

Analysis of Influencing Factors to Depth of Epidural Space for Lumbar Transforaminal Epidural Block in Korean

Department of Anesthesiology and Pain Medicine, Kwangju Christian Hospital,
*Kwangju Saewoori Spine Hospital, Gwangju, Korea

Lee Kyoung Kim, MD, Jung Ryul Kim, MD*, Sung Sick Shin, MD*,
In Ji Kim, MD, Bac Ne Kim, MD, and Gan Tac Hwang, MD

Background:

Transforaminal epidural steroid injection is one of the effective treatments in managing radicular pain. There have been some prospective studies on the depth to the epidural space with the transforaminal approach. However, there have been no studies about the depth in Asians, especially Koreans. This study was carried out in order to evaluate the depth to the epidural space and the oblique angle and factors that influence the depth to the epidural space during lumbar transforaminal epidural injection.

Methods:

A total of 248 patients undergoing fluoroscopically guided transforaminal epidural steroid injections were evaluated. At the L3–4, L4–5, L5–S1, and S1 levels, we measured the oblique angle and depth to the epidural space.

Results:

Needle depth was positively associated with body mass index (correlation coefficient 0.52, $P = 0.004$). The median depths (in centimeters) to the epidural space were 6.13 cm, 6.42 cm, and 7.13 cm for 50–60 kg, 60–70 kg, and 70–80 kg groups, respectively, at L5–S1. Age and height were not significantly associated with the needle depth.

Conclusions:

There is a positive association between the BMI (and weight) and transforaminal epidural depth but not with age, sex, and height. (Korean J Pain 2011; 24: 216-220)

Key Words:

BMI, correlation, depth, transforaminal epidural injection.

Received June 29, 2011. Revised September 19, 2011. Accepted September 19, 2011.

Correspondence to: Sung Sick Shin, MD

Department of Anesthesiology and Pain Medicine, Kwangju Saewoori Spine Hospital, 180-28, Hwajeong 1-dong, Seo-gu, Gwangju 502-240, Korea

Tel: +82-62-603-8000, Fax: +82-62-364-7500, E-mail: ruby0913@naver.com

© This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Copyright © The Korean Pain Society, 2011

INTRODUCTION

In patients with lower back and leg pain, the procedure of injecting medication into the epidural space of the spine has been used for years, with the caudal epidural block, intervertebral epidural injection, or transforaminal epidural injection being among the most common forms of the procedure. Theoretically, blocking with transforaminal epidural has merits compared to blocking with intervertebral or caudal epidural used mostly in the past, which include its ability to provide access to the closest site near the damaged nerve root or to the anterior epidural space, its capability to administer drugs (using even a smaller dose) in the targeted site and the resulting benefits of higher treatment effects and longer-term efficacy [1]. Its merits notwithstanding, a transforaminal epidural block is reportedly associated with adverse events (AEs) such as infection, hematoma, incidents of intravascular or subarachnoid penetration, direct nerve injury, and urinary retention [2]. These AEs are thought to be due to the depth of the needle that enters the epidural space and due to a lack of accuracy in needle placement.

This study was conducted (a) to determine the factors that affect the optimal depth of nerve block needles and to obtain the median needle depth during a lumbar transforaminal epidural block in Korean patients and (b) to draw implications to assist anesthesiologists in transforaminal epidural injections during nerve blocks, based on the aforementioned findings.

MATERIALS AND METHODS

A total of 248 patients with spinal stenosis were enrolled in the study. They had visited this hospital from 2008 through 2009 and received transforaminal epidural blocks. Their written consent was obtained before starting the procedure.

