OSTEOMETRIC DIMENSIONS OF THE LAMINAS OF THE SPINE

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ABSTRACT

The present study was undertaken to evaluate the dimensions of the laminas from C2 to L5 by using adult human spine specimens for the objective of providing a set of quantitative data for the laminas from C2 to L5 vertebrae.

There exists enormous amount of Anatomic data based on facet and pedicle parameters by different research workers, but it seems that the detailed studies based on measurements of laminar parameters from cervical to lumbar spines are almost nil.

Forty spines (920 vertebrae) were considered for the present study. Anatomic evaluation of the laminas included the laminar height, width, thickness, width angle & slope angle.

The greatest laminar height was observed at T11 for males & females (22.8 ± 2.1mm, 23.0 + 1.8mm) respectively. There was a marked change in pattern at L5 where there was a decrease in laminar height from that of preceding lumbar levels.

The greatest laminar width was at L5 for males & females (12.1 ± 2.4mm & 11.5 ± 2.1mm) respectively. The laminar thickness was maximum at T3 for males and females (5.2 ± 0.7mm & 5.1 ± 0.2mm) respectively. The maximum width angle was at T9 for males (99.2 ± 9.7mm) & at L4 for females (100.6 ± 12.3mm). The slope angle was maximum at L5 for males and females (113.5 ± 4.8mm & 118.0 ± 1.4mm) respectively.

Thus, for the proper understanding of the weight transmission through the spine and it related hypothesis the Anatomic parameters of the laminas provided by the present study are very important and also they provide an adequate database necessary for the surgical placement of sublaminar instruments in spine related surgeries.

Key words : Laminas, C2 to L5, laminar height, laminar width, width angle, slope angle

INTRODUCTION :

The laminas play an important role in formation of neural arch and in the stabilization of human spine. The vertebral laminae provide an important pathway for the transmission of weight through the spine as has been extensively and very correctly discussed by Pal & Routal (1986, 1987)[1,2].

Pal & Routal (1996)[3] have discussed the role of vertebral laminae in the stability of the cervical spine. According to Rongming et al (1999)[4], the morphometric anatomy of the laminas of the spine seems to be neglected in the literature although the other parts of the vertebrae from cervical to lumbar, such as the pedicle and facet joints have been well studied. According to Zindrick et al (1989)[5], the technique of spinal segmental wiring (as is quite popular for treatment of spinal deformity), the loads that are applied to the spine to reduce a spinal curve are distributed among several spinal segments, and it increases the stability that is derived from securely fixing each spinal segment as it offers a distinct advantage compared with earlier instrumentation devices. But, according to Zindrick et al (1989)[5], a major disadvantage of the above mentioned technique was that it may cause neurological complications when the wires are inserted, whether the wire touches or injures the dural sac, depends on the width of the available epidural space and on maximum depth of penetration of the wire into the spinal canal.

Thus in order to determine the depth of penetration of wires at the time of their passage under the lamina, Zindrick et al (1989)[5] measured the laminar thickness, laminar width and interlaminar distance of specimens of thoracic spine from cadavers.

According to Pal & Routal (1996)[3] none of the previous authors had considered the possible role of the neural arch in maintaining stability.

Pal & Routal (1986, 1987)[1,2], Pal (1988)[6,7] and Pal et al (1988)[8] had provided evidence that the neural arch

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shared in the transmission of the axial load borne by the cervical, thoracic, lumbar and sacral vertebrae.
Rongming et al (1999)[4] had given a complete set of data comprising of linear and angular measurements of C3 to L5 laminas.
Therefore based on the above authors brief reviews, the knowledge of quantitative anatomy of the laminas may be useful for various surgical procedures such as placing wires or clamps beneath the laminas; and also for determining the load of weight transmission through the laminas.
Henceforth, the present study was taken up to provide a set of quantitative data (laminar measurements) for laminas from C2 to L5.

MATERIALS & METHODS :
Forty adult human spines prepared by maceration for the osteology section of Anatomy dept., M. P. Shah Medical College were selected for the present study. The vertebrae were free from osteophytes and other abnormalities.

