technique and fluoroscopy. It would be helpful if this depth could be predicted using magnetic resonance imaging (MRI) images.

Methods: This is a case series of 10 patients undergoing cervical epidural steroid injections (CESIs). The following measurements were made: intraprocedural depth, measured on Tuohy needles intraprocedurally, and MRI depth, measured from the MRI cervical spine. Linear regression models were used to compare the 2 depths.

Results: For intraprocedural depth vs sagittal MRI depth, R (Version 4.2.0, R Foundation for Statistical Computing, Vienna, Austria, 2021) was 0.8744, *P* value < 0.0001. For intraprocedural depth vs axial MRI depth, R was 0.8582, *P* value < 0.001.

Conclusions: Knowledge of the cervical epidural depth prior to CESIs may improve the safety and efficacy of these procedures.

Key words: Cervical epidural depth, cervical radiculopathy, cervical epidural steroid injections, MRI depth, case series

BACKGROUND

Cervical epidural steroid injections (CESIs) are commonly performed for cervical radiculopathy and other pain syndromes originating from the cervical spine. For safety and accuracy, CESIs are performed under fluoroscopy. Patients are usually awake and in the prone position. There is moderate evidence that CESIs provide both short- and long-term pain relief in patients with cervical radicular symptoms (1). The procedures in the cervical region, however, carry a low but very serious risk of complications (2). An inaccurate needle passage may lead to a postdural puncture, arachnoiditis, and a spinal cord injury (3).

CESIs can be technically challenging because of patient anatomical variations, narrowness of the epidural space, and the proximity of the needle to the spinal cord (4). There have been studies that investigated the relationships between the distance from the skin to the epidural space in adults as it relates to patient age, height, weight, and neck circumference, but only a couple of studies (5,6) that have used estimates drawn from magnetic resonance imaging (MRI) as a factor for comparison.

From: [1]Department of Physical Medicine and Rehabilitation, MetroHealth System/Case Western Reserve University, Cleveland, OH; [2]Department of Pain Medicine and Physical Medicine and Rehabilitation, Medical College of Wisconsin, Milwaukee, WI; [3]Department of Pain Medicine and Physical Medicine and Rehabilitation, MetroHealth System/Case Western Reserve University, Cleveland, OH

Corresponding Author: Steven Kim, MD, E-mail: stevendkim1@gmail.com
Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.
Patient consent for publication: All patient information has been de-identified and is exempt per institutional requirements.
Authors adhere to the CARE Guidlines for writing case reports and have provided the CARE Checklist to the journal editor.
Accepted: 2022-11-16, Published: 2023-03-31

Cervical epidural depth, the distance from the surface of the skin to the epidural space, is currently assessed intraprocedurally using the loss-of-resistance technique and fluoroscopically obtained lateral or oblique images. It would be useful to clinicians if this depth could be reliably measured using MRI images, which are typically obtained prior to these procedures. Accurate reprocedural assessment of the cervical epidural depth holds the potential for improving patient comfort, reducing risks, and radiation exposure (5). The purpose of this study is to add to previous studies about whether there is a correlation between MRI depth and intraprocedural depth; this study is unique in that it assesses both sagittal and axial MRI images (Figs. 1 and 2).

