The Position of the Lumbar Vertebrae in Relation to the Intercrestal Line

Pisit Wattanaruangkowit MD*,
Kajorn Lakchayapakorn MD**

** Department of Radiology, Faculty of Medicine, Thammasat University, Pathum Thani, Thailand*
*** Division of Anatomy, Department of Preclinical Science, Faculty of Medicine, Thammasat University, Pathum Thani, Thailand*

Objective: *To determine the position of the lumbar vertebrae in relation to the intercrestal line and variation in distance between the midpoint of the $L_{4/5}$ interspinous space and the intercrestal line in varying patients age groups of Thai people.*
Material and Method: *The present study was a retrospective analysis of the antero-posterior and lateral lumbosacral vertebral radiographs of 270 patients, varying patients' age from 20 to 80 years. Intercrestal line was drawn connecting the two highest points on the iliac crests of antero-posterior radiographs. The distance from the intercrestal line to the midpoint of the $L_{4/5}$ interspinous space and $L_{4/5}$ intervertebral space were measured. The results were statistically analysed by using ANOVA testing.*
Results: *The intercrestal line crosses the midline of the posterior part of the lumbar vertebral column between the upper half of L_4 spinous process level and lower half of L_5 spinous process level, most often at the lower half of L_4 spinous process level (101 cases, 37.41%). This line crosses the anterior part of the lumbar vertebral column between the upper half of L_4 body level and lower half of L_5 body level, most often at the upper half of L_5 body level (103 cases, 38.15%). Regarding distance from intercrestal line to the midpoint of the $L_{4/5}$ interspinous space in varying patient age groups, the intercrestal line was most frequently found above the $L_{4/5}$ interspinous space in most age group (average 5.73 $\pm$ 5.72 mm; value $p > 0.05$ vs. 70-80 years). For the distance from intercrestal line to the midpoint of the $L_{4/5}$ intervertebral space in varying patient age groups, the intercrestal line was most frequently found below the $L_{4/5}$ intervertebral space in all age groups (average 6.60 $\pm$ 6.97 mm; value $p > 0.05$ vs. 70-80 years).*
Conclusion: *The intercrestal line crosses the posterior part of the lumbar vertebral column between the upper half of L_4 spinous process level and lower half of L_5 spinous process level, most often at the lower half of L_4 spinous process level (37.41%) and at the $L_{4/5}$ interspinous space level (27.78%). This line crosses the anterior part of the lumbar vertebral column between the upper half of L_4 body level and lower half of L_5 body level, most often at the upper half of L_5 body level (38.15%) and at the $L_{4/5}$ intervertebral space level (32.22%). The level of the intercrestal line tends to be high in elderly patients, neutral position and the intercrestal line by palpation tends to be identified at the higher level.*

Keywords: *Lumbar vertebrae, Spine, Intervertebral disc, Intercrestal line, Intercristal line Supracristal line, Jacoby's line, Tuffier's line, Iliac crest*

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Lumbar puncture is a common diagnostic procedure that is performed for collecting a sample of cerebrospinal fluid (CSF) for analysis and occasionally done as a therapeutic purpose. In clinical context, the safety site for lumbar puncture is established in the $L_{3/4}$ interspinous space or below[1,2]. The highest point on the iliac crest was commonly used be to the palpable landmark for the procedure.

The line drawn between the two highest points on the iliac crests called intercrestal line[3-5] or intercristal line[6,7] or Jacoby's line[4,5,8] or Tuffier's line[7,9] or supracristal line[10,11]. This line crosses the anterior part of the lumbar vertebral column at the lower body of L_4 level[1,10,11] or at the $L_{4/5}$ intervertebral space level[1,2,10,11]. This line crosses the posterior part of the lumbar vertebral column at the L_4 spinous process level[12,13] or at the $L_{4/5}$ interspinous space level[4,6,13].

Correspondence to:
Lakchayapakorn K, Division of Anatomy, Department of Preclinical Science, Faculty of Medicine, Thammasat University, Pathum Thani 12120, Thailand.
Phone: 0-2926-9710, Fax: 0-2926-9711
E-mail: kajorn98@hotmail.com

The objective of the present study was to determine the position of the lumbar vertebra in relation to the intercrestal line and variation in distance between midpoint of the $L_{4/5}$ interspinous space and the intercrestal line in varying patient age groups of Thai people.

