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Influence of Physical Characteristics on Skin to Lumbar Epidural Space Distance in Nigerian Adults

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Authors' contributions

This work was carried out in collaboration between both authors. Authors IUI and EKD participated in arrangement of the concept, designed the study, collected data and managed the literature searches. Author IUI did data analysis, interpretation of data, manuscript creation, critical write up and revision of the content. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: To estimate the skin to lumbar epidural space distance (SLESD) in Nigerian adults and determine the influence of age, height, weight and body mass index on it.
Study Design: It was a cross sectional descriptive study carried out on consenting patients enlisted for surgery with planned lumbar epidural anaesthesia. Patient selection was by a non-probability sampling technique.
Place and Duration of Study: The study was carried out at the Main theatre complex of the University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria from February to April, 2012.
Methodology: One hundred and twenty healthy adults of both sexes consisting of 60 consenting patients each, scheduled for elective surgeries under epidural anaesthesia were recruited. With asepsis precaution, epidural anaesthesia was established in the sitting position using a midline

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approached at L_3L_4 interspace. The epidural space was identified by loss of resistance to saline. The SLESD was read off from the centimetre markings on the needle by subtraction of the length of the needle outside from the whole length and rounded off to the nearest 0.25 cm. Pearson correlation coefficient was used to determine the relationship between SLESD and age, height, weight, body mass index (BMI) and the differences between males and females.

Results: The mean SLESD was 5.29 cm ± 0.06 ranging from 4 cm to 7 cm. Females had a slightly longer SLESD (5.37 cm) than the males (5.21 cm). The SLESD was significantly influenced by weight and BMI both having a *P* value .000. Height showed a negative correlation which was significant in both males and females with *P* = .01 and .015 respectively. Age had a significant correlation with SLESD only in females increasing with age.

Conclusion: The SLESD in Nigerian Adults is strongly influenced by weight, BMI and height. Age influences SLESD only in females.

Keywords: Distance; epidural space; correlation; physical characteristics.

1. INTRODUCTION

Lumbar epidural anaesthesia is a central neuraxial block that has varying applications ranging from operative surgeries to pain relief. It is the most widely used route of analgesia for pain relief in labour. It is quite versatile as the duration of analgesia is not limited by the duration of action of the drugs. This is because a catheter can be left in the epidural space thereby offering a durable analgesia through intermittent boluses, continuous infusion or patient control analgesia.

The skin to lumbar epidural space distance (SLESD) has been reported to vary from one ethnic group to another [1]. The distance also varies at different spinal level of the vertebral column of the same individual [2]. When the skin to epidural space distance is less than 4 cm, the risk of accidental dural puncture increases by three fold [3]. Accidental dural puncture with an epidural needle could result in a debilitating post dural puncture headache. Unrecognised dural tap with subarachnoid placement of the epidural catheter may lead to total spinal which in unskilled hands may result in mortality. The incidence of accidental dural puncture after epidural approach has been estimated to vary from 0.19% to 3.6% [4-6]. Once accidental dural puncture occurs, post dural puncture headache develops in more than 50% of these patients, which can cause significant morbidity [7]. The prevention of these complications, can be achieved if an Anaesthetist is able to predict the skin to lumbar epidural space distance. This becomes applicable as the process of identification of the epidural space may be equivocal. The estimation of skin to lumbar epidural space distance as a guide for the prediction of this depth could be useful in reducing accidental dural puncture and its complications.

The aim of the study was to determine the skin to lumbar epidural space distance (SLESD), influence of physical characteristics and the differences between Nigerian adult females and males

2. PATIENTS AND METHODS

The study was carried out at University of Calabar Teaching Hospital which is a tertiary healthcare facility in Nigeria. It was a cross sectional descriptive study carried out on 120 patients divided into two groups; group A consisting of 60 adult males and group B consisting of 60 adult females, enlisted for surgery with planned lumbar epidural anaesthesia. Patient selection was by a non-probability sampling technique, since an average of 20 to 25 lumbar epidural anaesthesia is done in the main surgical theatre respectively in a month. Sample size was calculated using formula for a single sample mean, d^2/e^2 where d is standard deviation of SLESD from a previous study [8] and e is the desired size of standard error of 0.13. Only patients between the ages 18 and 65 years scheduled for elective lower abdominal and lower limb surgical procedures and classified as American Society of Anesthesiologists' (ASA) physical status class I and II were included. Exclusion criteria included patients with lumbar spine deformities or oedema, coagulopathy, sepsis at the site of injection, obstetric patients, Patient's refusal of epidural anaesthesia, those with neurological problems, allergy to bupivacaine and emergency surgical procedures.

An approval for the study was obtained from the Hospital Health Research and Ethics Committee. The procedure of epidural anaesthesia was explained to all patients and written informed consent obtained during the preoperative assessment of the patients. A Preoperative assessment was carried out on all the patients the night before the surgery. The patient's name, hospital number, sex, age, diagnosis, proposed surgery, weight and height were recorded on the study pro forma. The body mass index of each patient was calculated using the formula: Body mass index (BMI) = weight (kg)/ height $(m)^2$. This was also recorded on the study pro forma for each patient. The age, weight, height and BMI were collectively referred to as Physical Characteristics. The patients were instructed to observe the fasting guidelines of six hours for solid food and two hours for clear fluids.

