The Distance from the Skin to the Epidural Space

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To determine whether there is any systemic relationship between the distance from the skin to the epidural space and physical constitution, the distance from the skin to the epidural space was measured in 1007 epidural punctures. The distance from the skin to the epidural space in male was greater than that in female ($P<0.001$). However, the analysis of the distance from the skin to the epidural space of the selected patients who had both a weight of 50–60 kg and a height of 1.5–1.7 m indicated no statistical difference between male and female. The best correlation was found 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. Ninety-five percent of the patients who received epidural puncture at the thoraco-cervical area (C7-T2) had a distance to the epidural space of 4.0–6.9 cm; 87% at the lower-thoracic area (T8-T10), 4.0–6.9 cm; 93 % at the thoraco-lumbar area (T12-L2), 3.0–4.9 cm; 85% at the mid-lumbar area (L2-L4), 3.0–4.9 cm. These results may be useful for young anesthesiologists to master epidural block safely and efficiently. (Key words: distance to the epidural space, thoraco-cervical, lower-thoracic, thoraco-lumbar, and mid-lumbar area)

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The distance from the skin to the epidural space varies considerably, both at the different parts of the spine in one individual and at the same part of the spine in different individuals. Obviously, general information about the distance from the skin to the epidural space before insertion of a needle would facilitate successful epidural puncture and should lead to a decrease in the rate of accidental dural puncture. Palmer et al.[1] measured the distance from the skin to the lumbar epidural space in an obstetric population and demonstrated the significant correlation between the distance from the skin to the epidural space and body weight. However, there is no report about the distance from the skin to the epidural space at the other parts of the spine. We studied the distance from the skin to the epidural space at the four levels of the spine.

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Methods

Data were gathered from 1007 epidural punctures performed for a variety of surgical procedures. Patients were placed in the flexed right-lateral position on a horizontal operating table. After subcutaneous infiltration with 2 ml of 1% procaine, a 17-guage Tuohy needle with the bavel pointing

Table 1. The distance from the skin to the epidural space at the four levels of the spine (n=1007) mean±SD (range) cm

	Male	Female	Difference
Thoraco-cervical (C7-T2)	5.7±0.9 (4.1~8.0)	5.2±0.7 (3.6~7.0)	$P<0.001$
Lower-thoracic (T8-T10)	5.2±0.7 (3.9~7.5)	4.6±0.7 (3.0~6.7)	$P<0.001$
Thoraco-lumbar (T12-L2)	4.1±0.6 (2.6~7.0)	3.6±0.5 (2.6~5.0)	$P<0.001$
Mid-lumbar (L2-L4)	4.4±0.6 (3.0~6.0)	4.0±0.7 (2.5~6.0)	$P<0.001$

cephalad was inserted into the epidural space via mid-line approach. The identification of the epidural space was performed with either dripping infusion method[2] or loss of resistance method. The epidural space at the thoraco-cervical area (C7-T1 or T1-T2 interspace) was punctured in 163 patients; the lower-thoracic area (T8-T9 or T9-T10 interspace), in 141; the thoraco-lumbar area (T12-L1 or L1-L2 interspace), in 482; the mid-lumbar area (L2-L3 or L3-L4 interspace), in 221. The distance from the skin to the hub was measured when the tip of the needle was in the epidural space and this distance was substrated from the entire needle length to obtain the distance from the skin surface to the epidural space. All punctures were performed by a anesthesiologist, and measurements were included in the analysis only if epidural blocks were successful. The patient's height and weight were obtained from hospital charts. The body mass index[4] and body surface area were calculated with them.

Data were expressed as mean ± SD and range. The difference between male and female was analyzed by Student's t-test and a value of $P<0.05$ was considered as statistically significant. The relationship between the distance from the skin to the epidural space and physical parameters was evaluated by multiple regression analysis.

Results

The distance from the skin to the epidural space in male was greater than that in female at every part of the spine examined (table 1). The deepest level was found at the thoraco-cervical area (male: 5.7 ± 0.9 cm, female: 5.2 ± 0.7 cm). The shallowest level was found at the thoraco-lumbar area (male: 4.1 ± 0.6 cm, female: 3.6 ± 0.5 cm). The data were also analyzed in a group of the selected patients who had both a weight of 50–60 kg and a height of 1.5–1.7 m (table 2). The distance from the skin to the epidural space did not show any statistical differences between male and female at any part of the spine examined.

Table 2. The distance from the skin to the epidural space at the four levels of the spine in the selected patients who have both a weight of 50–60 kg and a height of 1.5–1.7 m (n=353) mean±SD (range) cm

	Male	Female	Difference
Thoraco-cervical (C7-T2)	5.3±0.7 (4.1~6.9)	5.3±0.7 (4.0~7.0)	NS
Lower-thoracic (T8-T10)	5.0±0.6 (3.9~6.0)	5.0±0.7 (3.9~6.7)	NS
Thoraco-lumbar (T12-L2)	3.8±0.4 (2.6~5.0)	3.7±0.4 (2.8~5.0)	NS
Mid-lumbar (L2-L4)	4.3±0.6 (3.1~5.5)	4.2±0.4 (3.0~5.0)	NS

NS: not significant

The correlation coefficients between the distance from the skin to the epidural space and the physical parameters were showed in table 3. The best correlation was found between the distance from the skin to the epidural space and body weight. The correlation coefficient at the thoraco-cervical area in male and at the mid-lumbar area in female was 0.63 and 0.65, respectively. The correlation between the distance from the skin to the epidural space and height was less striking.

