ORIGINAL ARTICLE

Bali Journal of Anesthesiology (*BJOA*) 2019, Volume 3, Number 1: 37-40
E-ISSN: 2549-2276

Published by DiscoverSys

The correlation between the depth extent of Tuohy epidural needle with body mass index (BMI) to achieve loss of resistance in patients undergoing epidural anesthesia

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ABSTRACT

Background: Anesthesia management in obesity is quite challenging. Epidural anesthesia become one of the choices. The attention should be addressed in order to prevent the misidentification of epidural space. The estimation of the depth extent of epidural space becomes crucial, especially in obese patients due to an accumulation of subcutaneous and epidural adipose tissue, which consequently complicate the epidural catheter insertion. This study aimed to analyze the correlation of the depth extent of Tuohy epidural needle to achieve loss of resistance between normal-weighted and obese patients.

Method: This study was conducted with 56 adult patients aged 17 to 65 years who underwent elective surgery by epidural anesthesia inserted at level L2-L3 or L3-L4 interspace. Subjects are divided into normal and obese groups. Shapiro-Wilk and chi-square tests were used in the normality test. For normally distributed data, an independent t-test was used to test the hypothesis, otherwise, we used Mann-Whitney test

Results: The results showed that the loss of resistance in epidural needle insertion procedures was 60 mm in a patient with BMI more than 30 kg/m^2 and 50 mm in those with BMI <30 kg/m^2 ($p<0.001$).

Conclusion: The loss of resistance depth in epidural Tuohy needle insertion is significantly determined by BMI.

Keywords: *obesity, regional anesthesia, epidural space, loss of resistance, epidural anesthesia*

Cite This Article: Hartawan, I.G.A.G.U., Senapathi, T.G.A., Suranadi, I.W., Aribawa, I.G.N.M., Parami, P., Pradhana, A.P., Syamsuddin, J.B.T. 2019. The correlation between the depth extent of Tuohy epidural needle with body mass index (BMI) to achieve loss of resistance in patients undergoing epidural anesthesia. *Bali Journal of Anesthesiology* 3(1): 37-40. DOI:10.15562/bjoa.v3i1.119

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INTRODUCTION

Obesity is a common nutritional condition, defined as an abnormally high excessive amount of adipose tissue deposit compared with lean muscle mass. Over the past 20 years, its prevalence has increased dramatically to more than 1.6 billion and approximately 400 million worldwide populations have been diagnosed with overweight and obesity, respectively.[1] According to WHO (World Health Organization), obesity is defined as the body mass index (BMI) of more than 30 kg/m^2.[2,3] Anesthesia management in obesity is quite challenging, including difficult of intubation, ventilation, increase pulmonary aspiration risk, etc.

Regional anesthesia, particularly epidural anesthesia, has become one preferred type of anesthesia. One of the common problems in epidural anesthesia is the misidentification of the epidural space.[4-6] The estimated depth of loss of resistance (LOR) is an essential factor for successful epidural anesthesia in obese patients. The thickness of subcutaneous and epidural adipose tissue which may complicate epidural catheter insertion and expands the depth extent between ligament flavum and skin distance among obese patients.[5-7] Other contributing factors are troublesome positioning and the high false positive rate of loss of resistance technique to identify epidural space. Several complications, like post-dural puncture headache (PDPH) or spinal cord injury can occur when the insertion of the epidural needle is deeper than it should be.[8,9]

Previous studies showed significant differences between the depth extent of epidural space among patient with normal BMI and obese-categorized BMI. In 2007, one study involving 40 parturients went through normal delivery with lumbar epidural analgesia showed a positive correlation between BMI and body surface area (BSA) to the depth of epidural space, while the patient's height was a less convincing predictor.[10]

In 2011, Ravi *et al.* measured the distance between skin through the epidural space which was correlated with BMI ratio. They revealed that the mean distance average of LOR was 41.6±50.8 mm

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in BMI <30 kg/m^2 compared to 51.97±5.28 mm in patients with BMI >30 kg/m^2.[7,11-13]

Each race brings its own uniqueness in many ways, and body fat composition is one of those. This study aimed to see the comparison of the depth extent of the epidural needle to achieve LOR in patients with normal BMI and obese-categorized BMI patients. An excellent epidural space identification would markedly raise the success rate and reducing the complication of epidural anesthesia among obese patients.

DESIGN AND METHODS

This is an analytic, cross-sectional study conducted by collecting the data from medical records of 56 adults patient aged from 17 to 65 years old with physical status ASA I-III underwent surgery during June-October 2018 by epidural anesthesia through the insertion of an epidural catheter at L2-L3 or L3-L4 by the median approach. This study was approved by the Committee of Ethical Research of Udayana University/Sanglah General Hospital.

