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The relationship between body mass index (BMI) with the distance of the skin-epidural space in 3rd and 4th lumbar epidural anesthesia in nonobstetric surgery of Indonesian patients

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ABSTRACT

Skin to epidural space distance varies in an insertion of epidural needle which can greatly affect the identification of the epidural space and epidural anesthesia complications. Therefore, a careful prediction of skin to epidural space distance is needed in doing insertions. The purpose of this study was to evaluate the relationship between body mass index (BMI) and the distance of skin to the epidural space in the 3rd – 4th lumbar epidural anesthesia in nonobstetric surgery of Indonesian patients. This was a prospective observational study with cross sectional design involving patients of both sexes between the age 18-65 years with ASA physical status I-II who underwent non obstetric surgery with 3rd-4th lumbar epidural anesthesia in Dr. Sardjito General Hospital, Yogyakarta and in Satellite Hospital. Weight, height and BMI were considered as the independent variables, whereas skin to epidural space distance was considered as dependent variable. Data were collected and analyzed using multiple regression analysis continued using Pearson's correlation test to evaluate the relationship between BMI and skin to epidural space distance. One hundred patients selected from October to December 2011 were evaluated in this study. The mean of weight, height and BMI were 57.35 ± 11.59 kg, 155.98 ± 5.88 cm and 23.52 ± 4.26 kg/m^2, respectively. The mean of skin to epidural space distance of non obstetric surgery of Indonesian patients was 40.89 ± 9.95 mm. Multiple regression analysis showed that BMI had a strongest relationship ($r = 0.81$; $p < 0.03$) with skin to epidural space distance compared to weight ($r = 0.11$; $p = 0.78$) and height ($r = 0.04$; $p < 0.83$). Further analysis using Pearson correlation test showed that a significantly good correlation of BMI ($r = 0.92$; $p = 0.001$) and body weight ($r = 0.87$; $p = 0.001$) with the skin to epidural space distance were observed. In conclusion, BMI and body weight have a significant correlation with the skin to epidural space distance in non obstetric surgery patient.

ABSTRAK

Jarak kulit dengan ruang epidural sangat bervariasi pada tindakan insersi jarum epidural sehingga sangat mempengaruhi identifikasi ruang epidural dan komplikasi anestesi epidural. Oleh karena itu diperlukan prediksi jarak kulit dengan ruang epidural yang cermat agar dapat melakukan insersi dengan baik. Tujuan dari penelitian ini adalah untuk mencari hubungan antara indeks massa tubuh (IMT) dengan jarak kulit dengan ruang epidural pada anestesi epidural lumbalis 3-4 pada operasi nonobstetrik penderita Indonesia. Penelitian ini adalah penelitian observasional prospektif dengan rancangan potong lintang dengan melibatkan penderita dari kedua jenis kelamin berumur 18-65 tahun dengan status fisik I-II yang menjalani operasi nonobstetrik dengan anestesi

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epidural lumbalis 3-4 di RSUP Dr. Sardjito Yogyakarta dan rumah sakit satelit. Berat badan, tinggi badan dan IMT sebagai variabel bebas sedangkan jarak kulit dengan ruang epidural sebagai varibel tergantung. Data hasil penelitian dikumpulkan dan dianalisis menggunakan analisis multivariat dilanjutkan dengan tes korelasi Pearson untuk mengevaluasi hubungan IMT dengan jarak kulit dengan ruang epidural. Seratus penderita yang diseleksi mulai Oktober – Desember 2012 dievaluasi dalam penelitian ini. Rerata berat badan, tinggi badan dan IMT berturut-turut adalah 57,35 ± 11,59 kg, 155,98 ± 5,88 cm and 23,52 ± 4,26 kg/m^2. Rerata jarak kulit dengan ruang epidural pada pasien bedah non obstretik Indonesia adalah 40,89 ± 9,95 mm. Hasil analisis multi regresi menunjukkan IMT mempunyai hubungan paling kuat (0,81; p < 0,03) dengan jarak kulit dengan ruang epidural dibandingkan berat badan (r = 0,11; p = 0,78) dan tinggi badan (r = 0,04; p < 0,83). Analisis lebih lanjut menggunakan uji korelasi Pearson menunjukkan hubungan yang kuat secara bermakna antara IMT (r = 0,92; p = 0,001) dan berat badan (r = 0,87; p = 0,001) dengan jarak kulit dengan ruang epidural. Dari penelitian ini dapat disimpulkan bahwa IMT dan berat badan mempunyai hubungan bermakna dengan jarak kulit dengan ruang epidural.