The distribution of the distance from the skin to the epidural space at the four levels of the spine was showed in figure 1. Ninety-five percent of the patients who received epidural puncture at the thoraco-cervical area (C7-T2) had a distance to the

Table 3. The correlation coefficients between distance from the skin to the epidural space and physical parameters

	Male				Female			
	BW	HT	BMI	BSA	BW	HT	BMI	BSA
Thoraco-cervical (C7-T2)	0.63***	0.28	0.58***	0.59***	0.35***	−0.05	0.37***	0.26**
Lower-thoracic (T8-T10)	0.42***	0.24*	0.34*	0.40***	0.39***	0.29*	0.30*	0.40***
Thoraco-lumbar (T12-L2)	0.50***	0.004	0.56***	0.50***	0.58***	0.10	0.39***	0.48***
Mid-lumbar (L2-L4)	0.53***	0.23**	0.50***	0.49***	0.65***	0.22*	0.64***	0.59***

*: $P<0.05$, **: $P<0.01$, ***: $P<0.001$

BW: body weight, HT: height, BMI: body mass index, BSA: body surface area

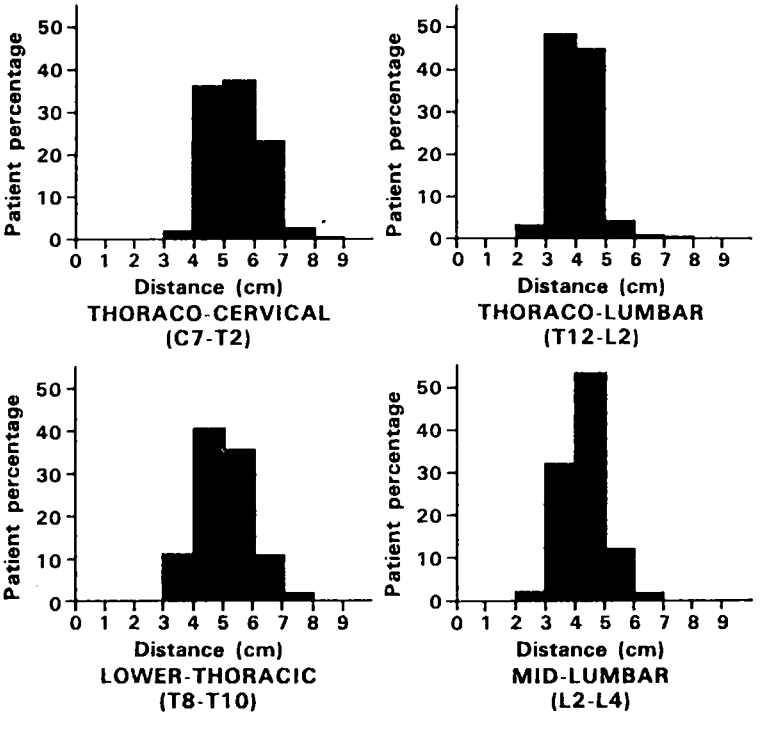

Fig. 1. The distribution of the distance from the skin to the epidural space at the four levels of the spine.

epidural space of 4.0–6.9 cm; 87% at the lower-thoracic area (T8-T10), 4.0–6.9 cm; 93% at the thoraco-lumbar area (T12-L2), 3.0–4.9 cm; 85% at the mid-lumbar area (L2-L4), 3.0–4.9 cm.

Discussion

The distance from the skin to the epidural space varies at different levels of the spine in the same patient. It also varies from patient to patient at the same vertebral level. Bromage demonstrated that the deepest level is the thoraco-cervical area and lumbo-sacral area where the spine has a natural lordotic curve[3]. Our data confirmed that the thoraco-cervical area is the deepest level in the

four levels of the spine examined. It was also revealed that the thoraco-lumbar area is the shallowest level in the four levels of the spine examined. The dstance from the skin to the epidural space at the lower-thoracic area was longer than that at the mid-lumbar area, because a needle inserted between the thoracic spinous processes via mid-line approach has to be directed at an angle of 45° to the skin so as to pass in parallel with the angulated spinous processes above and below.

The distance from the skin to the epidural space in male was greater than that in female, because of the difference in body constitution between male and female, whereas the distance to the epidural space in the population who had the same body constitution showed no difference between male and female.

Palmer et al.[1] reported that the distance from the skin to the epidural space at mid-lumbar area is directly related to body weight. Our results demonstrated that every part of the spine examined also correlated to body weight. A needle inserted via mid-line approach passes through the skin, the subcutaneus fat, the supraspinous and interspinous ligament, and the ligamentum flavum. The subcutaneus fat is the most variable in these anatomical layers at the same part of the spine in different individuals. Therefore, the fat occupying and enlarging subcutaneous tissue may account for most of the variation in the distance from the skin to the epidural space[1].

Our results may be useful for young anesthesiologists to master epidural block safely and efficiently. Although, it should be kept in mind that some patients have an epidural space located very near to or very far from the skin surface. Careful advancement of a needle and attentive detection of the "sign" at the time when the needle tip enters the epidural space is the most important for successful epidural puncture.

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References

1. Palmer SK, Abram SE, Maitra AM, von Colditz JH: Distance from the skin to the lumbar epidural space in an obstetric population. Anesth & Analg 62:944–946,1983
2. Hirabayashi Y, Matsuda I, Inoue S, Shimizu R: Epidural pressure and its relation to spread of epidural analgesia. J Anesth 1:168–172, 1987
3. Bromage PR: Identification of the epidural space, Epidural Analgesia. Edited by Bromage PR. pp196–197, WB Saunders, Philadelphia, 1978
4. Keys A, Fidanza F, Karvonen MJ, Kimura N, Taylor HL: Indices of relative weight and obesity. J Chron Dis 25:329–343, 1972