The laminas of C2 to L5 were measured by vernier calipers and the following dimensions were included : laminar height, laminar width, laminar thickness and angulation. For the angular measurements, protractor and long needles were used. For all the measurements, the present study followed the same method as that used by Rongming et al (1999)[4].

Laminar height : Each height was measured from the superior margin to the inferior margin of the lamina, (fig:1).

Laminar width : The width was measured from a line connecting the medial borders of the superior and inferior articular facets to the midline of the interior aspect of the spinous process, (fig:1).

Laminar thickness : The measurements of laminar thickness taken from the median laminar width were obtained for the lamina, (fig:2). The first measurement was taken 2mm below the superior laminar margin. The second measurement was taken

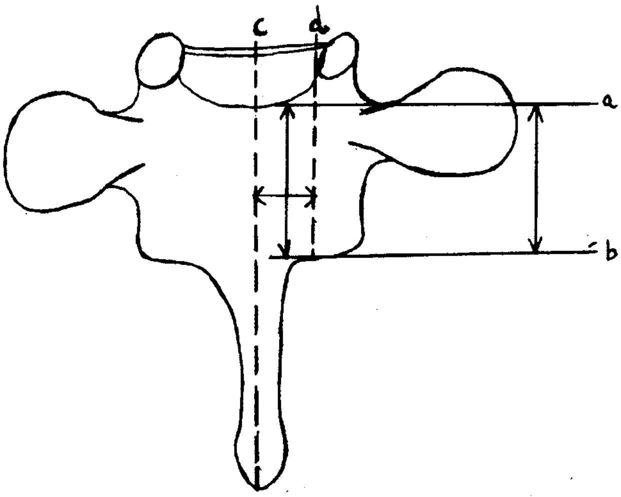

Figure : 1. Laminar height ab ; as seen in posterior view of vertebrae, a = superior laminar margin; b = inferior laminar margin; cd is laminar width; c = midline of the spinous process, d = line connecting medial borders of superior & inferior articular facets

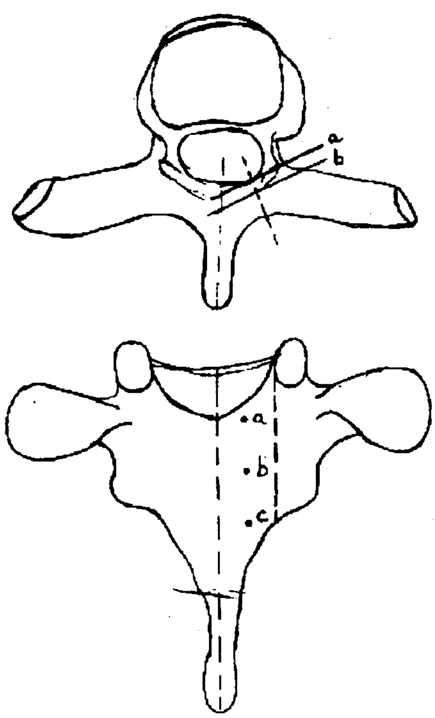

Figure : 2 Laminar thickness, ab, in the above diagram as seen in superior view, a is internal edge of the lamina; b is the external edge of the lamina; in the lower diagram as seen in posterior view, a is 2mm below the superior laminar margin, c is 2mm above the inferior laminar margin, b is equidistant between a and c points.

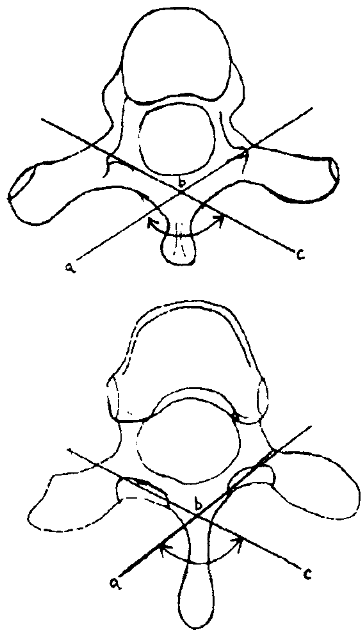

Figure 3 : In the upper diagram Width angle abc of the superior view of thoracic vertebrae; a = plane of right superior laminar border, c = plane of left superior laminar border. In the lower diagram Width angle abc of the inferior view of thoracic vertebrae, a = plane of left inferior laminar border, c = plane of right inferior laminar border

