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Corresponding Author:
Ji Hee Hong, M.D.
Department of Anesthesiology and Pain Medicine, Keimyung University School of Medicine, Dongsan Medical Center, 1035 Dalgubeol-daero, Dalseo-gu, Daegu 42601, Korea
Tel: +82-53-258-7767
E-mail: swon13@daum.net

Analysis of Factors Affecting Thoracic Epidural Anesthesia Performance Time

Jae Yun Lee, Kyung Min Noh, Seung Won Lee, Eun Young Cho, Ji Hee Hong

Department of Anesthesiology and Pain Medicine, Keimyung University School of Medicine, Daegu, Korea

Thoracic epidural anesthesia (TEA) is an efficient procedure for managing intraoperative and postoperative pain caused by liver resection, gastrectomy, or lung surgery. Precise difficulty prediction of TEA has the advantage of reducing the risk of complications. The purpose of this study was to identify factor correlated with TEA performance time under fluoroscopic guidance. From September 2017 to May 2018, 39 patients who were scheduled to receive TEA under fluoroscopic guidance for postoperative pain control were enrolled for this study. All thoracic epidural catheterization was performed by one physician who had more than 5 years of experience in spine intervention. TEA was performed one day before the elective surgery in the outpatient pain clinic. Body mass index (BMI) was found to be a factor associated with TEA procedure time. Correlation coefficients of procedure time with age, height, weight and BMI were 0.099, -0.129, 0.346, and 0.575, respectively. BMI needs to be considered as one factor that affects the difficulty of TEA.

Keywords: Age, Body mass index, Performance time, Thoracic epidural anesthesia

Introduction

Thoracic epidural anesthesia (TEA) is a widely accepted method for major thoracoabdominal surgeries such as hepatic resection, thoracotomy, and gastrectomy. Continuous epidural blockade using insertion of the epidural catheter provides excellent intraoperative and postoperative pain control [1-6]. In addition, a recent meta-analysis has suggested that TEA can decrease postoperative cardiac morbidity and mortality [7].

The spinous process of thoracic spine is longer than other vertebrae. It covers the midpoint of the vertebral lamina one level below. The thoracic spinal interlaminar space is very narrow and limited. Such anatomical difference provides technical difficulty to approach the thoracic region compared to the lumbar or cervical region. Traumatic placement of a needle during a neuraxial blockade has been related to many complications including postdural puncture headache, trauma to adjacent neural structure and even spinal hematoma, causing permanent neurologic deficit [8-11].

Precise prediction of difficulty of TEA can reduce the risk of complications. Anesthesiologists should consider other technical options if TEA is expected to be difficult [11].

Previous studies have identified factors associated with difficulty of epidural catheter placement, including age, gender, body mass index (BMI), and spine deformities [2,12-14], however, no definite factors have yet been identified.

Kula et al. [15] have used the number of attempts, epidural placement time, and the number of needle redirection to predict "difficulty" of neuraxial technique. They concluded that epidural failure rate was best predicted by BMI [15].

All above studies were performed blindly under the guidance of anatomical landmark palpation [2,12-15]. However, fluoroscopy is widely used in various pain procedure recently. It provides many advantages including detecting intravascular or intrathecal injection immediately by contrast medium injection. Therefore, different patient factors such as age, gender, height, weight, and BMI could result in difference in outcome if we use fluoroscopy.

The purpose of this study was to identify whether age, gender, height, weight, and BMI as patient factors would correlate with TEA performance time under fluoroscopy guidance.

Materials and Methods

This study was approved by the Institutional Review Board (IRB ref No: 2017-07-030). Patients were fully explained about the benefits and risks of this study and epidural consent forms were obtained from all patients. From September 2017 to May 2018, 39 patients who were scheduled to undergo elective hepatobiliary resection, pulmonary wedge resection, gastrectomy and esophagectomy due to cancer of liver, lung, stomach and esophagus were enrolled. Patients' individual data such as age, height, weight, and BMI were asked and recorded. BMI was calculated as weight divided by the square of height (kg/m^2). Patients with the following conditions were excluded; allergic reactions to local anesthetics or contrast agents, coagulopathies, history of spinal infections, and previous thoracic spine surgery.

All TEAs were performed by one physician who had more than 5 years of experience in spine intervention. TEA was performed one day before the elective surgery in the outpatient pain clinic.