Material and Method

The present study was a retrospective analysis of the antero-posterior and lateral lumbosacral vertebral radiographs of 270 patients, varying patient age from 20 to 80 years. The patients were divided into 6 groups according to age (20-30, 30-40, 40-50, 50-60, 60-70 and 70-80 years). These radiographs were of the patients in the Department of Radiology, Thammasat University Hospital, Thailand. They were reviewed and measured by the radiologist. Radiographs that showed an obvious vertebral deformity, *e.g.* scoliosis, vertebral fracture, history of previous vertebral surgery and films that failed to identify the intercrestal line were excluded.

The intercrestal line was drawn connecting the two highest points on the iliac crests of antero-posterior radiograph, the distance from intercrestal line to the midpoint of the $L_{4/5}$ interspinous space and the $L_{4/5}$ intervertebral space was measured (Fig.1, 2).

The level of the vertebrae was determined by using the 12^{th} rib to identify the T_{12} vertebra and counting down from this point or using the sacrum as a starting point.

The results were statistically analysed by using descriptine statistics and ANOVA. Statistical significance was noted for p-value ≤ 0.05.

Results

The intercrestal line crossed the posterior part of the lumbar vertebral column between the upper half of L_4 spinous process level and lower half of L_5 spinous process level (Table 1), most often at the lower half of L_4 spinous process level (101 cases, 37.41%) and at the $L_{4/5}$ interspinous space level (75 cases, 27.78%). This line crossed at the upper half of L_4 spinous process 4.44%, 2.22% and 2.22% in the patient group aged 30-40, 60-70 and 70-80 years respectively (Table 2, Fig. 3). This line crossed the anterior part of the lumbar vertebral column between the upper half of L_4 body level and lower half of L_5 body level (Table 3), most often at the upper half of L_5 body level (103 cases, 38.15%) and at the $L_{4/5}$ intervertebral space level (87 cases, 32.22%). This line crossed at the upper half

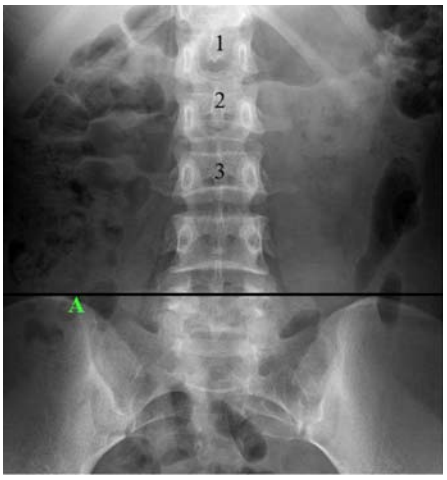

Fig. 1 Drawing from the highest points of bilateral iliac crests to establish the intercrestal line (A). The intercrestal line crosses the anterior part of vertebral column at the level of the upper half L5 vertebral body which is the most common finding in the present study

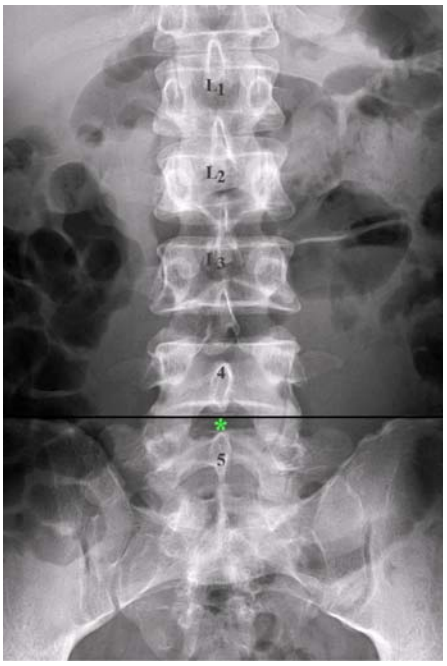

Fig. 2 The intercrestal line is just above the midpoint of L4/5 interspinous space and L4/5 intervertebral space which are the same locations in this patient (*). Distance from the midpoint (*) to intercrestal line were analysed
4 = spinous process of L4, 5 = spinoud process of L5, * = midpoint of L4/5 interspinous space and L4/5 intervertebral disc space