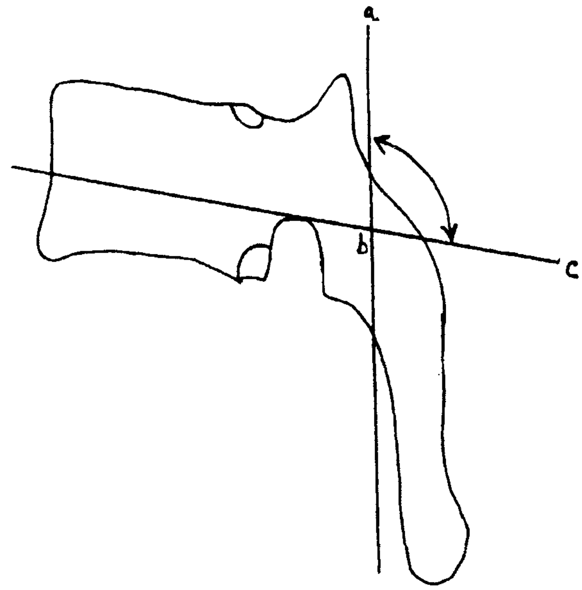

Figure 4 : Slope angle abc in a sagittal view of thoracic vertebrae; a = plane of the lamina; c = plane of the vertebral body.

				Thickness			
		Height	Width	Superior	Middle	Inferior	Total
C2	Male	11.5±1.4	11.4±1.1	2.9±0.8	5.4±1.4	4.4±1.4	4.2±0.9
	Female	10.7±0.5	11.7±0.9	2.0±0	5.0±1.4	4.5±1.9	3.8±1.1
C3	Male	10.4±0.7	11.5±1.1	2.3±0.6	3.4±0.8	2.4±0.7	2.7±0.6
	Female	10.5±1.2	12.5±1.0	2.0±0	2.7±0.5	2.0±0	2.2±0.1
C4	Male	10.5±1.3	11.6±1.0	1.9±0.5	2.8±0.6	2.0±0.7	2.2±0.5
	Female	10.0±2.0	11.3±0.5	1.6±0.5	1.6±0.5	1.6±0.5	1.6±0.5
C5	Male	10.5±1.1	11.4±1.0	1.9±0.4	2.9±0.9	2.0±0.5	2.3±0.5
	Female	10.3±1.5	11.6±1.1	1.3±0.5	1.6±0.5	1.3±0.5	1.4±0.5
C6	Male	11.6±1.5	11.3±1.3	2.3±0.6	3.5±0.7	2.8±0.6	2.9±0.5
	Female	11.0±1.0	11.6±0.5	1.3±0.5	2.3±0.5	1.6±0.5	1.7±0.5
C7	Male	14.8±1.7	9.5±2.0	2.6±0.8	4.9±1.1	3.8±1.0	3.8±0.8
	Female	14.2±0.9	9.2±1.5	2.0±0.8	4.2±0.9	3.2±0.9	3.1±0.8

Table 1(a)
Linear parameters of the cervical laminas.