In the theatre, an automated multi-parameter monitor was applied to each patient for pulse oximetry, continuous electrocardiogram (ECG) and non-invasive blood pressure monitoring. The base line vital signs were obtained, and venous access secured with an 18 gauge cannula on the forearm.

The lumbar epidural block was performed on each patient in the sitting position at L3 –L4 interspace using a midline approach under strict asepsis. A 25 gauge needle on the 5 ml syringe with three millilitres (mls) of 1% lidocaine was used to infiltrate the skin and the deeper tissues at L3 – L4. After ensuring analgesia, an 18 gauge, 8 cm long epidural needle with 1 cm marking and a Humber bevel tip with stylet was inserted through the same puncture point at right angle to the skin using the midline approach. The needle was advanced to a depth of 2.5 cm, the stylet was removed and the loss of resistance syringe filled with 5 ml of normal saline was attached to the hub of the epidural needle. Using the thumb of the injecting hand, a continuous pressure was exerted on the plunger while advancing the needle until loss of resistance was experienced.

The loss of resistance syringe was removed and the skin to epidural space distance was noted from the markings on the epidural needle. The skin to lumbar epidural space distance was determine by subtraction of the length of the needle outside from the whole length. The distance was rounded up to the nearest 0.25 cm as in a previous study [9] and the result was recorded on the study pro forma.

The epidural catheter was threaded into the epidural space up to a 5 cm length and correct placement was confirmed with 3 ml of 1.5% lidocaine with adrenaline (1:200,000). Patients were managed appropriately for the procedure till end of surgery.

2.1 Data Analysis

The Pearson Correlation coefficient (r) was used to test the correlation between skin to lumbar epidural space distance (SLESD) and patient's height, age, weight, body mass index (BMI) and the differences of these parameters between males and females. A P value of 0.05 was taken as significant. Statistical analysis was done with SPSS version 14 statistical package.

3. RESULTS

One hundred and twenty patients, scheduled for various surgical procedures, who had epidural anaesthesia, were recruited into the study. Sixty of the study participants were males while the other half (60) were females. The epidural space was identified in all the patients without difficulty. There was no accidental dural puncture. The mean age of the participants was 38.01 ± 11.80 years; the mean weight of participants was 71.58 ± 11.48 Kg; the overall mean height was 1.68 ± 0.06 metres and the mean BMI was 25.30 ± 3.81 kg/m^2 and the mean skin to lumbar epidural space distance was 5.29 ± 0.06 cm (Table 1).

Table 2 shows that there was significant correlation between the patients' weight, age, BMI and skin to lumbar epidural space distance with a *P value of .000, .001, and .000 f*or weight, age and BMI respectively. The height showed a negative correlation which implies that taller subjects had shorter SLESD however it was not statistically significant (*P = .548*).

Table 1. Summary of all the patients physical characteristics

Physical characteristic	Mean ± (SD)	Range
Age (years)	38.01± 11. 08	18 – 63
Weight (kg)	71.58 ± 11.48	36 – 110
Height (m)	1.68 ± 0.06	1.5 – 1.81
BMI (Kg/m^2)	25.30 ± 3.81	17.96 – 36.45
SLESD (cm)	5.29 ± 0.06	4.0 – 7.0

Table 3 shows that only the height was significantly different between the males and

females. Other measured variables were not statistically different.

Table 4 shows that there was a significant positive correlation between the skin to lumbar epidural space distance and weight, BMI but height showed a negative correlation in both males and females. Age on the other hand showed a significant positive correlation only in the females with the SLESD.

Table 2. Correlation between physical characteristics and SLESD for all the patients

Physical characteristics	Correlation values	Significance
Age (Yrs)	0.295	.001
Weight (kg)	0.525	.000
Height (m)	- 0.055	.548
BMI	0.568	.000

4. DISCUSSION

The epidural space exist as a real space containing fat and connective tissue. However in clinical practice it exists as a "potential space" reflecting not only the minimal contents of the space, but also its capacity to expand and to accommodate large volumes of injected fluids.

The skin to epidural space distance demonstrates both interpatient and intra-patient variation, with the latter at different levels of the spinal column [2,10,11]. In the lumbar region, Harrison et al. [10] reported that the distance is greatest at the third interspace. The distance from the skin to the epidural space also varies depending on the body habitus [2].

This study was designed to determine the relationship between skin to lumbar epidural space distance measured by loss of resistance technique and the patients age, sex, weight, height and body mass index in adult Nigerians undergoing different elective surgical procedures done under lumbar epidural anaesthesia.

