Distance from Skin to Epidural Space: Correlation with Body Mass Index (BMI)

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ABSTRACT

Background: Epidural anaesthesia is being increasingly used to provide anaesthesia for surgery on the lower abdomen, perineum and lower extremities. However success of the epidural technique depends upon the correct identification of epidural space. We conducted a study to find the distance from skin to the epidural space and its correlation with body mass index, to improve the success rate.

Patient and Methods: 120 adults patients belonging to ASA physical status I and II in the age group of 18-70 years, scheduled for surgery and or pain relief under epidural block, were taken up for the study. 60 patients of either sex were further subdivided into 2 subgroups of 30 patients each having BMI less than 30 or more than 30. The distance from skin to epidural space was measured as the distance between rubber marker and tip of Tuohy’s needle.

Results: It was found that with increase in Body mass Index, the distance from skin to the epidural space also increases. The distance from the skin to the epidural space does not depend on the age or the sex of the patients.

Conclusions: We formulated predictive equation of depth of epidural space from skin in relation to BMI based on linear regression analysis as: Depth (mm) = a + b (BMI). Where a = 17.7966 and b = 0.9777.

KEYWORDS: Epidural space, Body Mass Index

Since the advent of epidural block, many methods have been proposed to identify the epidural space. The majority of methods rely on the identification of the negative pressure or the loss of resistance encountered on entering the epidural space. The technique used today, involves loss of resistance detection, using either an air or saline filled syringe. The technical success of epidural blocks rest on correct identification of the epidural space.

We conducted this study to find a correlation between BMI and distance from the skin to epidural space, which would be of help for successful epidural in morbidly obese where anatomic landmarks are obscured.

PATIENTS AND METHODS

The study was conducted after the approval by Hospital Ethics Committee and a written informed consent obtained from all patients. A total of 120 adults (60 males : 60 females), belonging to ASA grade I and II, in the age group of 18-70 years, scheduled for surgery and or pain relief, under epidural block were taken up for the study. 60 patients of either sex were further subdivided into two subgroups of 30 each having BMI less than 30 or more than 30 kg m⁻². Exclusion criteria included increased intracranial pressure, uncorrected coagulopathy, patients receiving anticoagulants, obvious spinal deformity, previous spinal surgery, spinal trauma, local infection/mass/oedema, neurological disease, pregnancy, and generalised oedema of the body. Patients with inadequate epidural block were also excluded from the study.

Pre-anaesthetic check up was performed in all patients a day before surgery, which included a detailed history, general physical and systemic examination. The Body Mass Index of the patients was calculated by weight in kg divided by height in meter square. Examination of spine was done and L3-L4 interspinous space identified and marked with a marking pen.

Anaesthesia Technique

Patients were kept nil orally for 6 hours prior to the surgery. After shifting the patient to operation table, preoperative vital parameters like pulse rate, respiratory rate, non invasive blood pressure, electrocardiogram and SpO₂ were monitored and recorded. Intravenous access was secured with 18G cannula under all aseptic conditions. The patient was placed in sitting position with neck flexion (i.e. chin touching the chest) and feet resting on the stool. Under all aseptic precautions, area was cleaned and draped. The skin was anaesthetised by locally infiltrating 2% lignocaine. A rubber marker was inserted on the Tuohy’s needle and placed near the hub. The midline approach was used to introduce the needle. The needle was gradually inserted forwards, cranially, till 2 centimeters mark.

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After that, stylet was removed and loss of resistance syringe was attached. Needle was pushed gradually till epidural space was identified by loss of resistance to air. After that the rubber marker was advanced to touch the skin without applying excessive pressure.

Test dose of 1% lignocaine 3ml, with adrenaline (1:200,000) was given in epidural space. Monitoring of heart rate, respiratory rate, non invasive blood pressure and sensory and motor block, was done and recorded. After ruling out intravenous or intra thecal placement of the needle tip, the suitable drug was injected and the needle was withdrawn.

The nature, type and volume of the epidural drug was decided as per the need of surgical procedure. Another person who was not involved in the procedure, measured the distance from skin to epidural space, by measuring the distance between rubber marker and tip of Tuohy’s needle with the help of a measuring scale.

After measuring the distance from skin to epidural space, anaesthesia and analgesia was continued according to requirement for surgical procedure. A note was made whether epidural analgesia was satisfactory or unsatisfactory as desired for surgical analgesia or pain relief.

