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Original Article

Correlation of skin to lumbar epidural depth with demographic and anthropometric factors: A hospital based cross-sectional study

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Abstract:

Background: Epidural catheter placement is difficult techniques to acquire, with a success rate <60% at first attempt, and an overall success rate of nearly 90%. Availability of advanced techniques at low resource, high load settings is seldom possible making it no less than a blind technique. Hence thorough knowledge of influencing factors and ability to predict depth becomes an essential skill for an anesthetist.

Objective: To study correlation of skin to lumbar epidural depth with demographic and anthropometric factors

Methods: Hospital based cross-sectional study was carried among 40 cases posted for elective surgeries requiring lumbar epidural anesthesia. Age, sex, height, weight, Body mass index (BMI) were recorded. After ensuring correct position of needle by loss of resistance to air and hanging drop method, epidural catheter was threaded leaving nearly 6cm inside epidural space. Depth at which epidural space achieved was calculated by calculating length between skin and end of needle at hub and in turn subtracting it from 8cm.

Results: There was significant correlation between weight, BMI and epidural depth. Age, sex and height were not correlated.From multiple linear regression model it can be stated that sex and weight significantly predicted epidural depth. With increase in 1kg body weight, the epidural depth increased by 0.036cm. Males have on an average 0.361cm more depth compared to females.

Conclusion: Skin to epidural depth depends on weight and sex. Formula derived also helps to roughly determine depth and achieve successful placement of catheter in fewer attempts.

Key words: correlation, epidural depth, spinal anesthesia, anthropometry

INTRODUCTION:

Epidural anesthesia is a form of neuraxial anesthesia that is slower in onset and less profound, safer modality and gives scope for prolongation when compared to intrathecal analgesia. The goal for anesthetists using the epidural technique is to gain access to the epidural space to place the needle and catheter with as few attempts as possible in order to minimize patients' discomfort. [1]

Epidural catheter placement is thought to be among the most difficult techniques to acquire, with a success rate of as low as 60% at the first attempt, and an overall success rate of nearly 90%.[2]In order to locate the exact epidural space many methods have been tried. Most of them talk about the point where loss of resistance is felt in the epidural space. For this,

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syringe filled with saline or air is used. But, finally success depends upon the definitive location of the epidural space. [3]

Spinal anesthesia is the anesthesia of choice for most of the lower abdominal and lower limb surgeries. Naïve anesthetist may find it difficult to locate the exact the epidural space. It also is a challenge in those patients with either overweight/obese or underweight/very thin patients. In this situation, to reduce the complications associated with spinal anesthesia, a beforehand knowledge on what could be the estimated epidural space may be helps. [4] In the absence of such knowledge and under adverse conditions, there may several attempts to introduce the needle into the subarachnoid space. It causes severe dissatisfaction and discomfort to the patients. It may also increase the chances of epidural hematoma [5], neurological damage [6], and post-punctural headaches. [7]

Availability of advanced techniques at low resource, high load settings is seldom possible making it no less than a blind technique. Hence a thorough knowledge of the influencing factors and the ability to predict the depth becomes an essential skill needed to be acquired by an Anesthetist.In this study, we assessed the demographic and anthropometric factors influencing the skin to lumbar epidural depth.

MATERIAL AND METHODS:

A hospital based cross-sectional study was carried out at Department of Anesthesiology, Malla Reddy Institute of Medical Science, Hyderabad from January 2023 to May2023.

Institutional Ethics Committee permission was obtained. Written informed consent was taken from all eligible study participants.

Razavizadeh M et al [8] reported a strong correlation between body mass index (BMI) and depth of needle insertion (r = 0.95). We have taken this value for calculation of sample size in the present study. We took 95% confidence level and 80% power and using the following formula[9] the sample size came out to be 5.

Total sample size = $N = [(Z_\alpha + Z_\beta)/ C]^2 + 3 = 5$

But, we included 40 cases as per the eligibility criteria of the study during the study period.