Table 1. Relationship between the intercrestal line and the posterior part of the lumbar vertebral column

Vertebral level	Number of patients	Percentage
Upper half of L4 spinous process	4	1.48
Lower half of L4 spinous process	101	37.41
L4-5 interspinous space	75	27.78
Upper half of L5 spinous process	62	22.96
Lower half of L5 spinous process	28	10.37
Total	270	100

Table 2. Relationship between the intercrestal line and the posterior part of lumbar vertebrae in varying patient age groups

Vertebral level	Percentage of patients					
	20-30	30-40	40-50	50-60	60-70	70-80
Upper half of L4 spinous process	0	4.44	0	0	2.22	2.22
Lower half of L4 spinous process	33.33	28.89	64.44	37.78	37.78	44.44
Interspinous space L4-5	28.89	28.89	24.44	40	28.89	15.56
Upper half of L5 spinous process	28.89	28.89	17.78	17.78	20	24.44
Lower half of L5 spinous process	8.89	8.89	15.56	4.44	11.11	13.33
Total	100%	100%	100%	100%	100%	100%

Table 3. Relationship between the intercrestal line and the anterior part of the lumbar vertebral column

Vertebral level	Number of patients	Percentage
Upper half of L4 body	1	0.37
Lower half of L4 body	55	20.37
L4-5 intervertebral space	87	32.22
Upper half of L5 body	103	38.15
Lower half of L5 body	24	8.89
Total	270	100

Table 4. Relationship between the intercrestal line and the anterior part of the the lumbar vertebrae in varying patient age groups

Vertebral level	Percentage of patients					
	20-30	30-40	40-50	50-60	60-70	70-80
Upper half of L4 body	0	0	0	0	0	2.22
Lower half of L4 body	11.11	20	31.11	20	20	20
L4-5 intervertebral space	28.89	24.44	26.67	31.11	42.22	40
Upper half of L5 body	55.56	48.89	31.11	44.44	26.67	22.22
Lower half of L5 body	4.44	6.67	11.11	4.44	11.11	15.56
Total	100%	100%	100%	100%	100%	100%

of L_4 body 2.22% in the patients group aged 70-80 years (Table 4, Fig.4).

Regarding the distance from the intercrestal line to the midpoint of the $L_{4/5}$ interspinous space in varying patient age groups, the intercrestal line was most frequently found above the $L_{4/5}$ interspinous space (average 5.73 $\pm$ 5.72 mm). In the group 20-30 years, the average distance from the intercrestal line to the midpoint of the $L_{4/5}$ interspinous space was 4.36 $\pm$ 4.12 mm ($p < 0.021$ vs. 70-80 years). For 30-40 years, the average distance was 6.09 $\pm$ 5.53 mm ($p = 0.38$ vs. 70-80 years). In age 40-50 years, the average distance was 6.76 $\pm$ 6.24 mm ($p = 0.75$ vs. 70-80 years). In 50-60 years, the average distance was 4.44 $\pm$ 5.14 mm ($p < 0.025$ vs 70-80 years). In 60-70 years, the average distance was 5.60 $\pm$ 5.44 mm ($p = 0.20$ vs 70-80 years). In age 70-80 years, the average distance was 7.13 $\pm$ 7.09 mm (Fig.5).

In the matter of average distance from the intercrestal line to the midpoint of the $L_{4/5}$ intervertebral space in varying patient age groups, the intercrestal line was most frequently found below the $L_{4/5}$ intervertebral space (average 6.60 $\pm$ 6.97 mm). In 20-30 years, the average distance from the intercrestal line to the midpoint of the $L_{4/5}$ intervertebral space was 6.02 $\pm$ 6.09 mm ($p = 0.50$ vs. 70-80 years). In the group of 30-40 years, the average distance was 7.73 $\pm$ 6.64 mm ($p = 0.62$ vs. 70-80 years). In age 40-50 years, the average distance was 6.89 $\pm$ 7.46 mm ($p = 0.94$ vs. 70-80 years). In 50-60 years, the average distance was 5.20 $\pm$ 5.96 mm ($p = 0.22$ vs. 70-80 years). In 60-70 years, the average distance was 6.86 $\pm$ 7.44 mm ($p = 0.87$ vs. 70-80 years). In age 70-80 years, the average distance was 7.00 $\pm$ 8.08 mm (Fig. 6).

