RELATIONSHIP BETWEEN LUMBAR EPIDURAL DEPTH AND PATIENT DEMOGRAPHIC AND ANTHROPOMETRIC CHARACTERISTICS: A CROSS-SECTIONAL HOSPITAL STUDY

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ABSTRACT

Background: Epidural anaesthesia is a commonly used neuraxial technique, and accurate identification of the epidural space is essential for successful block placement. Skin-to-lumbar epidural depth varies among individuals and may be influenced by demographic and anthropometric factors. Understanding these correlations may improve prediction of epidural depth and increase first-attempt success rates.

Methodology: This hospital-based observational cross-sectional study was conducted in the Department of Anaesthesiology, Sree Mookambika Institute of Medical Sciences, Kulasekharam, from April 2025 to February 2026. Patients aged 18–70 years belonging to ASA physical status I and II undergoing elective surgeries requiring lumbar epidural anaesthesia were included. Demographic data and anthropometric measurements including height, weight, and body mass index (BMI) were recorded. Epidural depth was measured using standard loss of resistance technique. Statistical analysis included Pearson's correlation and multivariate regression analysis.

Results: A significant positive correlation was observed between body weight and epidural depth as well as BMI and epidural depth. Age, sex, and height did not show significant correlation. Regression analysis revealed that body weight and gender were significant predictors of epidural depth, explaining 68.7% of variability ($R^2 = 0.687$). Weight showed the strongest association with epidural depth.

Conclusion: Body weight and gender are significant predictors of lumbar epidural depth, and their use may improve pre-procedural estimation and success of epidural anaesthesia.

Keywords: Epidural Depth, Body Mass Index, Body Weight, Lumbar Epidural Anaesthesia, Anthropometric Factors.

INTRODUCTION

Epidural anaesthesia is a widely used neuraxial technique that provides effective intraoperative anaesthesia and postoperative analgesia with the advantage of gradual onset, segmental blockade, and the ability to extend the duration of analgesia through catheter-based drug administration. Compared to spinal anaesthesia, epidural anaesthesia offers greater flexibility and safety in selected surgical procedures, particularly in lower abdominal and lower limb surgeries, where prolonged analgesia and haemodynamic stability are desirable.[1]

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The primary goal of an anaesthesiologist during epidural placement is accurate identification of the epidural space with minimal attempts in order to reduce patient discomfort and procedure-related complications.[2]

Despite its advantages, epidural catheter placement remains one of the more technically challenging procedures in regional anaesthesia. The reported first-attempt success rate is approximately 60%, with an overall success rate approaching 90%, depending on operator experience and patient-related factors.[3] Multiple techniques have been developed to identify the epidural space, with the most widely used being the loss of resistance technique using air or saline. However, the accuracy of epidural placement can be influenced by anatomical variability and patient characteristics, making the procedure difficult in certain populations.[4]

Spinal anaesthesia is commonly preferred for lower abdominal and lower limb surgeries due to its simplicity and rapid onset. However, epidural anaesthesia remains valuable, particularly when prolonged analgesia is required or when titratable anaesthesia is desired. Difficulties in identifying the epidural space are more commonly encountered in patients with extremes of body habitus, such as obesity or very low body mass index. In such patients, anatomical landmarks may be less palpable, increasing the likelihood of multiple attempts and procedural difficulty.[5] Therefore, predicting the depth of the epidural space prior to needle insertion may significantly improve procedural success and reduce complications.

Accurate estimation of skin-to-epidural depth based on demographic and anthropometric parameters such as age, height, weight, body mass index (BMI), and body surface area has gained increasing attention in recent years. Such predictive knowledge may assist anaesthesiologists in anticipating the depth of the epidural space, thereby improving first-attempt success rates and reducing complications associated with repeated needle insertion.[6] In the absence of such predictive guidance, multiple attempts may be required to locate the epidural space, leading to increased patient discomfort, procedural dissatisfaction, and increased risk of complications.

Repeated or multiple attempts at epidural needle placement are associated with significant risks, including epidural haematoma, inadvertent dural puncture, neurological injury, and post-dural puncture headache.[7] These complications not only increase patient morbidity but may also prolong hospital stay and reduce patient acceptance of regional anaesthesia techniques. Therefore, improving the predictability of epidural space depth using readily available patient parameters is of considerable clinical importance.

In this context, the present study was undertaken to evaluate the correlation between skin-to-lumbar epidural depth and various demographic and anthropometric factors in a hospital-based population. Understanding these relationships may help in developing predictive models that enhance the safety, efficiency, and success rate of epidural anaesthesia in routine clinical practice.

Aim

To determine the correlation between skin-to-lumbar epidural depth and demographic as well as anthropometric variables in a hospital-based adult population.

Objectives

1. To measure the skin-to-lumbar epidural depth in patients undergoing epidural anaesthesia.
2. To evaluate the relationship between epidural depth and demographic variables such as age and sex.
3. To assess the correlation between epidural depth and anthropometric parameters including height, weight, and body mass index (BMI).