RESULTS
Mean age of patients with BMI < 30 was 44.77 ± 16.59 years in males and 46.53 ± 13.85 years in females. Mean age of patients with BMI > 30 was 48.43 ± 14.63 years in males and 53.80±10.59 years in females. This difference was statistically (p > 0.10) insignificant. [Table: 1]. It was seen that the depth of epidural space varied between 39.85 ± 6.44mm to 46.00 ± 7.87mm in patients with age subgroup between 20 years to 70 years (with BMI < 30). This difference is statistically not significant (p > 0.10) and in patients with BMI > 30, the depth of epidural space varied between 50.13 ± 4.79mm to 53.33± 6.92 mm amongst patients with age subgroups between 20 to 70 years,. This difference was statistically not significant ( p > 0.10). However, in all the age sub groups the depth of epidural space from skin is significantly more in patients with BMI > 30 than in patients with BMI <30 (p < 0.01). (Figure 1)

In patients with BMI < 30 as the weight of patients increased from 41 Kg to 100 Kg, the mean epidural space depth increased from 38.25 ±7.07mm to 45.33 ± 5.01mm which is statistically significant (p < 0.01). In patients with BMI > 30, as the weight increases from 61 kg to 140 kg, the depth of epidural space increased from 50.00 ± 0.00mm to 63.64 ± 10.02mm. This is also statistically significant (p < 0.01). Hence the distance from the skin to the epidural space increases with increase in weight of the patients (p<0.0 1) (Figure 2).

The mean depth of epidural space varies from 45.96 ± 8.22mm to 48.90 +10.29mm in both the groups with increase in height from 141 cm to 180 cm. But there was no statistically significant correlation of distance from the skin to the epidural space with the height of the patients. (Figure 3)

| Table 1  | Demographic profile |
|----------|---------------------|
|          | BMI < 30            | BMI > 30            |
|          | Male    | Female  | Male    | Female  |
| No of Patients (n) | 30      | 30      | 30      | 30      |
| Age (years) Mean ±SD | 44.77±  | 46.53±  | 48.43±  | 53.80±  |
|          | 16.59   | 13.85   | 14.63   | 10.59   |
| BMI (Kg m-2) Mean ±SD | 25.23±  | 25.00±  | 34.26±  | 34.24±  |
|          | 2.69    | 2.96    | 4.71    | 4.53    |

Figure 1
Relationship of depth of epidural space with age

Figure 2
Relationship of depth of epidural space with weight

Figure 3
Relationship of depth of epidural space with height
Mean depth of epidural space in males with BMI < 30 is 44.43 ± 4.67, (r value 0.033) and in males with BMI > 30 is 51.40 ± 5.96 (r value 0.713) which is not statistically significant. The mean depth of epidural space in females with BMI < 30 is 38.77 ± 5.48 mm, (r value 0.476) and in females with BMI > 30 is 52.53 ± 4.52 (r value 0.687). In females the correlation of BMI and depth of epidural space is statistically significant. The relationship of depth of epidural space with BMI and sex (Table 2) shows that as BMI increases, the depth of epidural space also increases. The mean depth of epidural space in all patients with BMI < 30 is 41.60 ± 5.80 and the depth is 51.97 ± 5.28 in patients with BMI > 30. Thus, there is a significantly positive relationship (r value 0.762) between depth of epidural space and BMI. (Table 3)

### Table 2

**Relationship of Depth of Epidural Space with BMI and Sex**

| BMI   | Male Mean ± SD | Female Mean ± SD | Total Mean ± SD |
|-------|----------------|------------------|-----------------|
|       | r value        | r value          | r value         |
| BMI < 30 | 44.43 ± 4.67   | 38.77 ± 5.48     | 41.60 ± 5.80    |
| BMI > 30 | 51.40 ± 5.96   | 52.53 ± 4.52     | 51.97 ± 5.28    |
| p-value | 0.033***       | 0.713***         | 0.687***        |

*** p < 0.01, ** p < 0.05, ns: >0.10 non significant

### Table 3

**Relationship of Depth of Epidural Space with BMI and Sex**

| BMI (kg m$^{-2}$) | Depth of Epidural Space (Mean ± SD) |     |     |
|-------------------|-------------------------------------|-----|-----|
|                   | Male Mean ± SD                      | Female Mean ± SD | Total Mean ± SD |
|                   | (Mean ± SD)                         | (Mean ± SD) | (Mean ± SD)     |
| 18-25             | 44.14 ± 5.52                        | 36.38 ± 4.75  | 40.00 ± 6.28    |
| 25-30             | 44.69 ± 4.27                        | 41.50 ± 5.08  | 43.20 ± 4.86    |
| 30-35             | 49.23 ± 2.62                        | 50.68 ± 3.75  | 49.95 ± 3.28    |
| > 35              | 57.38 ± 8.43                        | 57.63 ± 1.51  | 57.50 ± 5.85    |
| p-value           | < 0.01                              | < 0.01        | < 0.01          |