Discussion

The intercrestal line is a surface guideline to determine the L_4 spinous process or $L_{4/5}$ interspinous space level[6]. According to Gray's anatomy for students[12], this line crosses posterior of the lumbar

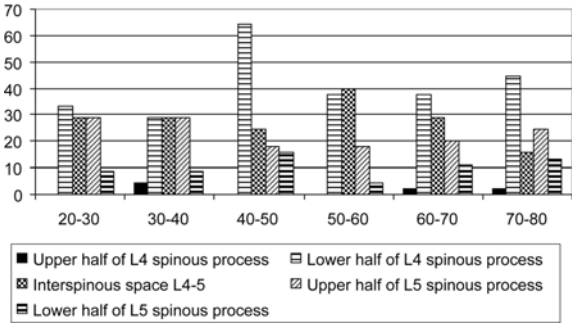

Fig. 3 Relationship between the intercrestal line and the posterior part of the lumbar vertebrae in varying patient age groups

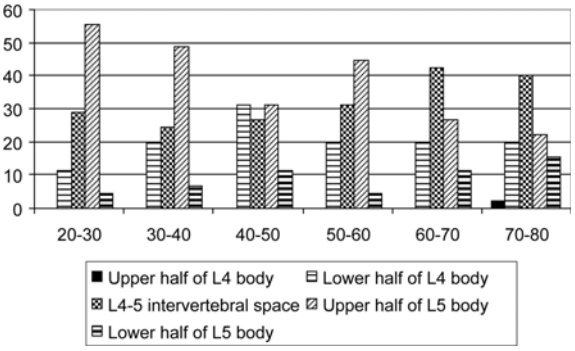

Fig. 4 Relationship between the intercrestal line and the anterior part of the lumbar vertebrae in varying patient age groups

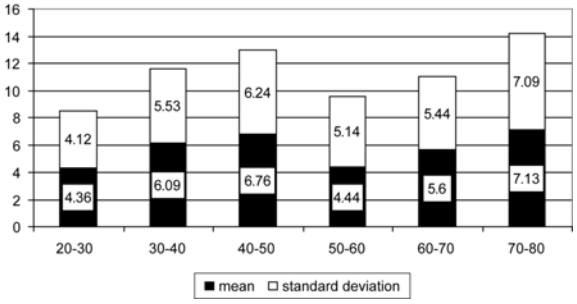

Fig. 5 Variation of the average distance from the intercrestal line to the midpoint of the $L_{4/5}$ interspinous space in varying patient age group

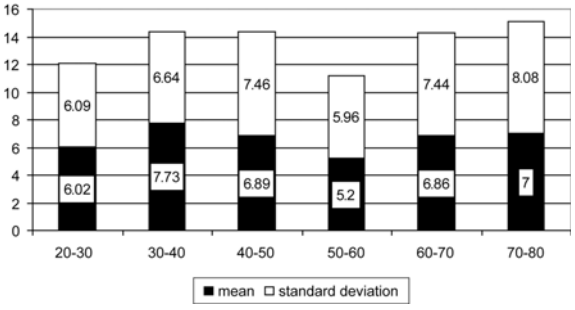

Fig. 6 Variation of the average distance from the intercrestal line to the midpoint of the $L_{4/5}$ intervertebral space in varying patient age group

vertebral column at the L_4 spinous process level. From radiological studies[6,14,15], this line crosses the L_4 spinous process 43-56%, $L_{4/5}$ interspinous space 26-30.7% and found above the L_4 spinous process 1.3-3.7%. The authors found this line crosses the L_4 spinous process 38.89% (upper half of the L_4 spinous process 1.48% and lower half of the L_4 spinous process only 37.41%), at the $L_{4/5}$ interspinous space 27.78% and not found above upper half of the L_4 spinous process (Table 1). In addition, the intercrestal line crosses the anterior of the lumbar vertebral column at the L_4 body level or at the $L_{4/5}$ intervertebral space level[1,2,10]. From radiological studies[11], this line crosses lower half of the L_4 body 40.80%, at the $L_{4/5}$ intervertebral space level 31.90%, at the upper half of the L_5 body 18.6% and the highest level at the upper half of the L_4 body 8.70%. The authors found this line crosses the upper half of the L_5 body 38.15%, at the $L_{4/5}$ intervertebral space 32.22%, at the lower half of the L_4 body only 20.37%, at the lower half of the L_5 body 8.89% and not found above the upper half of the L_4 spinous process (Table 3).