Patients aged 18-70 years of either gender falling under American Society of Anesthesiologists (ASA) grade I and II posted for elective surgeries requiring lumbar epidural anesthesia having normal electrocardiogram (ECG) were included in the present study. Those undergoing emergency procedures and with co-morbidities were excluded from the present study.

Age and sex were recorded. The age was confirmed using the appropriate Government identification card produced by the patients. Height was measured with the help of a stadiometer nearest to the 1cm asking the patient to stand straight without any footwear, look straight forward. Standardized electronic weighing machine was used to record the weight to the nearest 0.1 kg. The weighing machine was kept on a flat surface and zero was ensured. Patient was asked to stand on the weighing machine with minimal clothing, without any additional material in the pocket and without footwear. Height and weight were thus recorded as per the standard guidelines laid down by World Health Organization. [10] Body mass index (BMI) was calculated as per the standard formula using weight in kg divided by height in meter square.

On arrival to operative room, standard monitor was connected to all patients which included, pulse oximeter, electrocardiography, and noninvasive arterial blood pressure. After securing

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I.V. cannula (18 G/20 G) in the upper limb, intravenous fluids were given at a volume of 5 mL/kg. All patients were given epidural anesthesia in sitting/ lateral position. 18G Tuohy needle (length of needle 8 cm) was inserted by midline approach into L2-L3 or L3-L4 interspace. After ensuring the correct position of the needle by loss of resistance to air and hanging drop method, epidural catheter was threaded leaving nearly 6 cm inside the epidural space. Depth at which the epidural space achieved was calculated by calculating the length between the skin and end of the needle at hub and in turn subtracting it from 8 cm. Test dose of 3ml of 2% Lignocaine with Adrenaline was injected after negative aspirate to ensure appropriate placement of the catheter. Based on the need the case was then managed under sole epidural or spinal anesthesia.

The data was entered in the Microsoft excel sheet. There was no missing data in the present study. Formula for BMI was entered to auto-calculate it. Later it was exported to SPPS statistical software version 21. Correlation between epidural space and age, sex, height, weight and BMI was carried out. All the factors were then entered in the multiple linear regression model to obtain the prediction equation for epidural space.

RESULTS:

The age ranged from 20-79 years with a mean of 49.9$\pm$13.5 years. The height ranged from 120-177 cm with a mean of 158.2$\pm$11.1 cm. The weight ranged from 40-87 kg with a mean of 61.4$\pm$11.7 kg. The BMI (kg/m^2) ranged from 14.5-48.6 with a mean of 24.8$\pm$6.1. Males and females were almost equal in number. There was a significant positive correlation between weight and epidural depth as well as between body mass index and epidural depth. Age, sex and height were not found to be correlated with the epidural depth. (Table 1)

First height was also included in the model. But, due to that there was high multi-collinearity as shown by variance inflation factor (VIF). Hence, it was removed from the final model. 68.7% of the variation in the model was explained by the variables (r^2 = 0.687). From the model it can be stated that sex and weight significantly predicted the epidural depth. With increase in one kg body weight, the epidural depth increased by 0.036 cm. The males have on an average 0.361 cm more depth compared to females. Age and BMI were not found to be significantly related with epidural depth. The Prediction equation was given as follows from the model. (Table 2)

epidural depth = 0.592 + 0.011(age) + 0.361(sex) + 0.036(weight) + 0.020 (BMI)

DISCUSSION:

Usually spinal anesthesia seems to be straightforward. But, sometimes it can be tricky in those with overweight/obese cases or very thin patients. The younger anesthetists usually find it difficult to perform. Therefore, availability of any prediction equation for the epidural depth can help perform the procedure for those with relatively lesser experience.

There are many studies carried out on similar theme but most of them are from other countries. Hence, comparison with those studies can pose problems as the body built is different for Indians compared to their Western counterpart. In the present discussion we would like to highlight these ethnic differences mentioning the place of study. At the same time, we will also compare the results with available Indian studies.