METHODS

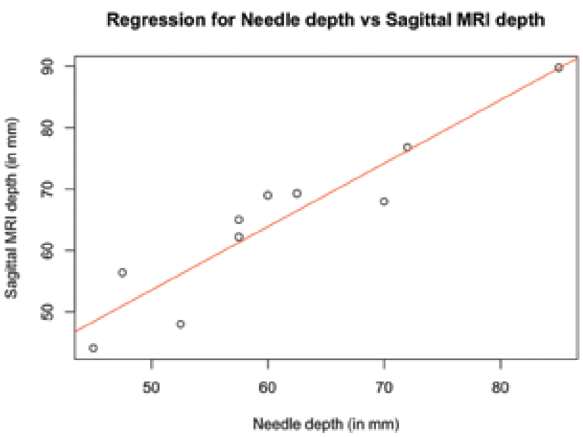

Fig. 1. Regression for (Intra-procedural) Needle depth vs Sagittal MRI depth

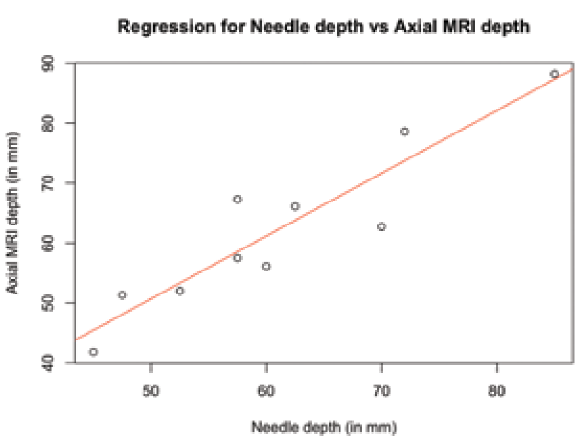

Fig. 2. Regression for (Intra-procedural) Needle depth vs Axial MRI depth

This is a case series involving patients diagnosed with cervical radiculopathy and scheduled for interlaminar CESIs as part of their routine clinical care. Given that the data collected was part of ongoing clinical care, and that any reviews of this data was performed using deidentified information, a Health Insurance Portability and Accountability Act of 1996 Authorization was waived by institutional policy.

Patients were included in the study if they were scheduled for an interlaminar CESI at C6-C7 or C7-T1, had an MRI C-spine obtained in the usual supine position with visible posterior skin edge on axial and sagittal views, and were between the ages of 18-99. They were excluded in the study if the CESI was above C6-C7 or below C7-T1, if they had cervical posterior spinal fusion at the injection levels, or if their MRI images had the posterior edge of the skin cutoff (Fig. 3). Ten patients were included in the study.

For the 10 patients included in the study, the following measurements were made: intraprocedural depth, as measured on centimeter-wide markings, recorded at 0, 0.25, 0.5, and 0.75 cm on Tuohy needles from the skin to the epidural space during the procedure, and MRI depth, as measured on axial and sagittal views of the patient's previous MRI of the cervical spine. These distances from the skin to the epidural space were measured by a board-certified pain physician. Images were

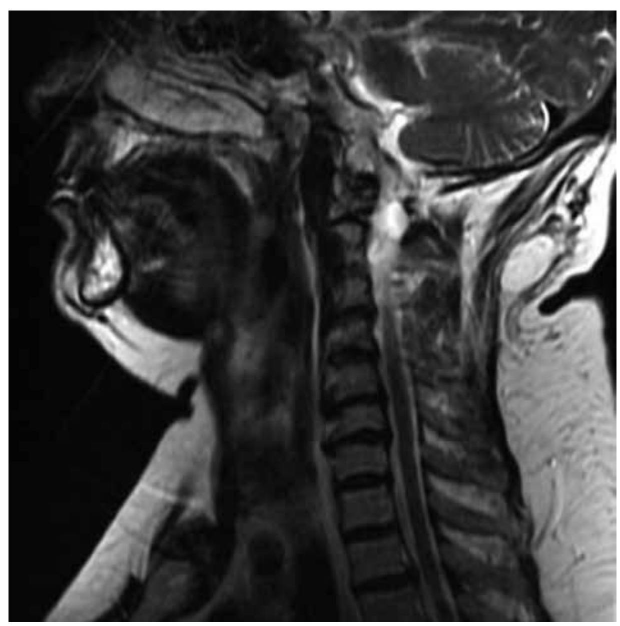

Fig. 3. MRI in sagittal view in which posterior margin of skin cut-off (exclusion criteria).

accessed via the institutional online Picture Archiving and Communication System (PACS) software (Centricity Enterprise Web; GE Healthcare, Waukesha, WI) and measurements obtained using the PACS software tool by drawing a line from the skin to the posterior epidural space. To approximate the trajectory of the needle on the midline cut of the sagittal T2-weighted image, the line was made from the skin to the middle of the interspinous space as parallel as possible to the spinous processes (Fig. 4). In the midline axial T2 images, a second measurement was made starting at the posterior edge of the skin to the anterior edge of the ligamentum flavum (Fig. 5).