				Thickness			
		Height	Width	Superior	Middle	Inferior	Total
T1	Male	16.6+1.4	7.6+1.3	3.5+0.9	6.1+1.0	4.0+1.0	4.5+0.9
	Female	15.5±1.9	7.2±0.5	3.2±0.5	6.2±0.9	3.7±0.9	4.4±0.7
T2	Male	16.6±1.7	6.5±1.0	4.2±0.7	6.6±0.9	3.7±0.9	4.8±0.6
	Female	16.5±3.0	5.7±0.5	3.7±0.9	6.2±0.9	3.7±1.5	4.5±0.9
T3	Male	17.6±1.9	5.7±0.8	4.7±0.8	6.8±0.8	4.1±1.0	5.2±0.7
	Female	15.5±0.7	5.0±0	5.0 ±0	7.0±0	3.5±0.7	5.1±0.2
T4	Male	18.9±1.9	5.4±1.0	4.5±0.9	6.9±1.1	3.5±1.0	5.0±0.7
	Female	17.7±2.2	5.5±0.5	4.0±1.1	6.5±1.0	3.5±1.2	4.6±0.9
T5	Male	19.6±2.0	5.7±1.1	4.5±0.9	7.2±1.0	3.3±1.0	5.0±0.7
	Female	18.0±2.1	5.0±0	4.2±0.5	6.7±1.2	3.0±0.8	4.6±0.7
T6	Male	20.0±1.4	5.6±0.9	4.4±1.0	7.1±1.3	3.1±0.9	4.9±0.8
	Female	19.7±2.0	5.2±0.5	4.0±0.8	6.2±0.9	3.0±0.8	4.4±0.6
T7	Male	20.3±1.6	5.4±1.0	4.3±1.1	6.8±0.9	3.1±0.9	4.7±0.7
	Female	20.2±2.5	5.7±0.9	3.7±0.9	6.2±0.9	2.2±0.5	4.0±0.6
T8	Male	20.8+1.7	5.7+1.1	4.3+1.2	7.0+1.2	3.0+0.7	4.7+0.8
	Female	19.2+1.5	6.2+0.9	3.2+0.5	6.5+1.0	2.5+0.5	4.0+0.5
T9	Male	20.8+1.6	5.4+0.9	4.1+1.2	7.1+1.1	3.0+0.8	4.7+0.8
	Female	19.0±1.4	5.5±0.5	2.7±0.5	7.0±1.6	2.5±1.0	4.0±0.9
T10	Male	22.0±1.9	5.7±0.8	3.9±1.0	6.5±1.1	3.0±0.9	4.5±0.7
	Female	20.7±3.3	5.0±1.4	2.7±0.5	6.7±1.2	2.7±0.5	4.0±0.7
T11	Male	22.8±2.1	6.0±1.0	3.4±0.9	6.0±1.3	3.6±1.1	4.3±0.8
	Female	23.0±1.8	5.7±1.2	2.0±0	4.5±0.5	2.5±0.5	3.0±0
T12	Male	21.6±2.7	6.5±1.0	2.8±0.8	5.8±1.0	4.9±1.2	4.5±0.7
	Female	22.0±1.4	6.7±0.5	3.0±0	5.7±1.7	4.2±0.5	4.3±0.4

Table 2(a)
Linear parameters of the thoracic laminas.

				Thickness			
		Height	Width	Superior	Middle	Inferior	Total
L1	Male	20.5±1.9	6.6±1.3	3.5±0.9	6.3±1.2	5.1±1.1	5.0±0.7
	Female	21.3±3.5	7.3±1.5	2.3±0.5	6.3±1.5	5.6±0.5	4.7±0.5
L2	Male	21.1±2.1	6.9±1.3	3.1±0.9	6.5±1.0	5.0±1.2	4.8±0.7
	Female	20.6±1.1	7.0±2.0	3.3±0.5	6.3±1.1	4.0±1.0	4.5±0.3
L3	Male	22.1±2.4	7.8±1.6	3.0±0.9	6.5±1.0	5.0±1.2	4.8±0.7
	Female	22.0±2.5	6.5±1.2	2.7±0.5	6.2±2.0	4.7±1.2	4.5±0.9
L4	Male	20.3±2.2	9.0±2.0	2.7±0.8	6.3±0.7	4.7±0.7	4.6±0.4
	Female	22.2±0.9	7.5±1.0	2.2±0.5	5.7±1.7	4.0±2.1	4.0±1.1
L5	Male	17.0±2.2	12.1±2.4	3.0±0.6	5.8±0.9	3.8±1.3	4.2±0.7
	Female	18.0±1.4	11.5±2.1	2.0±1.4	5.5±0.7	3.0±0	3.5±0.2

Table 3(a)
Linear parameters of the lumbar laminas.