Shiraishi et al[5] have reported the location of conus medullaris. Conus medullaris is located beneath L_3 body in 3.5% and intercrestal line crosses at the upper half of the L_3 body 2.1%. The authors found this line crosses the highest level at the upper half of the L_4 spinous process 1.48% and the upper half of the L_4 body 0.37%.

Walsh et al[11] studied the relation of the intercrestal line to the anterior part of the lumbar vertebra in varying age group. The intercrestal line varies significantly from age 80-90 years. According to this matter, the authors found that the relation of the intercrestal line to the anterior part of the lumbar vertebra does not varied significantly from age 70-80 years. However, they did not mention the relation of the intercrestal line to the posterior part of the lumbar vertebrae[11], but the authors found that the relation does not vary significantly from age 70-80 years. The average distance from the intercrestal line to midpoint of the $L_{4/5}$ interspinous space in patients aged 70-80 is less than in the patients aged 80-90[11]. Degenerative change of vertebral column in those aged 70-80 years may be less than those aged 80-90 years. The level of the intercrestal line tends to be high in the older age group.

Snider et al[16] reported the level of the intercrestal line is associated with sex, height, weight or BMI. They found that weight and BMI had no correlation with the intercrestal line. The intercrestal line most often crosses at L_4 vertebral body in males and L5 vertebral body in females and subjects with a intercrestal line crosses L_4 are taller than those with a intercrestal line crosses L_5. Shiraishi et al[4] studied the position of intercrestal line at heights of the spinous process in extension, neutral and flexion positions of the lumbar vertebra. In the neutral position, intercrestal line most often crosses the middle 1/3 region of the L_4 spinous process in males, at the $L_{4/5}$ interspinous space in females. In the flexion position, it crosses the $L_{4/5}$ interspinous space both males and females. The authors found the intercrestal line most often crosses the L_4 spinous process in the neutral position. The intercrestal line in neutral position tends to cross the lumbar vertebra higher than the flexion position[4], thus, the intercrestal line by palpation tends to be identified at the higher level, L_3 or $L_{3/4}$ interspinous space[4] and the authors found the level of the intercrestal line tend to high in the old age group. So the intercrestal line can be used as a surface guide-line for lumbar puncture or spinal anaesthesia and the position for lumbar puncture or spinal anaesthesia should be lower than the intercrestal line one level or below.

Further studies are necessary to determine the relationship between the intercrestal line and the level of the lumbar vertebrae in varying patient positions (lateral recumbent with knees to chest, sitting with feet unsupported and sitting with feet supported and chest to knees).

Conclusion

The present study concludes that the intercrestal line crosses the posterior part of the lumbar vertebral column between the upper half of L_4 spinous process level and lower half of L_5 spinous process level, most often at the lower half of L_4 spinous process level (37.41%) and at the $L_{4/5}$ interspinous space level (27.78%). This line crosses the anterior part of the lumbar vertebral column between the upper half of L_4 body level and lower half of L_5 body level, most often at the upper half of L_5 body level (38.15%) and at the $L_{4/5}$ intervertebral space level (32.22%). The level of the intercrestal line tends to be high in elderly patients, neutral position and the intercrestal line by palpation tends to be identified at the higher level.

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ตำแหน่งของกระดูกสันหลังส่วนเอวที่สัมพันธ์กับ intercrestal line

พิศิษฐ วัฒนเรืองโกวิท, ขจร ลักษณ์ชยปกรณ์

วัตถุประสงค์: *เพื่อหาตำแหน่งอ้างอิงของกระดูกสันหลังส่วนเอวที่สัมพันธ์กับ intercrestal line และความผันแปรของระยะทางระหว่างจุดกึ่งกลางของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และ 5 กับ intercrestal line ในกลุ่มอายุต่าง ๆ ของคนไทย*