Keywords: skin to the epidural space distance - body mass index - lumbar epidural anesthesia 3-4 - non-obstetric surgery - anesthesia

INTRODUCTION

Epidural anesthesia is one of the techniques of regional anesthesia. Normally, it is performed by injecting local anesthetic drugs into the epidural space in order to obtain analgesia effect of highly specific dermatomes. Epidural anesthesia was first introduced by Corning in 1885 with cocaine to reduce pain in the feet. In 1895 Cathelin used epidural anesthesia on the sacral, which was then known as caudal analgesia. In 1910, Lawen studied the anatomy of spinal and epidural injections and claimed that the canal sacralis would not go into the subarachnoid space.[1-3]

Epidural anesthesia is used as analgesia during and after surgery to reduce labor pain. It is also used as a supplement to the light general anesthesia to reduce bleeding during surgery with the potential for hypotension, blocking the transmission of afferent impulses, hormonal and autonomic responses following surgery.[3]

Many factors can affect the successful of epidural anesthesia, even among skilled anesthesiologists. Among the complication factors, it is obesity that makes it difficult to identify anatomical landmarks and to identify the epidural space. Obesity increases the long period of procedure, and the rates of failure and complication occurence.[4] Brummet *et al.*[5] conducted a study on mothers who gave birth and received epidural anesthesia. The success rates of epidural analgesia in these patients were recorded. The study showed that the failure rates of epidural analgesia in obese patients (7.7%) and morbid obese patients (11.7%) were significantly higher than in normal patients (5.1).[5]

If an anesthesiologist can predict the distance of the skin to the epidural space, it can increase the success of epidural catheter placement and speed of insertion action. Moreover, it can also reduce complications due to improper insertion. In this case, it needs a good planning in order to anticipate the difficulties that can happen suddenly. This study was conducted to determine the relationship between body mass index (BMI) with the distance of the skin-epidural space in 3rd and 4th lumbar epidural anesthesia in a nonobstetric surgery of Indonesian patients.

MATERIALS AND METHODS

Subjects

This was a prospective observational study with cross-sectional design. A total of 100

patients of both sexes between the age 18-65 years with ASA physical status I-II who underwent nonobstetric surgery with 3rd-4th lumbar epidural anesthesia in Dr. Sardjito General Hospital, Yogyakarta and in Satellite Hospital were taken up for the study. Exclusion criteria included contraindications for epidural anesthesia, the presence of abnormalities of the spine, patients having spinal surgery history and oedema anasarka. Drop out criteria included failure to identify epidural space and failure to identify epidural space through midline approach. The study was conducted after receiving the approval of the Medical and Health Research Ethics Committee, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta and a written informed consent obtained from all patients.

Anaesthesia technique

Pre-anaesthetic check up was performed in all patients before surgery, which included a detailed history, general physical and systemic examination. The body weight and height of patients were measured by a calibrated tool in the ward and BMI of the patients were calculated by weight in kg divided by height in meter square (kg/m^2).

The patient was placed in the surgery operating room and an intravenous line was installed using abbocath 18G on the left or right veins connected to a 3 way stopcock and an infusion set. After shifting the patients to operation table, preoperative vital parameters like electrocardiogram (ECG), pulse rate (PR), respiratory rate (RR), non invasive blood pressure (NIBP), mean arterial pressure (MAP), heart rate (HR) and SpO_2 rate were monitored and recorded prior to the anesthetic procedure.