		Slope Angle	Width Angle		
			Superior	Inferior	Total
C2	Male	107.3±4.7	92.9±10.5	84.8±10.7	88.9±8.3
	Female	112.5±5.0	93.7±7.5	93.7±7.5	93.7±7.5
C3	Male	106.3±4.1	91.0±6.3	90.1±6.9	90.5±6.1
	Female	109.5±3.3	100.7±9.9	98.7±11.8	99.7±10.8
C4	Male	104.1±4.3	88.6±6.4	89.3±6.7	88.9±6.1
	Female	108.3±1.1	93.3±15.2	93.3±15.2	93.3±15.2
C5	Male	104.5±4.9	86.3±5.5	88.4±6.1	87.3±5.3
	Female	108.3+2.8	93.0+14.7	94.6+12.6	93.8+13.6
C6	Male	105.6±5.2	88.3±6.4	89.9±5.8	89.1±5.2
	Female	110.0±0	95.6±12.5	96.6±11.5	96.1±12.0
C7	Male	108.6±4.2	88.4±4.8	90.8±6.8	89.6±5.0
	Female	111.0±2.7	97.5±9.5	97.5±9.5	97.5±9.5

Table 4(a).
Angular parameters of the cervical laminas.

			Width Angle		
		Slope Angle	Superior	Inferior	Total
T1	Male	105.7±3.4	88.8±5.5	91.5±6.4	90.2±4.7
	Female	110.7±4.3	88.2±5.6	90.7±1.5	89.5±3.3
T2	Male	106.2±3.4	85.0±8.5	91.9±5.9	88.4±5.7
	Female	109.0±4.3	87.5±5.0	87.5±5.0	87.5±5.0
T3	Male	107.3±3.3	84.3±6.8	93.8±7.4	89.1±5.4
	Female	109.0±0	87.5±3.5	88.5±2.1	88.0±2.8
T4	Male	106.6±4.0	89.6±10.9	94.3±7.3	91.9±8.1
	Female	110.0±0	87.5±5.0	90.0±0	88.7±2.5
T5	Male	105.7±3.1	90.8±8.1	96.8±10.4	93.8±7.4
	Female	108.7+2.6	93.7+11.0	88.7+2.5	91.2+6.2
T6	Male	105.5+3.5	91.4+9.6	94.9+9.9	93.2+8.1
	Female	108.7+2.5	87.5+5.0	88.7+2.5	88.1+3.7
T7	Male	104.5±4.6	93.9±9.2	99.4±10.2	96.6±7.8
	Female	108.7±2.6	87.5±5.0	86.7±4.7	87.1±4.8
T8	Male	104.0±2.9	94.9±11.7	99.1±9.7	97.0±8.8
	Female	106.7±1.7	90.0±0	90.0±0	90.0±0
T9	Male	103.9±2.7	95.2±10.2	103.3±12.1	99.2±9.7
	Female	108.0±2.4	90.0±0	90.0±0	90.0±0
T10	Male	104.3±3.8	89.8±9.4	100.5±12.2	95.1±10.0
	Female	105.0±0	90.0±0	90.0±0	90.0±0
T11	Male	105.6±4.1	89.2±9.7	100.3±11.5	94.8±9.5
	Female	106.5±1.9	82.5±9.5	88.7±6.2	85.6±7.7
T12	Male	109.4±2.5	88.8±6.9	96.1±9.9	92.4±7.2
	Female	109.7±0.5	87.5±5.0	90.0±0	88.7±2.5

Table 5(a).
Angular parameters of the thoracic laminas.

		Slope Angle	Width Angle		
			Superior	Inferior	Total
L1	Male	110.3±3.8	93.1±7.7	94.5±8.2	93.8±7.5
	Female	107.6±1.1	90.0±0	92.6±4.6	91.3±2.3
L2	Male	109.7±2.9	94.5±7.2	92.5±6.7	93.5±6.4
	Female	111.0±3.4	90.0±0	90.0±0	90.0±0
L3	Male	110.6±3.4	95.7±8.3	93.2±7.4	94.5±5.9
	Female	109.2±3.3	101.2±14.3	100.0±9.1	100.6±11.0
L4	Male	113.1±3.9	91.5±9.5	95.3±9.0	93.4±8.2
	Female	116.7+6.6	102.5+15.0	98.7+10.3	100.6+12.3
L5	Male	113.5±4.8	88.1±11.6	99.1±12.9	93.6±10.7
	Female	118.0±1.4	90.0±0	92.5±3.5	91.2±1.7

Table 6(a).
Angular parameters of the Lumbar laminas.