วัสดุและวิธีการ: *เป็นการศึกษาแบบย้อนหลัง โดยศึกษาจากภาพถ่ายรังสีของกระดูกสันหลังส่วนเอว และกระดูกใต้กระเบนเหน็บในระนาบหน้าหลัง (anterior-posterior view) และด้านข้าง (lateral view) ของผู้ป่วยจำนวน 270 ราย ในช่วงอายุระหว่าง 20-80 ปี จากนั้นลากเส้นเชื่อมระหว่างจุดสูงสุด ของกระดูกปีกสะโพกเพื่อประเมินตำแหน่งของกระดูกสันหลัง ด้านหลังวัดระยะทางจากจุดกึ่งกลางระหว่าง spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และ 5 กับ intercrestal line และด้านหน้าวัดจุดกึ่งกลางระหว่าง body ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และ 5 กับ intercrestal line นำข้อมูลที่ได้มาวิเคราะห์โดยใช้ univariate ANOVA testing ที่ระดับความเชื่อมั่น 95% ($p \leq 0.05$)*

ผลการศึกษา: *พบว่า intercrestal line ผ่านแนวกึ่งกลางด้านหลังกระดูกสันหลังส่วนเอว โดยอยู่ระหว่างครึ่งบนของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และ ครึ่งล่างของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 5 ตำแหน่งที่พบมากที่สุดอยู่บริเวณครึ่งล่างของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 (101 ราย, 37.41 %) และ intercrestal line ผ่านแนวกึ่งกลางด้านหน้ากระดูกสันหลังส่วนเอว โดยอยู่ระหว่างครึ่งบนของ body ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และ ครึ่งล่างของ body ของกระดูกสันหลังส่วนเอวชิ้นที่ 5 ตำแหน่งที่พบมากที่สุดอยู่บริเวณครึ่งบนของ body ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 (103 ราย, 38.15 %) ระยะทางจาก intercrestal line ถึงจุดกึ่งกลางระหว่าง spinous process ของกระดูกสันหลังส่วนเอวที่ 4 และ 5 ในกลุ่มอายุต่าง ๆ พบว่าเส้นนี้อยู่เหนือต่อจุดกึ่งกลางระหว่าง spinous process ของกระดูกสันหลังส่วนเอวที่ 4 และ 5 เกือบทุกกลุ่มอายุ (ค่าเฉลี่ย 5.73 ± 5.72 mm; $p > 0.05$ เทียบกับกลุ่มอายุ 70-80 ปี) ระยะทางจาก intercrestal line ถึงจุดกึ่งกลาง ระหว่าง body ของกระดูกสันหลังส่วนเอวที่ 4 และ 5 ในกลุ่มอายุต่าง ๆ พบว่าเส้นนี้อยู่ต่ำกว่าจุดกึ่งกลางระหว่าง body ของกระดูกสันหลังส่วนเอวที่ 4 และ 5 ทุกกลุ่มอายุ (ค่าเฉลี่ย 6.60 ± 6.97 mm; $p > 0.05$ เมื่อเทียบกับกลุ่มอายุ 70-80 ปี)*

สรุป: *intercrestal line ผ่านแนวกึ่งกลางด้านหลังกระดูกสันหลังส่วนเอว โดยอยู่ระหว่างครึ่งบนของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และครึ่งล่างของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 5 ตำแหน่งที่พบมากที่สุดอยู่บริเวณครึ่งล่างของ spinous process ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 (37.41%) และจุดกึ่งกลาง ระหว่าง spinous process ของกระดูกสันหลังส่วนเอวที่ 4 และ 5 (27.78%) intercrestal line ที่ผ่านแนวกึ่งกลาง ด้านหน้ากระดูกสันหลังส่วนเอว โดยอยู่ระหว่างครึ่งบนของ body ของกระดูกสันหลังส่วนเอวชิ้นที่ 4 และครึ่งล่างของ body ของกระดูกสันหลังส่วนเอวชิ้นที่ 5 ตำแหน่งที่พบมากที่สุดอยู่บริเวณครึ่งบนของ body ของกระดูกสันหลังส่วนเอว ชิ้นที่ 4 (38.15%) และจุดกึ่งกลางระหว่าง body ของกระดูกสันหลังส่วนเอวที่ 4 และ 5 (32.22%) ระดับของ intercrestal line มีแนวโน้มอยู่สูงขึ้นในกลุ่มที่อายุมากขึ้น ในท่าที่ลำตัวตรง และระดับของ intercrestal line ที่ได้จากการคลำมีแนวโน้มอยู่สูงขึ้น*