Present study was conducted in non-pregnant adults of age 18-70 years. Hence, comparison with those studies having performed surgeries in obstetrics cases is avoided here. Craig F et

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al [11] carried out a study in children of age 0.01-16 years in London and found that height was linearly correlated with the depth of the needle. But, obviously as the present study was among adults, we did not find any correlation between height and epidural depth. In a study from Iran [8] conducted among adults, the authors found an inverse relationship with the height but it was not found to be statistically significant. We did not report any inverse relation but the correlation was not statistically significant. Abe KK et al [12] had patients in the age group of 25 days to 80 years. They used Computed Tomography (CT) scans to assess the depth in 175 cases. We cannot compare results with this study as the age group variation is very wide and we did not use the CT scan but rather we used the anthropometric and demographic profiles. This is because, we wanted to give prediction equation for low resource settings.

We found on that weight and BMI were significantly correlated with the epidural depth. Whereas on multiple linear regression, BMI was not significantly predicting the epidural depth. In the final model, the weight and sex were found to be significant predictors. The final model prediction was given after controlling for other three factors. Hence, it is more valid and at the same time, the r^2 value of the model was also very high i.e. 0.687.

In study conducted by Ravi KK et al[13] 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. These findings are similar to the present study findings. This is an Indian study conducted among non-pregnant adults of age 18-70 years. Hence, findings of the present study are strengthened by this comparison with the very similar study as there are no ethnic differences and the age group also similar. But, in their particular study, the authors did not use the correlation coefficient and multiple linear regression to give unbiased predictive equation.

Fati PN et al [14] studied 274 patients aged 18-70 years who underwent surgery under spinal anesthesia in Ethiopia. The mean height, weight reported by them was more compared to what we found. They observed that the mean distance from skin to subarachnoid space was 5.13 ± 0.69 which was much more compared to present study finding of 3.9 ± 0.7. These differences are due to ethnic population differences. However, they also found that weight and BMI were significantly associated with subarachnoid depth in which we found that weight was significantly associated while BMI was not.

There are certain strengths and limitations of the present study. The use of correlation coefficient and multiple linear regression gives unbiased results. The confounding bias is taken care of. Few studies are available in India on this particular important anesthesia related topic and hence this study is important. The sample size was also calculated taking into account the use of correlation in the analysis and objectives. But, this study has small sample size of only 40 and carried out in a single center. Hence, further studies with adequate sample size are required in Indian set-up. The study was conducted among non-pregnant adults, hence findings of the study can be applied to pediatric and pregnant population.

CONCLUSION

We conclude that the skin to epidural depth depends on weight and sex. The formula then derived also helps to roughly determine the depth and achieve successful placement of the catheter in fewer attempts in non-pregnant adults undergoing lower abdominal and lower

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limb surgeries that requires spinal anesthesia. Weight, sex and BMI should be taken into consideration before giving spinal anesthesia.

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ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

Tables:

Table 1: Distribution of study subjects as per studied characteristics and correlation with epidural depth

Characteristics	Range	Mean±SD	Pearson Correlation	Sig. (2-tailed)
Age (years)	20-79	49.9±13.5	0.166	0.306
Height (cm)	120-177	158.2±11.1	0.075	0.646
Weight (kg)	40-87	61.4±11.7	0.749	0.000
Body mass index (kg/m^2)	14.5-48.6	24.8±6.1	0.591	0.000
Epidural depth	2.5-5.5	53.9±0.7	1	--
		Number(%)		
Sex	Male	21 (52.5%)	0.305	0.056
	Female	19 (47.5%)		

Table 2: Multiple linear regression model for predicting epidural depth

	Unstandardized Coefficients				95.0% Confidence Interval for B		Collinearity Statistics
	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	VIF (variance inflation factor)
(Constant)	.592	.428	1.385	.175	-.276	1.461	
Age	.011	.005	2.232	.032	.001	.020	1.006
Sex	**.361**	**.126**	**2.876**	**.007**	**.106**	**.617**	1.008
Weight	**.036**	**.008**	**4.690**	**.000**	**.020**	**.051**	1.955
BMI	.020	.015	1.326	.193	-.010	.050	1.955