2mm above the inferior laminar margin. The third measurement was taken at a point equidistant from the two previous points. These three measurements were then averaged to provide a mean laminar thickness for each vertebral level.

Width angle : The width angle is formed between the two laminas in the transverse plane. The vertex of the angle is formed at the spinous process, (fig:3). Two angular measurements were taken : a superior, or inlet, angle formed by superior borders of both laminas. An inferior, or outlet, angle formed by the inferior borders of both laminas. The superior and inferior angles were then averaged to provide a mean width angle for each vertebral level.

Slope angle : The slope angle represents the tilt of each lamina in relation to the horizontal plane of the vertebral body, (fig:4). The slope angle was measured as the plane of the lamina in relation to the horizontal plane of the vertebral body. After measurements, the means and their standard deviations were calculated in all male vertebrae and in all female vertebrae.

RESULTS :

920 vertebrae (in 40 spines) were studied. The results of linear and angular measurements of the laminas from C2 to L5 are shown in tables 1(a) to tables 6(a).

DISCUSSION :

Zindrick et al (1989)[5] had measured the laminar thickness, laminar width and interlaminar distance in the thoracic spine during the study of the factors affecting the penetration of wires into the spinal canal. According to Rongming et al (1999)[4], the Zindrick et al (1989)[5] had measured the laminar height, thickness, interlaminar distances and epidural space in the thoracic spine during the study of the factors affecting the penetration of wires into the spinal canal. But, Zindrick et al (1989)[5] had used the word laminar width and not laminar height as mentioned by Rongming et al (1999)[4]. And perhaps that could be the explanation that as Zindrick et al (1989)[5] had considered the laminar width as the distance from the most cephalad to the caudad edge of the lamina which is almost the same as laminar height that has been discussed by Rongming et al (1999)[4] as the distance measured from superior margin to the inferior margin of the lamina. Again according to Rongming et al (1999)[4], the laminar heights in the thoracic spine were close to those of Zindrick et al (1989)[5]. However as the study of Zindrick et al (1989)[5] suggests that there is no usage of word laminar height and instead the laminar width is used.

The measurements by the present study showed that the least laminar height was at C3 level for males (10.4 ± 0.7mm) and at C4 level for females (10.0±2.0mm); whereas the maximum laminar height was at T11 (22.8+ 2.1 males & 23.0±1.8 females). The study by Rongming et al (1999) showed that the minimum laminar height in case of males was at C3 (10.8±0.9) and C4 (10.8±1.1); for females the minimum laminar height was at C4 (10.0±0.9). Also the maximum laminar height by Rongming et al (1999) was at T11 (25.2+2.7 males & 24.9±2.4 females).

The laminar height according to the present study decreased from C2 to C4 and then gradually increased to T8. From T9 to L4 laminar height stayed between 20.0 to 23.0 mm. There was marked change in pattern at L5 where there was a decrease in laminar height from that of above preceding lumbar levels. According to Rongming et al (1999)[4], the laminar height decreased from C2 to C4 and then gradually increased to T8; From T9 to L4, laminar height stayed between 20mm to 25mm and also a marked change in pattern was noted at L5, where there was a decrease in height from that of the previous lumbar levels.

According to Rongming et al (1999)[4], the greatest laminar width was at L5 (15.8±1.9 males & 15.6±2.1 females) in lower thoracic & lumbar vertebrae and the least was at T4 (5.9±0.8 males & 5.5±0.7 females). In the cervical & upper thoracic vertebrae the maximum width was at C3 (16.2±1.1 males) & C2 (15.2±1.2 females); the laminar width progressively decreased from C3 to T4 and then progressively increased until the width reached a maximum at L5.