The patients were placed in sitting position on the edge of operating table with feet resting on the stool. The patients leaned forward hugging the pillow with neck flexion, i.e. chin touching the chest. The skin area was cleaned and draped under aseptic precautions. The skin was infiltrated with local anesthetic 2% lidocaine till periosteum. The epidural needle was inserted gradually using stylet till the ligament interspinosum. After that, the stylet was removed and a 10 cc syringe containing the air was attached. Syringe was pushed gradually till epidural space was identified by loss of resistance to air. The boundary of skin with the epidural needle was marked with a marker. The syringe was removed from the epidural needle and an epidural catheter was inserted slowly to the epidural space. The skin to epidural space distance was measured by measuring the distance between the marker and the tip of epidural needle with the help of a measuring scale. After measuring the distance from skin to epidural space, anesthesia and analgesia were continued according to the requirement for surgical procedure.

Data analysis

Data of body weight, body height, BMI and the skin to epidural space distance were presented as mean ± SD and as median. Multivariate analysis was used to evaluate the relationship between independent and dependent variables, while Pearson correlation analysis was used to evaluate the relationship between two variables. The correlation was considered as a good correlation, moderate correlation and weak correlation if the Pearson correlation coefficient (r) value > 0.8, 0.6 to 0.79 and 0.4 to 0.59, respectively.[6] All tests were considered significant if p value <0.05.

RESULTS

Characteristics of subjects are shown in TABLE 1. Means of age, body weight, body height and BMI of subjects were 45.87±12.99 years, 57.35±11.59 kg, 155.98±5.88 cm, and

23.52±4.26 kg/m², respectively. Among subjects involved in this study, 30% of subject was male and 70% was female. Proportion of subjects with BMI <18.5, BMI 18.5-24.9 and BMI ≥ 25 were 17%, 47% and 36%, respectively, while proportion of subjects with ASA physical status I was 48% and ASA physical status II was 52%.

TABLE 1. General characteristics of subjects involved in thsi study

Variables	Number (n)	Mean ± SD
Age (years)	100	45.87 ± 12.9
Sex		
• Male	• 30 (30%)	
• Female	• 70 (70%)	
Weight (kg)	100	57.35 ± 11.59
Height (m)	100	155.98 ± 5.88
Body mass index	100	23.52 ± 4.26
• <18.5 kg/m²	• 17(17%)	17.52 ± 0.91
• 18.5-24.9 kg/m²	• 47 (47%)	22.28 ± 1.80
• ≥25 kg/m²	• 36 (36 %)	27.99 ± 2.57
ASA		
• I	48 (48%)	
• II	52 (52%)	

The skin to epidural space distance based on BMI of subjects is presented in TABLE 2. Mean of the skin epidural space distance of all subjects was 40.89±9.94 mm. Mean of the skin epidural space distance of subjects with BMI <18.5 kg/m², BMI 18.5-24.9 kg/m² and BMI >25 kg/m² were 29.76 ± 3.40 mm, 37.00 ± 5.32 mm and 51.22 ± 6.85 mm, respectively. Significant difference of the skin to epidural distance based on the BMI classification was observed in this study (p<0.05). Multiple regression analysis showed that BMI had a strongest relationship (r= 0.81; p<0.03) with skin to epidural space distance compared to weight (r= 0.11; p=0.78) and height (r= 0.04; p<0.83).