Patients were laid on the fluoroscopy table with prone position. Anteroposterior (AP) view was obtained to verify the interlaminar area of 10th or 11th thoracic vertebra. The needle entry point was thoroughly sterilized with povidone iodide and 1% lidocaine was injected locally into the needle entry point. An 18-gauge Tuohy needle of epidural catheter set (Arrow FlexTip PlusTM, Arrow International, USA) was slowly inserted into the 10th or 11th interlaminar space. The epidural space was found by using loss-of-resistance technique when the needle approached the targeted spinolaminar line. Once the loss-of-resistance was felt, 2 ml of contrast medium was injected to verify the thoracic epidural space in AP and lateral views. If needle reinsertion was required during the procedure, the procedure mentioned above was repeated. After the epidural space was confirmed using contrast medium, an epidural catheter was carefully inserted through the Tuohy needle and advanced into the cranial direction up to thoracic spine 7-8 level. A small amount of contrast medium was injected to pass through the catheter before inserting through the Touhy needle to improve visualization of the location of catheter. The performance time was defined as the interval from the time of 1% lidocaine injection to the time of completing the catheter insertion after confirming the epidural space. It was measured by another physician who was blinded to the patient's demographic data using a stop watch. The epidural catheter was sutured with nylon 5-0 around the skin and fixed firmly with an adhesive plater. Patients who completed this procedure were sent to their hospital rooms.

In this study, the effect size for multiple regression analysis was set as 0.35 with an α error of 0.05, a β error of 0.2, two sided test, the number of predictors of 5. The final sample size was 43.

All statistical analyses were performed with SPSS version 21.0 (IBM Corp., USA). Data on age, height, BMI, needle entry level were analyzed by Pearson's correlation analysis and multiple regression analysis. Statistical significance was set at $p < 0.05$.

Results

Mean age, height, weight, BMI, and performance time of the 39 subjects were 64.1 years, 160.7 cm, 62.5 kg, 24.1 kg/m^2, and 261 seconds, respectively. Regarding gender distribution of subjects, there were 23 (59%) men and 16 (41%) women (Table 1).

Among various cancers enrolled in this study, patients with stomach cancer were the most common (41.0%) (Table 2).

Correlation coefficients of performance time with age, height, weight, and BMI were 0.099, -0.129, 0.346 and 0.575,

Table 1. Patient demographics and procedure data

Variables	Mean ± SD
Age (years)	64.1 ± 11.2
Gender (male/female)	23 (59%)/16 (41%)
Height (cm)	160.7 ± 9.1
Weight (kg)	62.5 ± 11.0
BMI (kg/m^2)	24.1 ± 3.2
Performance time (sec)	261 (223-368)

BMI, body mass index.

respectively (Table 3). Multiple regression analysis was performed to determine whether age, gender, height, and BMI affected performance time. The non-standardized beta value of BMI was 0.032 ($p < 0.05$) (Table 4).

Data of performance time according to BMI showed a positive linear relationship in scatter plot (Fig. 1).

Discussion

In this study, performance time increased significantly as BMI increased. BMI also showed positive linear correlation with the performance time.

This study showed that BMI was associated with the procedure time. performance time was used as a variable that represented difficulty of TEA.

This was based on other previous studies which demonstrated that performance time increased as difficulty of the procedure increased [15].

During the design of this study, we expected that the effect of BMI and age would be minimized compared to blind technique due to clear identification of bony landmark by using fluoroscopy. However, increased BMI was associated with the performance time in both cases of fluoroscopy guidance and blind technique under anatomical landmark palpation.

McCormick et al. [16] compared total fluoroscopy time during lumbar epidural steroid injection among patients with normal, overweight and obese BMI. They concluded that fluoroscopy time was increased during interlaminar epidural injections and during L5-S1 transforaminal injections in patients who are obese. These relationships were not affected by injection number, performance of bilateral injections, or trainee involvement.

Increased depth of epidural space due to obesity might lead to poor image of bony landmark of fluoroscopy, thus enhancing technical difficulties for needle orientation ultimately. BMI has also been suggested as a weak factor for difficulty of neuraxial block in previous studies [9,10]. Obesity was also associated with difficulty and failure of neuraxial blockade [15].

Weight was also shown as a correlating factor in the present study. It was considered as a confounding factor in this study. It is likely due to the fact that the formula for calculating BMI includes weight. Therefore, weight and BMI correlated with each other.

In this study, BMI was significantly associated with TEA performance time under fluoroscopy. It can be thought that BMI is one of factors that influence the distance from skin to subarachnoid or epidural space. This is supported by previous re-

Table 2. Type of disease

Disease	N (%)
Hepatoma	10 (25.6%)
Lung Cancer	11 (28.2%)
Gastric Cancer	16 (41.0%)
Esophagus Cancer	2 (5.1%)

Table 3. Correlation coefficients between performance time and independent variables

Variable	Cc	*p*-Value
Age	0.099	> 0.05
Height	-0.129	> 0.05
Weight	0.346	< 0.05
BMI	0.575	< 0.05

BMI, body mass index; Cc, correlation coefficient.