There is a correlation of Body Mass Index (BMI) with the distance from the skin to the epidural space. As the BMI increases, the distance from skin to the epidural space also increases. Predictive equation of depth of epidural space in relation to BMI: Depth (mm) = a + b (BMI). Where a = 17.7966 and b = 0.9777

**DISCUSSION**

The techniques of extradural anaesthesia and analgesia have become common in surgical patients following its introduction in the labor wards and obstetric operating rooms. Although, extradural anaesthesia for obstetric surgery has been superseded by spinal anaesthetic techniques, extradural analgesia following major surgery is now common place in modern postoperative care. The success of epidural anaesthesia depends upon the correct identification of the epidural space and correct placement of the tip of the epidural needle / epidural catheter in the extradural space. Lai et al, defined the depth of the epidural space as the distance from overlying skin to the tip of the needle just penetrating epidural space. If proper identification of the epidural space is not done, and needle is not appropriately advanced, a false loss of resistance may be encountered at the level of ligamentum flavum and catheter placement at this site will result in failure of block. On the other hand, if the needle is advanced too far, dural puncture will occur and large doses of local anaesthetic drugs if injected intrathecally, can have rapid and fatal effects on the cardiovascular and respiratory systems. Also, the risk of developing post dural puncture headache is very high after accidental dural puncture because of the large bore of the Tuohy’s needle, which leads to CSF leak.

Therefore, it is very important to determine the distance from the skin to the epidural space and to find a suitable parameter for correct estimation of the distance from skin to epidural space. The estimation of depth of epidural space will also be very useful in morbidly obese patients as the anatomical landmarks in them are usually obscure. This will help us to have better patient outcome and we can avoid general anaesthesia, which carries a significant risk in these patients due to difficult airways, poor respiratory reserve and high oxygen consumption and moreover, regional anaesthesia have been described as the safest approach to obese patients.

In our study no relationship was found between age and depth of epidural space in patients in both the groups. But in all the age groups, as the BMI increased, the depth of the epidural space also increased and this difference was statistically significant (p < 0.01). It was also found that as the weight of the patients increased, the depth of the epidural space also increased in both the groups. In patients with BMI < 30 the mean epidural space depth increased from 38.25 + 7.07mm to 45.33 + 5.01mm as weight increased from 41 to 100 kg and the mean depth of epidural space increased from 50.00 + 0.00mm to 53.64 + 10.02mm as weight increased from 61 to 140kg in patients with BMI > 30. This difference was found to be statistically significant in both the groups (p value < 0.01). Palmer S et al also found direct relationship between patient weight and distance from the skin to the epidural space (p < 0.0001).

Hirabayashi et al, studied the distance from the skin to the epidural space in 1007 epidural punctures, to determine whether there was any systemic relationship between the distance from skin to the epidural space and physical constitution. Like our study, they also found the best correlation between the distance from the skin to the epidural space and body weight. The correlation between the distance from the
skin to the epidural space and height was less striking. Our study also demonstrated similar finding.

In our study there was no correlation between height of the patient and depth of epidural space, but in patients with different heights as the BMI is increasing, the depth of epidural space is also increasing. Palmer S et al also showed that there was no relationship between height and distance from the skin to the epidural space. Rosenberg H et al studied the distance from the skin to the epidural space in a series of 50 non-obstetric patients. The correlation was less striking between distances and height, height: weight ratio and Ponderal index.  

Shiroyama K et al. have concluded that the distance of most Japanese parturient women are 3-4cm at the L1-2 interspace and the value can be predicted by the formula: 

\[ \text{SE distance (cm)} = 0.05 \times \text{body weight (kg)} + 0.36 \]

In our study it was found that as the BMI increases the depth of epidural space also increases. This increase is statistically significant (r value 0.762). The mean depth of epidural space in patients of BMI 30 was 41.60±5.80mm and in patients of BMI> 30 was 51.97±5.28mm. Kim K et al (2003) also observed that as the BMI increased, the average distance at which the epidural space is encountered is also increased. Lin et al 1995 in their study have concluded that BMI could be a guideline for identification of epidural space during epidural anaesthesia.

We have formulated predictive equation of depth of epidural space in relation to BMI based on linear regression analysis: Depth (mm) = a + b [BMI]. Where ‘a’ is the constant and is equal to 17.7966 and ‘b’ is the regression coefficient and is equal to 0.9777.

It is evident from our study that there is no correlation of distance of skin from epidural space between the age, sex and the height of the patients. There is a definite correlation of body weight and body mass index of patients with distance from skin to epidural space. As the BMI increases, the depth of epidural space also increases. Correct prediction of the distance from the skin to the epidural space will help to correctly place the epidural catheters with less incidence of procedure related complications and making epidural drug administration a safe practice.

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