TABLE 2. The skin to the epidural space distance base on BMI value

Variables	Mean ± SD	Median (min. – max.)
Skin to the epidural space distance (mm)	40.89 ± 9.95	40.00 (25-70)
BMI classification		
• < 18.5 kg/m²	29.76 ± 3.40	29.00 (25-40)
• 18.5 – 24.9 kg/m²	37.00 ± 5.32	36.00 (25-55)
• ≥ 25 kg/m²	51.22 ± 6.85	50.00 (40-70)
Insertion angle (°)	2.55 ± 4.46	2.50 (0-20)

Further analysis using Pearson correlation test showed that a significantly good correlation of BMI (r=0.92; p=0.001) and body weight (r=0.87; p=0.001) with the skin to epidural space distance were observed as shown in TABLE 3 and FIGURE 1 and 2. However, body height showed a weak correlation with the skin to epidural space distance (r=0.18; p=0.073) (TABLE 3 and FIGURE 3).

TABLE 3. Pearson correlation analysis beetwen weight, height and BMI with the skin to the epidural space

Variables	Number (n)	Pearson correlation coefisien	p
Body mass index	100	0.92	0.001
Weight	100	0.87	0.001
Height	100	0.18	0.073

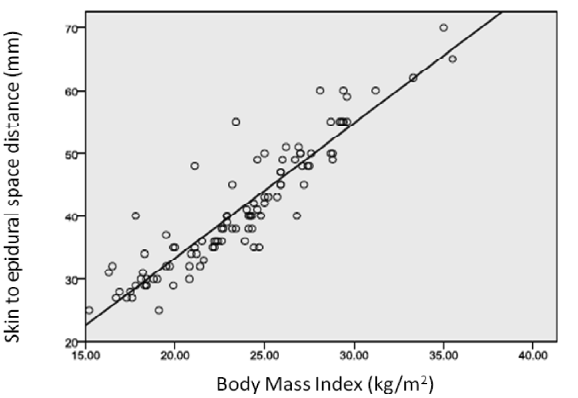

FIGURE 1. Pearson correlation test of the BMI and the skin to the epidural space distance

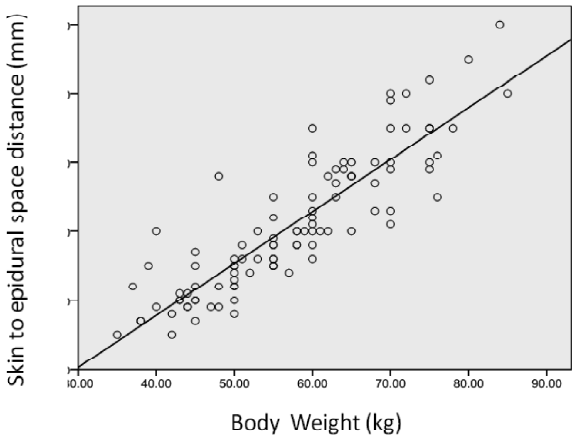

FIGURE 2. Pearson correlation test of the body weight and the skin to the epidural space distance

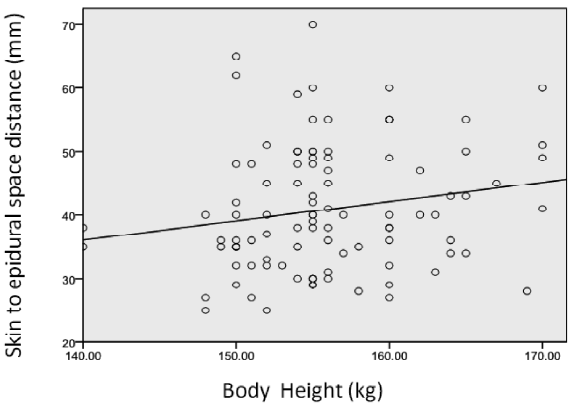

FIGURE 3. Pearson correlation test of the body height and the skin to the epidural space distance