Table 4. Results of multiple regression analysis between procedure time and independent variables

Variable	Performance time					
	Beta	SB	t	*p*	VIF	DW
(Constant)	2.624		2.037	< 0.05		2.112
Gender	-0.055	-0.152	-0.552	> 0.05	3.974	
Age	0	-0.03	-0.157	> 0.05	1.926	
Height	-0.005	-0.262	-0.859	> 0.05	4.884	
Weight	-0.003	-0.325	-0.752	> 0.05	3.725	
BMI	0.032	0.555	3.888	< 0.05	1.072	

BMI, body mass index; DW, Durbin-Watson value; SB, standardized beta coefficient; VIF, variance inflation factor.

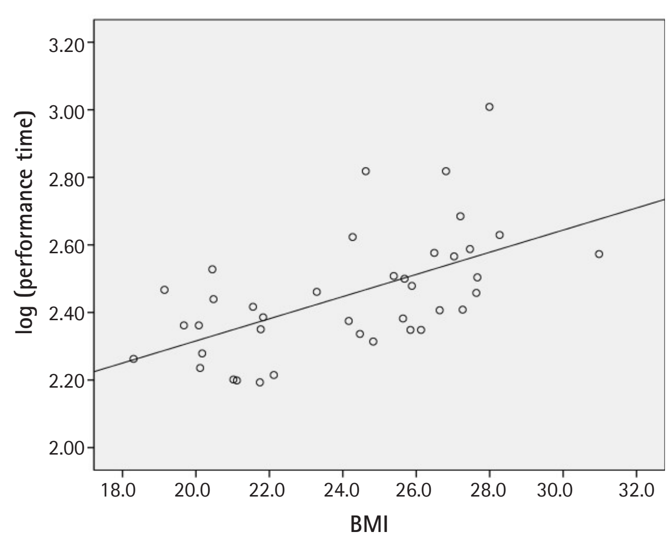

Fig. 1. Scatter plot between BMI and performance time. When performance time according to BMI was presented as scatter plot, it shows a positive linear relationship (correlation coefficient = 0.575). BMI: body mass index.

ports demonstrating clear association between the depth of epidural space and BMI [17-19]. Kim et al. [12] have shown that the distance from skin to subarachnoid or epidural space is associated with difficulty in performing a neuraxial blockade.

Younger age is also associated with first puncture success [2]. It is expected that less spine deformity or degenerative change of spine will be encountered in younger patients compared to older patients. This difference of spinal anatomy according to age group could contribute to difficulty of epidural or spinal procedure. However, in this study, age did not show any correlation with TEA performance time under fluoroscopy. All patients enrolled in this study were old aged patients of cancer mostly. Therefore, the uneven age distribution of this study might have led to a different result. Since this study was performed in various cancer patients, patients with younger age were rare compared to older ages.

This study has several differences compared to other previous studies. Kim et al. [12] considered a provider factor (performer's level of experience) as well as patient factors. In this study, the provider factor was ruled out by having only one performer for the procedure.

Additionally, the quality of lumbar spine anatomical landmarks was considered in previous studies [2,12]. However, in this study, all TEAs were performed under fluoroscopic guidance which made finding the anatomical landmark unnecessary.

We selected lower thoracic level (T10-T11) instead of middle thoracic level to insert epidural catheter. The selection of lower thoracic level was performed based on the result of previous study. The epidurography which was performed at lower thoracic level showed mean spread of 7-8 segment after injection of 2.5 ml of contrast medium. In addition, most of epidurography done at lower thoracic level demonstrated dominant cephalad spread and its spread reached up to T3-4 level [20-22]. This epidurography study means that epidural catheterization which was performed at lower thoracic level is enough for the sensory block during intra- and postoperative period. We experienced severe patient discomfort and suffering due to multiple needling at middle thoracic level.

This study has several limitations. First, the number of patients was not enough to meet the final sample size calculated previously. We had some difficulties enrolling TEA patients. In spite of full explanation of the benefit of thoracic epidural analgesia, quite many patients refused to be enrolled due to the fear of needling to thoracic spine. Second, the age distribution of this study was uneven. Most patients were flocked to old age group. Therefore, it has some limitation to apply results of this study to the whole age group. Third, the level of experience of physician's assistant who operated the fluoroscopy device was not consistent. Therefore, variable level of experience might have affected the result. However, this effect of variable experience level of physician's assistant would be minimal compared to experience level of TEA performer. In this study, we only had one TEA performer.

In conclusion, this study showed that BMI had positive correlation with difficulty of TEA under fluoroscopy guidance. Therefore, physicians should consider BMI when evaluating difficulty of TEA to minimize performance time and the occurrence of complications.

Conflict of interest

All authors declare no conflicts-of-interest related to this article.

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