The epidural space was identified in all the patients without difficulty. There was no accidental dural puncture. This could be because the skin to epidural space distance was not less than 4 cm. Sutton et al. [2] reported that when the skin to epidural space distance is less than 4 cm, the risk of accidental dural puncture increases by three fold. The mean skin to epidural distance in this study was 5.29±0.06 with a range of 4 -7 cm. This is longer than 4.98 +/- 0.95 reported by Stamatakis et al. [9] in the Greek adult population. Adachi et al. [2] in a retrospective study of elderly and obese patients in Japan reported a mean distance of 4.1± 0.9 cm in the lumbar region [2]. Similarly Cha et al. [12] reported a distance of 4.6 +/- 0.69 cm among Korean adults [12]. The longer distance of SLESD in this study could indicate that Nigerian adults may have tendency of having more truncal subcutaneous adipose tissue though with a mean BMI of 25.3 kg/m^2 (range 17.96 – 36.45). In a study by Eastwood et al. [13] on ethnic differences in body fat deposition, they reported that African Caribbeans living in London had more abdominal and lower body subcutaneous adipose tissue when compare to Europeans. In a retrospective study in obstetric patients in America, D'Alonzo and colleagues reported a much longer distance of 6.3 +/ - 1.6 cm in African Americans parturient than all other ethnic groups studied which included Asians, Caucasian, Hispanic and others [1]. In Sharma et al. [14] study, though also in obstetric patients, a greater SLESD was reported in blacks (6.0) with a BMI of 26.9 than the Asians (5.0) and Chinese (4.8). These distances were significantly and positively correlated with the weight and body mass index. This implies that with increase in weight and body mass index, the SLESD also increases. This is similar to findings in this study in that there was a significant positive correlation between SLESD with weight and body mass index having a P value of 0.000 for both. Some other authors have also reported a good correlation between SLESD with weight and BMI [9,15]. Others had a significant correlation with weight [2,11,16,17], BMI only [1,12] or weight and ponderal index [18,19]. In both the body mass index and ponderal index, height is an independent variable which remains relatively constant in adults while the body weight varies. This could be the reason why the authors that had positive correlation between SLESD and weight also had with body mass index or ponderal index [9,16,18,19].

Height had a weak negative correlation of 0.055 with SLESD in the general study group which was not statistically significant *(P =.55*). This is similar to the report of Sutrisno et al. [15] in Indonesian patients with a correlation value of 0.04 and a *P* value of <0.8. On the contrary Shiroyama et al. [20] found a significant correlation between SLESD and height among Japanese obstetric patients. The difference might be that the study group was female patients. However, in the sex stratification analysis in this

Table 3. Comparison of physical characteristics between males and females

Physical characteristics	Males ± SD (Range)	Females ± SD (Range)	P value
Age (years)	38.35±12.46 (18 – 63)	37.77±11.20 (20 - 63)	.188
Weight (kg)	72.68±12.61 (50 – 110)	70.47±10.21 (36 – 91)	.058
Height (m)	1.70±0.06 (1.50 – 1.80)	1.66±0.06 (1.50 – 1.81)	.021
BMI (Kg/m^2)	25.03±3.95 (18.40- 34.89)	25.57±3.68 (17.96 – 36.45)	.827
SLED (cm)	5.21±0.05 (4.25- 6.0)	5.37±0.65 (4.0 – 7.0)	.330

study, (Table 4) height hand a significant negative correlation with SLESD in both males and females (*P= .01, .015*). This negative correlation could imply that taller individuals had shorter SLESD which is contrary to positive correlation found by other authors [9,14,15].

Table 4. Sex stratified correlation of skin to lumbar epidural space distance and physical characteristics

Physical characteristics	Males (*P*)	Females (*P*)
Age (years)	0.193(*.14*)	0.407(*.001*)
Weight (kg)	0.604(*.000*)	0.505(*.000*)
Height (m)	-0.330(*.01*)	-0.312(*.015*)
BMI (Kg/m^2)	0.503(*.000*)	0.629(*.000*)

Age showed a significant correlation with SLESD in females but not in males. The SLESD in females tended to increase with increasing age. This was a similar finding with Matsumoto et al. [21] and Adachi et al. [2] in Japanese adult patients. Stamatakis et al. [9] in a study of Greek population also reported a moderate correlation of age with SLESD.

The SLESD was longer in females than the males though it was not statistically significant *(P= .13)*. This is in line with Eastwood et al. [13] findings that African Caribbean women had more lower body subcutaneous adipose tissue than their men. On the contrary Stamatakis et al. [9] in Greek population and Matsumoto in Japanese population reported a longer SLESD in males than females [21].

5. LIMITATIONS OF THE STUDY

The use of anatomical landmarks for the identification of L3 – L4 interspace may not always be correct. However, all attempts were made to introduce the Touhy needle perpendicularly to the skin but sometimes, the angle of insertion needed to be slightly altered. This may slightly overestimate the length.

6. CONCLUSION

The SLESD in Nigerian adult females is longer than that of the males. The SLESD is strongly influenced by BMI and weight. Height, though significant, showed a negative correlation with SLESD implying that taller individuals had shorter SLESD. These finding though could be taken as a guideline but should not be used as a criterion for careless advancement of epidural needle as epidural space could be nearer the surface than predicted especially in tall individuals. As such, initial insertion of the Tuohy needle when performing an epidural block should not go beyond 2.5 cm before the attachment of the loss of resistance syringe.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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