For the procedure, patients were instructed to assume the prone position; Betadine[®] was applied to sterilize the puncture site; sterile cloths were placed over it. Using fluoroscopic guidance and the bony landmark, a puncture mark for the nerve block was confirmed; lidocaine 1% was administered subcutaneously to the needle infiltration site. The fluoroscope was operated such that the site of the block was situated at the center; the inferior endplate became parallel, and the spinous process overlapped with the

line extending from the vertebral body's protrusion; the fluoroscopic equipment was adjusted to get a better oblique view of the scotty dog sign. The single-injection technique was adopted; the nerve block needle for the procedure was a 9 cm 22G K-3 lancet-point spinal needle (Smiths Medical UK, USA). The anatomical target was the vertical lower-center of the pedicle, which is superior to the passing nerve roots. Using the lateral view of the fluoroscopy, the nerve block needle was advanced gradually until its tip was placed inside the epiradicular membrane, right before the posterior side of the vertebral body, or inside the inferior part of the pedicle. After insertion of the needle, a minute was given to see if there was blood in the tubing. When no blood was evident, an inhalation test was carried out to check for the presence of blood. After confirming the absence of both blood and cerebrospinal fluid, a contrast medium was injected. Using fluoroscopy, observations were made of the spreading of the contrast medium inside the epidural space medial to the pedicle. During the observations, the fluoroscopic images were recorded on a real-time basis to observe the intravascular spreading of the contrast medium. Whenever the spreading was considered satisfactory, the length and angle of the nerve block needle were measured. For each intervertebral disc, the median depth of the needle was obtained; correlation coefficients were calculated to examine the relationship between the needle depth and the patients' age, height, sex, weight, and BMI, and for needle insertion at each lumbar level. In addition, the median needle depth was calculated in relation to weight and BMI. SPSS was used for statistical analysis ($P < 0.05$).

RESULTS

Of the 248 patients enrolled in this study, 5, 14, 161, and 68 patients were assigned to the L3/4, L4/5, L5/S1, and S1 intervertebral discs, respectively, for the sake of measuring the needle depth. In these groups, the depth to the epidural space was 8.0 cm, 6.7 cm, 6.5 cm, and 5.2 cm, respectively. ANOVA for different lumbar intervertebral discs was not performed due to the small sample sizes in the L3/4 disc and L4/5 disc groups; only a comparison of the L5/S1 and S1 discs was done (Table 1). The results show that there were correlations between the patients' weight and BMI and the depth of the epidural space; the correlation coefficients were 0.536 and 0.522. No correlations

were found between the patients' age and sex and the depth to the epidural space (Table 2). At the L5/S1 intervertebral disc, the median needle depth was 6.13 cm in patients weighing 60 kg or less, 6.42 cm in patients weighing between 60 and 70 kg, 7.13 cm in those weighing between 70 and 80 kg, 7.38 kg in those weighing between 80 and 90 kg, and 7.53 cm in those weighing 90 kg or more; the median needle depth in all patients was 6.5 cm (Table 3). At the L5/S1 intervertebral disc, the median needle depth in the low weight group (BMI \leq 18), the normal weight group (18.5 < BMI < 23), and the high weight group (23 \leq BMI) was 6.18 cm, 6.62 cm, and 7.46 cm, respectively (Table 4).

DISCUSSION

In the pathology of lower back and leg pain, a crucial

Table 1. Descriptive Statistics by Lumbar Level

	L3/4	L4/5	L5/S1	S1	P value
Patients (n)	5	14	161	68	
Age (yrs)	63.4	63.6	56.4	46.8	0.207
Wt (kg)	58.6	60.4	64.4	66	0.134
Height (cm)	157	159	162.7	166.3	0.746
BMI	26.5	24.3	19.9	16.6	0.192
Depth to epidural (cm)	8.0	6.7	6.3	5.9	0.212

BMI: body mass index (kg/m²). P value is for two sample t-test between L5/S1 and S1.

Table 3. Mean Value of Weight Group

	< 60 kg	60–69.9 kg	70–79.9 kg	80–89.9 kg	> 90 kg	P value
Depth (cm)	6.13	6.42	7.13	7.38	7.53	0.001
At L5–S1 (n)	(46)	(73)	(27)	(12)	(3)	
Depth (cm)	4.84	5.17	5.44	5.58	5.9	0.002
At S1 (n)	(18)	(23)	(19)	(6)	(2)	

n: number of patients.