Linear regression models were used to compare intraprocedural needle depth vs sagittal MRI depth, and intraprocedural needle depth vs axial MRI depth. A third linear regression model was made to compare sagittal MRI depth and axial MRI depth. All statistical analyses were performed using R 4.2.0 (R Foundation for Statistical Computing, Vienna, Austria, 2021) (Fig. 6).

RESULTS

On average, the axial MRI images were more accurate to the actual needle depth. On 7 of the 10 patients, the MRI overestimated the depth on sagittal (average of 0.5 cm) and on 5 of the 10 on axial (0.41 cm). However, both provide relatively accurate depths for the CESI. Comparing intraprocedural needle depth vs sagittal MRI depth, R was 0.8744, *P* value < 0.0001 (Fig. 1).

Comparing intraprocedural needle depth vs axial MRI needle dept, R was 0.8582, *P* value < 0.001 (Fig. 2). Comparing axial vs sagittal MRI depth, R was 0.8756, *P* value < 0.0001. Both axial MRI and sagittal MRI depths were positively correlated to the intraprocedural needle depth, both with *P* values < 0.05.

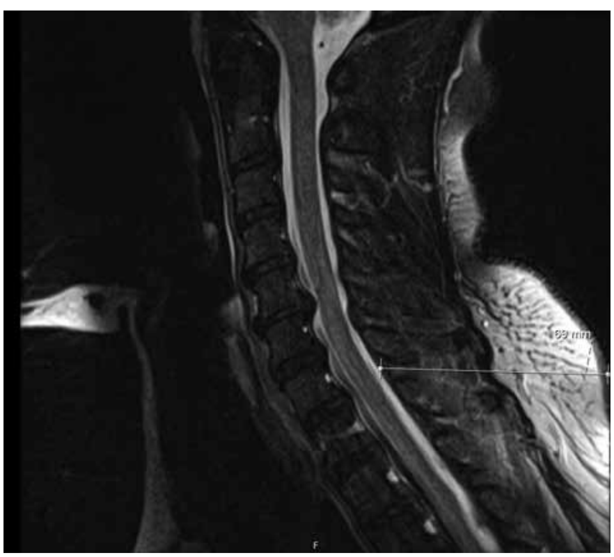

Fig. 4. Example of midline cut of sagittal MRI image used to obtain depth measurement.

DISCUSSION

This study compared MRI-derived measurements of epidural depth to intraprocedural depth in patients undergoing CESI. The data gathered suggest that estimates obtained from MRI can be a valuable tool in predicting actual depth of needle placement in CESI. Inappropriate advancement of the Touhy needle may lead to serious

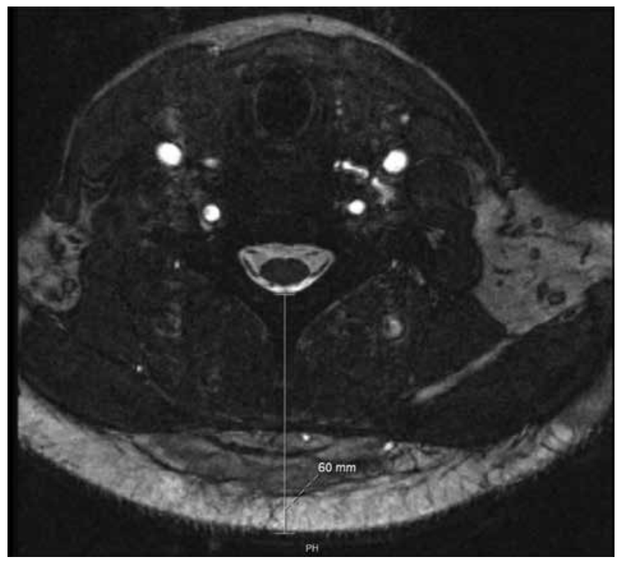

Fig. 5. Example of cut of axial MRI image used to obtain depth estimate.