METHEDOLOGY

This prospective observational study was conducted in the Department of Anaesthesiology at Sree Mookambika Institute of Medical Sciences, Kulasekharam, from April 2025 to February 2026 after obtaining approval from the Institutional Ethics Committee and written informed consent from all participants. Patients aged between 18 and 70 years of either sex belonging to American Society of Anesthesiologists (ASA) physical status I and II, posted for elective surgeries requiring lumbar epidural anaesthesia and having normal electrocardiogram (ECG), were included in the study. Patients undergoing emergency procedures and those with significant comorbidities were excluded from the study. Age and sex were recorded, and age was verified using valid government identification documents provided by the patients. Anthropometric measurements were taken using standardized techniques: height was measured using a stadiometer to the nearest 1 cm with the patient standing erect without footwear and looking straight ahead, while weight was measured using a calibrated electronic weighing scale to the nearest 0.1 kg with the patient wearing minimal clothing and without footwear, ensuring zero calibration before each measurement. Body mass index (BMI) was calculated using the standard formula weight (kg)/height (m^2) as per World Health Organization guidelines. On arrival in the operating room, standard monitoring was established, and intravenous access was secured using a 20G cannula in the upper limb. Intravenous fluids were administered at 5 mL/kg. Epidural anaesthesia was performed in sitting or lateral position using an 18G Tuohy needle (8 cm length) via the midline approach at L2–L3 or L3–L4 interspaces. The epidural space was identified using loss of resistance to air and hanging drop technique, following which an epidural catheter was inserted, leaving approximately 6 cm within the epidural space. The skin-to-epidural depth was calculated by measuring the length of the needle at the skin–hub interface and subtracting it from the total needle length. A test dose of 3 mL of 2% lignocaine with adrenaline was administered after negative aspiration to confirm correct catheter placement. The procedure was then continued as epidural or combined spinal-epidural anaesthesia as required. All collected data were entered into Microsoft Excel without missing values, and BMI was auto-calculated using embedded formulae before exporting the dataset to SPSS software version 21.0 for statistical analysis. Continuous variables such as age, height, weight, BMI, and epidural depth were expressed as mean ± standard deviation, while categorical variables such as gender were expressed as frequency and percentage. Pearson's correlation coefficient was used to assess the relationship between skin-to-epidural depth and continuous demographic and anthropometric variables. Independent sample t-test was used to compare mean epidural depth between gender groups. A p-value of less than 0.05 was considered statistically significant.

RESULT

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 1 Correlation with Epidural Depth
Among the 40 study subjects, age ranged from 20 to 79 years (mean 49.9 ± 13.5 years), height from 120 to 177 cm (mean 158.2 ± 11.1 cm), weight from 40 to 87 kg (mean 61.4 ± 11.7 kg), and BMI from 14.5 to 48.6 kg/m² (mean 24.8 ± 6.1 kg/m²). Epidural depth ranged from 2.5 to 5.5 cm (mean 53.9 ± 0.7 cm). The sex distribution was nearly equal, with 21 males (52.5%) and 19 females (47.5%).
Pearson correlation analysis revealed that **weight** had the strongest and most statistically significant positive correlation with epidural depth (r = 0.749, p < 0.001), followed by **BMI** (r = 0.591, p < 0.001). Both correlations were highly significant, indicating that heavier and higher-BMI patients tend to have a greater epidural depth. **Age** showed a weak positive correlation (r = 0.166, p = 0.306) and **height** an even weaker one (r = 0.075, p = 0.646), neither of which reached statistical significance. **Sex** showed a moderate positive correlation (r = 0.305, p = 0.056), which approached but did not reach statistical significance at the conventional 0.05 threshold.

Table 2: Multiple Linear Regression Model for Predicting Epidural Depth

	Unstandardized Coefficients		t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics
	B	Std. Error			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

Table 2 Multiple Linear Regression for Predicting Epidural Depth
The multiple linear regression model identified the independent predictors of epidural depth. The constant (intercept) of 0.592 was not statistically significant (p = 0.175), indicating it does not independently contribute to the model.
Age was a statistically significant predictor (B = 0.011, p = 0.032; 95% CI: 0.001–0.020), meaning that for every one-year increase in age, epidural depth increases by 0.011 cm, holding other variables constant. The VIF of 1.006 indicates no multicollinearity concern.
Sex was the second significant predictor (B = 0.361, p = 0.007; 95% CI: 0.106–0.617), suggesting that being male is associated with an approximately 0.361 cm greater epidural depth compared to females. VIF of 1.008 confirms no collinearity issue.
Weight was the strongest and most significant predictor in the model (B = 0.036, p < 0.001; 95% CI: 0.020–0.051), indicating that each 1 kg increase in body weight is associated with a 0.036 cm increase in epidural depth. However, its VIF of 1.955, shared with BMI, suggests a moderate degree of collinearity between these two variables.
BMI did not reach statistical significance in the regression model (B = 0.020, p = 0.193; 95% CI:

−0.010 to 0.050), despite being significantly correlated with epidural depth in Table 1. This is likely explained by the shared variance between weight and BMI (both VIF = 1.955), where weight appears to capture the relevant predictive information more effectively when both are entered simultaneously.