Table 4. ANOVA for BMI, Lumbar Level

	BMI < 18.5	18.5 < BMI < 23	BMI > 23	P value
Depth (cm)	6.18	6.62	7.46	0.001
At L5–S1 (n)	(50)	(97)	(14)	
Depth (cm)	4.95	5.22	5.91	0.001
At S1 (n)	(20)	(40)	(8)	

n: number of patients.

role is played by the physical strains resulting from degenerative changes occurring in the intervertebral discs, posterior longitudinal ligament, and intervertebral joints as well as from inflammation. The nucleus pulposus of the intervertebral discs is among the locations from which enzyme-products and inflammatory mediators such as phospholipase A2 (PLA2s) and substance P are released; PLA2s and SP are associated with inflammatory responses [1]. That inflammation plays a big part in the generation of pain sensations in patients with lower back and extremity pain and gives grounds to inject steroids into the epidural space. However, even the most accurately executed injection of steroids into the epidural space of the lumbar or sacral region of the spine could still fail to attenuate lower back and/or extremity pain. The reason for such failure is the failure in maintaining an appropriate concentration of the drugs that is required for the target point rather than the administered drugs not working in the epidural space [3]. Among the anatomical structures related to the vertebrae and their surrounding structures are the intervertebral disc annulus fibrosus, the posterior

Table 2. Correlation Coefficient Between Depth and Wt, BMI, Level, Age, Sex

	Age (yrs)	Weight (kg)	Height (cm)	BMI
Depth	0.079	0.536	0.082	0.522
P value	(0.232)	(0.032)	(0.214)	(0.004)

longitudinal ligament, the posterior roots, and the dorsal root ganglion. Situated near or anterior to the epidural space, these structures are associated with the activation of pain receptors and hence, with lower back and leg pain [4]. Thus, the clinical viability of a transforaminal epidural block is recognized in that the technique, as compared with either the interlaminar or sacral approach, is capable of taking a more target-specific approach and is able to administer drugs in the anterior epidural space (the site of primary pathology) in the smallest dose and at higher concentrations. Nevertheless, the transforaminal approach is associated with postprocedural complications including hematoma, nerve injuries, and dural puncture and intravascular injection incidents. Therefore, an accurate prediction of the depth to the epidural space, as well as precise placement of the needle, is important.

Predicting the optimal depth of the needle is crucial, because the length, if too long or short, can cause problems for the clinician. The longer the needle, the more difficult it becomes for the anesthesiologist to control its direction; the increased difficulty in controlling the direction also leads to greater discomfort felt by patients and to increased vulnerability for complications. A shorter needle, on the other hand, may require the anesthesiologist to re-insert the needle in order to reach the target mark. Brummett et al. [5] reported that a needle 8.89 cm (3.5 inch) in length was long enough for patients with a BMI of 25 kg/m^2 or less; that a 12.7 cm (5 inch) needle was usable in most patients with a BMI of 30 kg/m^2 or above [5]. In their study, the longest distance to the epidural space was 8.6 cm; the patient in question weighed 93 kg, with a BMI of 26 kg/m^2 . The second longest distance to the epidural space was 8.5 cm; the patient weighed 67 kg, with a BMI of 20.4 kg/m^2 . Comparing these two patients brings attention to clinicians that in patients with a lower BMI value or weight, the distance to the epidural space can still be relatively longer. Brummett et al. [5] reported that the shortest distance to the epidural space was 4.2 cm; that the patient weighed 60 kg, with a BMI of 18 kg/m^2 . In this study, the correlation coefficient between the patients' weight and the needle depth was 0.536; the correlation coefficient between the BMI and depth was 0.522, which were statistically significant.