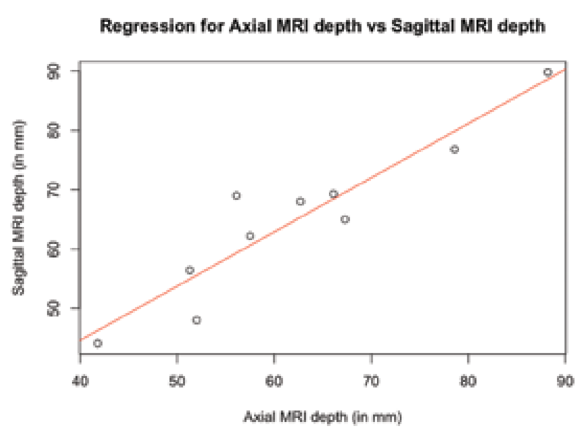

Fig. 6. Regression for Axial MRI depth vs Sagittal MRI depth

complications, including postdural puncture and spinal cord injury. Although these procedures are commonly performed under fluoroscopic guidance, accurate preoperative assessment of depth may help decrease the risk of these complications (5,6).

This study has several limitations. There were only 10 cases, which decreases the power of the study. Owing to its case series design, there is no control to compare cases to. Furthermore, there are many factors like patient age, weight, and body mass index that may influence the association of the factors analyzed in this study. There is no validation of methods used to measure MRI depths as there was only one investigator to make the measurements. Additionally, there is the potential for bias as the same investigator made the measurements for intraprocedural depth.

Given the limitations of this study, caution should be used to translate the findings to clinical use. There is currently no standardized protocol for measuring MRI depth and procedural depth for CESIs. As a result, information from MRI regarding needle depth should be viewed as inadequate (6). There needs to be a standardized approach to MRI and procedural measurements to fully elucidate the correlation between the 2 depths. Confirmation of this method as a useful tool will require further studies.

CONCLUSIONS

This study further supports previous studies that there is a high agreement between MRI and intraprocedural measurements. Our study is unique in that it analyzed both axial and sagittal cuts of MRI images, and the limited data suggest axial MRI images are more accurate and that both measurements may slightly overestimate the actual depth. Nevertheless, knowledge of depth from the surface of the skin to the epidural space prior to the CESI using MRI measurements may supplement the safety of these procedures by providing relatively accurate predictions of intra-procedural needle depth. Additional research is necessary to replicate these findings and establish a protocol for clinical use.

REFERENCES

1. Manchikanti L, Abdi S, Atluri S, et al. An update of comprehensive evidence-based guidelines for interventional techniques in chronic spinal pain. Part II: Guidance and recommendations. *Pain Physician* 2013; 16:S49-S283.
2. Cohen SP, Bicket MC, Jamison D, Wilkinson I, Rathmell JP. Epidural steroids: A comprehensive, evidence-based review. *Reg Anesth Pain Med* 2013; 38:175-200.
3. Rathmell JP, Michna E, Fitzgibbon DR, et al. Injury and liability associated with cervical procedures for chronic pain. *Anesthesiology* 2011; 114:918-926.
4. Yoon SP, Kim HJ, Choi YS. Anatomic variations of cervical and high thoracic ligamentum flavum. *Korean J Pain* 2014; 27:321-325.
5. Algrain H, Liu A, Singh S, Vu TN, Cohen SP. Cervical epidural depth: Correlation between cervical MRI measurements of the skin-to-cervical epidural space and the actual needle depth during interlaminar cervical epidural injections. *Pain Med* 2018; 19:1015-1022.
6. Jones JH, Singh N, Nidecker A, Li CS, Fishman S. Assessing the agreement between radiologic and clinical measurements of lumbar and cervical epidural depths in patients undergoing prone interlaminar epidural steroid injection. *Anesth Analg* 2017; 124:1678-1685.