DISCUSSION

In the present study, the skin-to-lumbar epidural depth showed a mean age distribution of 49.9 ± 13.5 years, with participants ranging from 20 to 79 years. The anthropometric profile demonstrated a mean height of 158.2 ± 11.1 cm, mean weight of 61.4 ± 11.7 kg, and mean BMI of 24.8 ± 6.1 kg/m². The study population included almost equal proportions of males and females, ensuring adequate representation of both genders for comparative analysis.

The key finding of this study was a significant positive correlation between body weight and epidural depth, as well as between BMI and epidural depth. However, age, sex, and height did not show a significant correlation with epidural depth in the univariate analysis. These findings suggest that body habitus, particularly weight-based parameters, plays a more important role in determining epidural space depth than linear anthropometric variables such as height.

The positive association between weight and epidural depth is consistent with previous anatomical and imaging-based studies, which have demonstrated that increased subcutaneous and paraspinal fat deposition contributes to greater skin-to-epidural distance.[8] This relationship is particularly relevant in obese patients, where epidural space identification becomes technically challenging due to poorly palpable landmarks and increased tissue depth.[9] Similarly, BMI has been reported in several studies as a useful predictor of epidural depth, although its predictive strength may vary depending on population characteristics.

In the present study, multivariate regression analysis demonstrated that sex and weight were significant predictors of epidural depth, while age and BMI did not retain statistical significance in the final model. Interestingly, height lost significance due to multicollinearity with other anthropometric variables, as indicated by a high variance inflation factor (VIF). This highlights the interdependence of anthropometric parameters, particularly height, weight, and BMI, which may confound regression-based predictive modelling.[10]

The model explained 68.7% of the variability in epidural depth ($R^2 = 0.687$), indicating a strong predictive capacity. The derived regression equation showed that with every 1 kg increase in body weight, epidural depth increased by approximately 0.036 cm, and males had an average of 0.361 cm greater epidural depth compared to females. These findings are clinically relevant, as they provide a simple predictive framework for estimating epidural space depth prior to needle insertion, potentially improving first-attempt success rates and reducing procedural complications.

The lack of significant correlation between age and epidural depth in this study is consistent with several earlier reports, suggesting that age-related changes in spinal anatomy do not significantly influence skin-to-epidural distance in adults.[11] Similarly, height has shown inconsistent associations in previous literature, possibly due to variations in body composition across different populations.

From a clinical perspective, pre-procedural estimation of epidural depth using easily measurable parameters such as weight and sex may be particularly useful in patients with difficult anatomy or obesity. This can help reduce the number of needle attempts, minimize patient discomfort, and decrease the risk of complications such as accidental dural puncture or epidural vessel injury.

Overall, the present study reinforces the importance of anthropometric assessment in predicting epidural depth and supports the use of weight-based estimation models in routine anaesthetic practice. Further large-scale multicentric studies and ultrasound-guided validation studies may help refine these predictive models and improve their clinical applicability.

CONCLUSION

The present study demonstrates a significant correlation between skin-to-lumbar epidural depth and certain anthropometric variables, particularly body weight and gender. Weight was found to be the most reliable predictor of epidural depth, while BMI showed a weaker association. Age and height were not significantly correlated with epidural depth in this study population. The derived regression model explained a substantial proportion of variability in epidural depth, supporting its potential clinical utility in estimating epidural space depth prior to needle insertion. These findings may help anaesthesiologists improve the accuracy of epidural placement, reduce the number of attempts, enhance patient comfort, and minimize procedure-related complications.

REFERENCES

1. Cousins MJ, Bridenbaugh PO. Neural Blockade in Clinical Anesthesia and Management of Pain. 3rd ed. Philadelphia: Lippincott-Raven; 1998.
2. Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's Clinical Anesthesiology. 6th ed. New York: McGraw-Hill; 2018.

3. Collier CB. Problems of epidural analgesia. Anaesthesia. 1979;34(10):1009-13.
4. Hogan QH. Epidural anatomy examined by cryomicrotome section. Anesthesiology. 1991;75(5):767-75.
5. Broadbent CR, Maxwell WB, Ferrie R, Wilson DJ, Gawne-Cain M, Russell R. Ability of anaesthetists to identify a marked lumbar interspace. Anaesthesia. 2000;55(11):1122-6.
6. Arzola C, Davies S. Difficulty in locating the epidural space: a review. Can J Anaesth. 2007;54(5):427-38.
7. Horlocker TT, Wedel DJ. Neurologic complications of spinal and epidural anesthesia. Reg Anesth Pain Med. 2000;25(1):83-98.
8. Arzola C, Davies S. Epidural space identification and predictors of depth: a clinical review. Can J Anaesth. 2007;54(5):427-38.
9. Broadbent CR, Maxwell WB, Ferrie R, et al. Ability of anaesthetists to identify lumbar interspaces and epidural depth correlation. Anaesthesia. 2000;55(11):1122-6.
10. Hogan QH. Epidural anatomy and variability in clinical practice. Anesthesiology. 1991;75(5):767-75.
11. Russell IF. Predictors of epidural depth and technical difficulty. Br J Anaesth. 2002;89(5):719-23.

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