In their study with American subjects, Brummett et al. [5] reported that the depth to the lumbar epidural space was 7.5 cm in a group of patients with a BMI less than

18 kg/m^2 , 7.5 cm in patients with a BMI of 18 kg/m^2 – 25 kg/m^2 , 8.4 cm in patients with a BMI of 25 kg/m^2 – 30 kg/m^2 , 10 cm in patients with a BMI of 30 kg/m^2 – 35 kg/m^2 , 10.4 cm in patients with a BMI of 35 kg/m^2 – 40 kg/m^2 , and 12.2 cm in patients with a BMI of 40 kg/m^2 or above. Among the variables they measured, only the BMI was significantly correlated to the distance to the epidural space. In this study, the median depth to the epidural space in patients with a BMI of less than 18 kg/m^2 was 5.87 cm; and the figure in patients with a BMI of 18 kg/m^2 – 25 kg/m^2 was 6.34 cm and 8 cm in patients with a BMI of 25 kg/m^2 – 30 kg/m^2 . These figures were different from the results of Brummett et al. [5] and D'Alonzo et al. [6] who reported that the distance to the epidural space was related to the race of the patients, although it is assumed to be difficult to prove that the aforementioned differences in the depth to the epidural space as reported by this study and by Brummett et al. [5] were in fact attributable to a racial factor. According to D'Alonzo et al. [6], the number of morbidly obese patients in South Korea was smaller than that of other countries. The largest value of BMI in the patients was 27 kg/m^2 ; there were no patients with a BMI of 30 kg/m^2 or above. In this study, a significant correlation was found between the patients' BMI and the depth of the transforaminal epidural block needle; the patients' age or sex was not significantly related to the needle depth. The penetration angle during the needle insertion into the transforaminal epidural space, in particular, was initially assumed to be related to the BMI or weight. A significant correlation between the angle and BMI (weight), however, was not found in their results, presumably due to the use of the fluoroscope during the advancing of the needle towards the bony landmark; thus, the penetration angle in heavier and lighter patients did not vary significantly.

In this study, the median depth of the needle placement for the transforaminal epidural block in the patients was 6.3 cm; the longest distance was 8.6 cm. Given the patients' BMI was the biggest factor affecting the depth of the nerve block needles, the following conclusions were drawn: (a) the depth to the epidural space can be predicted based on the BMI values; (b) the possibility of an exceptional depth cannot be excluded, and thus, a reference depth must be calculated by measuring the depth with contrast-enhanced fluoroscopy or ultrasonic waves prior to the procedure, and only after the reference depth is ob-

tained should the procedure be performed taking into consideration the patient's BMI. Such an approach will likely help minimize postprocedural AEs and reduce the likelihood for having complications such as nerve injuries.

REFERENCES

1. Hong JH, Lee YC, Lee HM, Kang CH. An analysis of the outcome of transforaminal epidural steroid injections in Patients with spinal stenosis or herniated Intervertebral Discs. *Korean J Pain* 2008; 21: 38–43.
2. Goodman BS, Posecion LW, Mallempati S, Bayazitoglu M. Complications and pitfalls of lumbar interlaminar and transforaminal epidural injections. *Curr Rev Musculoskelet Med* 2008; 1: 212–22.
3. Kim DW, Shim JC, Shin YC. Evaluation of contrast flow patterns with fluoroscopic guided lumbar transforaminal epidural injections. *J Korean Pain Soc* 2004; 17: 159–65.
4. Choi BI, Han JM, Kweon TD, Lee YW. The prognostic factors of selective transforaminal epidural block in patients with low back pain. *Korean J Pain* 2007; 20: 54–9.
5. Brummett CM, Williams BS, Hurley RW, Erdek MA. A prospective, observational study of the relationship between body mass index and depth of the epidural space during lumbar transforaminal epidural steroid injection. *Reg Anesth Pain Med* 2009; 34: 100–5.
6. D'Alonzo RC, White WD, Schultz JR, Jaklitsch PM, Habib AS. Ethnicity and the distance to the epidural space in parturients. *Reg Anesth Pain Med* 2008; 33: 24–9.