Purposive sampling was used in this study so that we reach a similar number of male and female subjects in each group. A total of 56 subjects were divided into two groups: Group N (those with a BMI less than 30 kg/m^2) and Group O (those with a BMI ≥30 kg/m^2). Those with vertebrae abnormality, local edema at needle insertion site or general edema, or central nervous system abnormality were excluded from the study. The LOR was measured to 1 cm precision.

Data were analyzed using SPSS 18.0 software. Shapiro-Wilk and chi-square tests were used in the normality test. For normally distributed data, an independent t-test was used to test the hypothesis, otherwise, we used the Mann-Whitney test. A p value of <0.05 was considered significant.

RESULTS

The mean age of the subjects in Group N was 52 compared to 48 in Group O. In both groups, more subjects were inserted with epidural Tuohy needle at L3-L4 than L2-L3. Shapiro-Wilk test on

Table 1 Subject characteristics

	Groups	
Variables	**Group N (n=28)**	**Goup O (n=28)**
Age (years), median (IQR)	52 (21)	48 (19)
Sex		
Male, n(%)	14 (50)	14 (50)
Female, n(%)	14 (50)	14 (50)
ASA physical status		
I, n(%)	0 (0)	6(21.4)
II, n(%)	17 (60.7)	11 (39.3)
III, n(%)	11 (39.3)	11(39.3)
Lumbar insertion point		
L2-L3, n(%)	9 (32.1)	11 (39.3)
L3-L4, n(%)	19 (67.9)	17 (60.7)

IQR: interquartile range; n: sample size, L: lumbar; ASA: American Society of Anaesthesiologists

Table 2 The comparison of LOR in both groups

	BMI		
Variable	**Group N**	**Group O**	**p-value**
LOR (mm), median (IQR)	60 (10)	50 (10)	<0.001[a]

LOR: loss of resistance depth; BMI: body mass index; IQR: interquartile range, [a]*Mann-Whitney test*

Table 3 The comparison of LOR in each gender

	Sex		
Variable	**Male**	**Female**	**p-value**
LOR (mm), median (IQR)	50 (10)	50 (15)	0.348[a]

LOR: loss of resistance depth; IQR: interquartile range, [a]*Mann-Whitney test*

age resulted that the data regarding age was not normally distributed. The chi-square test on sex, ASA physical status, and insertion point revealed no significant difference result (p>0.05). The comparison between LOR according to BMI ratio is presented in table 2. Mann-Whitney revealed that LOR among obese patients was deeper than in non-obese patients (p <0.001).

We also compared the correlation between LOR and sex difference in patients with epidural catheter insertion as shown in table 3. The LOR variable among male and female patients was not statistically different in this study (p=0.348).

DISCUSSION

This study has been conducted to analyze the correlation between the depth of Tuohy epidural needle to achieve the loss of resistance in epidural catheter insertion in patients underwent epidural anesthesia. This study showed that the loss of resistance in obese patients was deeper than in non-obese patients (60 mm vs. 50 mm, p<0.001). The finding was similar to the previous study conducted by Ravi *et al.* which reported that the LOR in obese patients was deeper than non-obese patients (51.97±5.28 mm vs. 41.6±5.28 mm).[6]

Hirabayashi[12] reported that body weight, BMI, and BSA were significantly correlated to the LOR depth in epidural catheter insertion. It also proposed a formula derived from a linear regression equation to predict the LOR depth: 17.8 + (0.98xBMI) mm.

In a study conducted in Nigerian adults, Adegboye[14] reported in 2017 that the skin to lumbar epidural mean space distance was 4.60±0.83 cm. The report also stated that height, age, and sex do not correlate to LOR. They proposed a formula for calculating LOR depth: 3.33 + (0.05xBMI) cm.

Besides BMI, another factor that is known correlated to LOR is ethnicity. Sharma[15] reported that LOR amongst ethnic groups differed at any given body mass index, and it was significantly greater in Black/ British Black and White parturients compared to Asian and Chinese.

The correlation between BMI and LOR is not only found in the lumbar region. Greene[16] reported that there was a strong association between computed tomography (CT) measurement and LOR depth in thoracic level and that the presence of morbid obesity changed the relationship.

Some design-related limitations are present in this study. This is a cross-sectional study conducted by searching secondary data by looking at anesthesia records. Cross-sectional data is the least useful method in making an analytical conclusion. And also, the precision of the measurement recorded in our hospital was always to 1 cm. Future studies are needed, especially in Indonesian ethnic, to find out how deep is the LOR in Indonesian people.

By better estimating the LOR depth, a safer epidural catheter placement can be achieved in epidural anesthesia, with the end goal of providing better anesthesia experience for all parties involved: the patient, the anesthetist, and the surgeon.

CONCLUSION

The LOR depth was determined by BMI and not significantly affected by sex differences. Further studies are needed with a larger number of subjects and better precision to be able to make a better prediction of LOR depth among Indonesian patients.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

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