The present study showed that the laminar width was maximum at L5 (12.1+2.4 males & 11.5+2.1 females) in the lower thoracic & lumbar vertebrae; and the least was at T4 & T9 (5.4+1.0 & 5.4±0.9) for males respectively and at T3 & T5 (5.0±0 & 5.0±0) for females respectively. In the cervical & upper thoracic vertebrae the maximum laminar width was at C4 (11.6±1.0 males) and at C3 (12.5±1.0 females).

The present study showed that the laminar width progressively decreased from C3 to T7 and then from T9 onwards it gradually started increasing till it reached the maximum at L5 level.

The present study showed that the laminar thickness was minimum at C4 (2.2±0.5 males) & C5 (1.4±0.5 females); the laminar thickness was maximum at T3 (5.2±0.7 males & 5.1±0.2 females). The present study observed that the laminar thickness decreased from C2 to C5 and again it increased from C6 to C7; then it increased till T3 level after which it remained constant within the range of 4.0 5.0mm till L5 vertebrae.

According to Rongming et al (1999)[4], the greatest laminar thickness was at T2 (5.4±0.3 males & 4.4±0.8 females) and minimum laminar thickness was at C5 (2.0±0.7 males & 1.8±0.4 females).

But quite contradictory to the present study, Rongming et al (1999)[4] stated that the laminar thickness increased in upper thoracic region and decreased in lower thoracic region and that a variation of laminar thickness was noted in the lumbar region; whereas the present study had observed constant readings in these regions.

The present study had observed the maximum width angle at T9 (99.2±9.7 males) and at L3 & L4 (100.6±11.0 & 100.6±12.3 respectively for females). The minimum width angle was at T2 (88.4±5.7 males) & at T11 (85.6±7.7 females).

There was a constant reading for the present study where the width angle remained between 85mm to 97mm throughout the vertebral column with no specific increase or decrease noted at certain levels.

According to Rongming et al (1999), the widest angle was at C3 (124.7±10.1 males) and at T6 (111.5±7.4 females); and the narrowest was at C2 (98.4±8.1 males) & L3 (99.8±6.4 females).

The present study showed that the slope angle was maximum at L5 (113.5±4.8 males & 118.0±1.4 females) and minimum at T9 (103.9±2.7 males) & T10 (105.0±0 females). The present study showed that the slope angle increased in cervical column and remained somewhat constant in thoracic column and again increased in lumbar column and there was marked significant difference between the sexes with female slope angles being more than the male slope angles at various places.

According to Rongming et al (1999)[4], the maximum slope angle was at L3 (140.1+7.3 males) & L4 (116.7+3.2 females); and minimum slope angle was T9 (98.3+2.9 males & 96.9+3.1 females).

According to Rongming et al (1999)[4], the most of laminar measurements showed no significant difference between male and female specimens, although mean values were generally greater in males than in females, which indicates that sexual difference may not play a significant role in the dimensions of the laminas of the spine.

The present study also observed the same changes except in slope angle where constantly the female readings were more than male readings in cervical, thoracic and lumbar vertebral levels.

According to Rongming et al (1999)[4] another finding was that the change of the laminar dimension and shape corresponded well with the transition of the spine from cervical to lumbar region. In the cervical region, the laminas were shorter and thinner, but generally wider than those in the thoracic and lumbar regions.

The present study also noted the similar pattern of change of dimensions of laminae at various levels corresponding well with transition of the spine and the laminar widths in cervical column to be more than those in thoracic & lumbar columns.

According to Rongming et al (1999)[4], C7 is differentiated from the levels above it by its maximum laminar height and minimum laminar width. But clearly the explanation for the above noted change is missing by Rongming et al (1999)[4].

The present study had also observed the same feature of C7 having maximum laminar height and minimum laminar width as compared to its above cervical vertebrae. The above changes in laminar height in cervical region could be explained based on the findings of Pal & Routal (1996)[3] that the diffusion of load is low in the laminae between C3 to C6 and minimal at C5 in the role of vertebral laminae in the stability of the cervical spine. Therefore the present study showed the minimal laminar height at C3 to C5 levels. According to Pal & Routal (1996)[3], the laminar indices indicate that the neural arches of axis and C7 have a significant load bearing function in the cervical spine. Thus, the present study also showed that laminar height was maximum at C7 & C2 levels as compared to C3, C4, C5 levels. However the explanation with regard to the changes in laminar height in cervical column by Rongming et al (1999)[4] is lacking.