DISCUSSION

Multiple regression analysis showed that BMI had a strongest relationship (r= 0.81; p<0.03) with skin to epidural space distance compared to weight (r= 0.11; p=0.78) and height (r= 0.04; p<0.83). These results were similar with previous studies reported by some authors. Segal *et al.*[7] reported that among parameters evaluated namely weight, height, BMI, age, parity, the point of puncture and positioning of patients, BMI had the strongest relationship with the skin to epidural space distance (r = 0.689; p <0.001) compared with other parameters. The strongest relationship between BMI with the distance skin to epidural space (r^2=0.38; p<0.0001) compared with weight and height was also reported in 2009 among women who underwent epidural anesthesia delivery.[8] In addition, a positive relationship between BMI and depth of the epidural space during lumbar transforaminal epidural steroid injection (r=1.13; p<0.001) has been reported by Brummette *et al*.[5] However, there were no relationships between the patient's age, parity and the vertebral height with depth of the epidural space.

This study found that the BMI can be considered as the best predictor of the skin to epidural space distance in the lumbar epidural anesthesia for nonobstetric surgery. An anesthesiologist should be careful when the epidural needle depth is close to the prediction according to BMI, and thereby should increase the speed of action and prevent the complications due to improper insertion.

Mean of the skin epidural space distance of all subjects obtained from this study was 40.89±9.94 mm. The mean of the skin epidural space distance was different based on the BMI of subjects. The mean of the skin epidural space distance of subjects with underweight (BMI <18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2) and overweight (BMI ≥ 25 kg/m^2) were 29.76 ± 3.40 mm, 37.00 ± 5.32 mm and 51.22 ± 6.85 mm, respectively. These BMI values were not much different with BMI values reported by some authors.

Shiroyama *et al.*[9] reported that the mean distance of the skin to the epidural space of the mother in childbirth in Japan with weight of 52 kg and BMI of 22.23 kg/m^2 was 35 mm. Although the mean distance of the skin to epidural was different compared to this study, the difference was normal due to the difference in the weight and BMI of the subjects. The mean of weight and BMI of subjects of this study were 57.35

kg and 23.53 kg/m^2, respectively. D'Alonzo *et al*.[10] reported that the mean skin to the epidural space distance of the ethnic Asian obstetric population was 48 ± 9 mm, whereas Meikle-john[11] found the mean distance of the skin to the epidural space in obstetric Asian population was 43 cm. Although these mean values were higher than mean value (40.89±9.94 mm) obtained from this study, this variation was reasonable. Fluid retention and hormonal factors could increase the skin to the epidural space distance in obstetric patients.

A strong positive correlation of BMI (r=0.92; p=0.001) and body weight (r=0.87; p=0.001) with the skin to epidural space distance in non obstetric surgery patients were found in this study. This finding is consistent with the hypothesis that the increase in BMI will be followed by the increase in skin to the epidural space distance. The increase in BMI and body weight will be followed by the increase in subcutaneous fat that causes the increase in the skin to epidural space distance. Therefore, it can be concluded that both the BMI and body weight have positive correlation with the skin to epidural space distance.

A positive relationship between the BMI and the skin to the epidural space distance will be helpful in clinical practice especially in the practices of lumbar epidural anesthesia. Based on the regression analysis between the BMI with the skin to the epidural space distance, it was obtained a content value of -9.6 and regression coefficient value of 2.14. Therefore, the simple equation of the linear regression model between the BMI with the skin to the epidural space distance can be described as - 9.6 + (2.14 x BMI). This available equation is useful for anesthesiologists to choose an appropriate needle size base on BMI; whether the needle size of 9 or 11 or 13 cm that will be chosen. Appropriate choice of the needle size can increase the comfort between both patients and anesthesiologists, improve efficiency and reduce complications in the practices lumbar epidural anesthesia. The simple equation or formula can be applied to non obstetric patients, both men and women aged 18-65 years who will undergo surgery with 3rd - 4th lumbar epidural anesthesia.

CONCLUSION

In conclusion, BMI and body weight have a significant positive correlation with the skin to epidural space distance in nonobstetric surgery of Indonesian patients. The simple equation of the linear regression model between the BMI with the skin to the epidural space distance can be described as - 9.6 + (2.14 x BMI).

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