According to Rongming et al (1999)[4], in the thoracic region, the laminar height increases, but the laminar width decreases, which is consistent with the decrease of the mediolateral diameter of the spinal canal. Again there is lack of any logical reasoning and explanation by Rongming et al (1999)[4] for the above change.

The present study also noted the similar readings in the thoracic column and had tried to explain it based on the study by Pal & Routal (1986)[1] on weight transmission through the cervical & upper thoracic regions of the vertebral column in man; in which they had explained that from C7 level downwards, the compressive force is transmitted through two columns, i.e: one anterior formed by the bodies & intervertebral discs and one posterior formed by successive articulations of the laminae.

Therefore based on the above comcept of Pal & Routal (1986)[1], compressive force passing throughout the thoracic column through two columns, the present study suggests a logical explanation of increase in laminar height in thoracic vertebral column as thoracic laminae forms posterior column.

According to Rongming et al (1999)[4], in the lumbar region, the laminas, like the other parts of the vertebrae, become more massive and L5 is markedly different from the other lumbar vertebrae, with a minimum laminar height and a maximum laminar width.

The present study had observed the same changes in lumbar vertebrae with L5 showing the minimum laminar height and maximum laminar width compared with other lumbar vertebrae. Again the explanation is lacking by Rongming et al (1999)[4] as to the differentiating feature of L5 lamina. The change in laminar dimensions at L5 vertebra could be better understood by following the principles of weight transmission through lower thoracic and lumbar regions of the vertebral column by Pal & Routal (1987)[2].

According to Pal & Routal (1987)[2], the reduced surface area of the body, the strong pedicles and high articular facet / body area ratio indicate that a considerable part of the load from L5 body is transferred to its laminae and therefore neural arch at the level of L5 plays a role in load transmission.

According to Pal & Routal (1989), at the level L5 where transfer of weight from the anterior to the posterior column is suspected, load through the pedicles has to pass in an antigravity direction, i.e: opposite to the direction of inclination of the pedicles and therefore transfer of load from the body to the laminae in L5 will thus be upwards against gravity through the strong pedicles.

According to Pal & Routal (1987)[2], there occurs instability of spine following laminectomy; which explained the aetiology of instability in the lumbar region and progressive kyphosis and swan neck deformity in the cervical region following laminectomy.

Conclusion :

Thus, the present study conceptualizes a fact that is based on research work by Pal & Routal (1987); the lamina of L5 will have maximum width as compared to remaining lumbar vertebrae and the height of lamina of L5 will be less than the remaining lumbar vertebrae in order that the load is transmitted from the body of L5 to the laminae through pedicles in a diffuse manner; hence the lamina of L5 will have maximum width as compared to other lumbar vertebrae, and minimum height L5 in order to equally distribute and diffuse the load from body through pedicles to the lamina.

Thus, according to Pal & Routal (1986, 1987, 1996)[1-3] laminae play an important part in the transmission of weight through the vertebral column.

Thus the Present study had highlighted the importance of lamina in weight transmission through spine by providing useful anatomic data of the laminas of the entire spine. The anatomical data for the lamina as presented by the present study could be used for preparation of plastic models or specimens of the spine that can be utilized for the purpose of demonstration in Anatomy and Orthopedics.

The anatomy of the spinal cord could be jeopardized by the surgeon, if he attempts to place the sublaminar instruments without having proper knowledge of the size & shape & angulation of laminas of vertebrae at different levels.

Therefore, the present study could benefit the posterior spinal fixation for the management of unstable spine during surgical placement of wires, clamps & hooks with rods that is placed around or beneath the laminas.

Thus the present study had provided all important anatomic parameters of the laminas of all the vertebrae suggesting the importance of these measurements in maintaining the stability of the spine during various spinal surgeries by the adequate knowledge of the quantitative dimensions of the laminas.

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