Original Article

A Study of Height and Width of the Pedicles of Human Dry Fifth Lumbar Vertebrae

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Abstract:

Background: *Lumbar segment is the most mobile part of human spine and thus most vulnerable to wear and tear. Minute anatomic details of lumbar vertebra is essential to know for its repair procedures.* ***Objective:*** *This study was carried out with an attempt to construct data on horizontal & transverse diameters of the pedicles of 153 fully ossified dry human fifth lumbar vertebrae.* ***Method:*** *This was a cross sectional, analytic type of study which was carried out on 153 dry fifth lumbar vertebrae that are fully ossified, complete & morphologically normal bones. This study was performed in the Department of Anatomy, Sir Salimullah Medical College, Dhaka from January 2012 to December 2012.* ***Result:*** *This study observed that the mean ± SD of pedicle height was 10.4 ± 1.6 mm on left & 10.9 ± 1.8 mm on right side in male. The mean ± SD of the same variables was 9.4 ± 1.4 mm on left & 9.7 ± 1.5 mm on right side in female. The mean ± SD of pedicle width was 16 ±2 mm on left & 15.3 ± 2 mm on right side in male. The mean ± SD of the same variables was 13.5 ± 2.2 mm on left & 13.3 ± 2.5 mm on right side in female. All values were significantly higher in male than that of female.* ***Conclusion:*** *The size of pedicle of fifth lumbar vertebrae varies in accordance to ethnic as well as racial variations. Bangladeshi people have their own morphological variations of fifth lumbar vertebra in comparison to western citizens.*

Keywords: Lumbar vertebra, pedicle height, pedicle width

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Introduction

The vertebral column is the axial skeleton which acts as a firm support to the body, transfer the body weight to the legs, enclose & protects the spinal cord& cauda equina[1].Due to present lifestyle & with its speed, the incidence of assaults on the vertebral column is increasing[2].Since the lumbar segment is the mobile part of vertebral column, it is subject to instability following trauma, in particular that related to road traffic accidents, the use of heavy mechanical devices & adventure sports apart fromnumerous orthopedic disorders such as prolapsed intervertebral discs, spondylosis, kyphosis, scoliosis, ankylosing spondylitis & neoplastic metastases[3]. Therefore, it may require immobilization of the vertebral column for its activity to be regained[4]. With the help of screw, various devices like rods, plates, wires etc. can be applied to spine for immobilization or fixation[5].The fifth lumbar vertebra consists of a body in front and a neural arch behind.The pedicle connects the neural arch to the body.It is short thick, dorsal projections from the superior part of body at the junction of its lateral & dorsal surfaces[6]. Its upper margin forms the superior vertebral notch & lower margin forms the inferior vertebral notch & both contribute to corresponding intervertebral foramen containing spinal nerves[7]. As pedicle is the strongest part of the vertebra made of entirely cortical bone with a small core of cancellous bone, so it has become the preferred anchoring site for fixation[8]. Pedicle screws allow short segment & rigid fixation[9]. Transpedicular screw fixation of spine is becoming increasingly popular as it is more stable & versatile because it

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provides three dimensional fixations. In several studies, researchers demonstrated fusion rates of 90% or greater with pedicle screw fixation[10]. The success of this technique depends upon the ability of the screw to obtain & maintain purchase within the vertebral body. This is determined, among other factors, by the choice of screw for a particular pedicle size[11]. A screw that is larger than the pedicle may result in cortex perforation or even break the pedicle. Knowledge of the minimal dimensions is, therefore needed before inserting a screw into a pedicle[12]. The complications associated with oversized pedicle screw are dural tears, leakage of C.S.F & injuries to nerve roots7. Morphometric data on the dimensions of the pedicles are therefore useful in preoperative planning & in the designing of pedicle screws[11]. Being part of vertebral body, pedicle is subject to ethnic variations as reported in various studies. Hence, ethnic specific data on pedicle morphometry is necessary to avoid misplacement & inappropriate size of implants[13].

Objectives

The aim of the present study is to collect data on the different dimensions of the pedicles of adult dry fifth lumbar vertebrae in the Bangladeshi population to establish normative data & to find out whether they differ from those of other population.

Materials and Methods

Operational definition for the variables used in this study:

Pedicle height (PH):Minimum vertical distance between the upper and lower borders of the lateral surface of the pedicle7.

Figure 1: Measurement of pedicle height

Pedicle width (PW): Minimum transverse distance between the medial and lateral borders of the superior surface of the pedicle7

Figure 2: Measurement ofpedicle width

Result

Sex of the collected bones were determined by using discriminant function analysis formula[14]& other sex differentiating features of the fifth lumbar vertebra. Then grouping was done (Table 1). To evaluate the significance of the results obtained unpaired Student's 't' test were carried-out between male & female.

Table I: Grouping of the samples

Sex	No
Male	74
Female	79

Table II:Pedicle height at the left & right side of fifth lumbar vertebrae in male & female in mm

	Pedicle height		
Sex	**Left Mean + SD**	**Right Mean + SD**	**Comb. Total Mean + SD**
Male (n=74)	10.4 ± 1.6 (7.32 - 14.5)	10.9 ± 1.8 (7.42 - 15.9)	10.7± 1.7
Female (n=79)	9.4 ± 1.4 (5.41-12.21)	9.7 ± 1.5 (6.36 -15.34)	9.6 ±1.5
p value	<0.001***<0.001***		

Figure in parentheses indicate range. Comparison between sex was done by unpaired Student's 't' test, *** = significant, Comb. = Combined.

Table III:Pedicle width at the left & right side of fifth lumbarvertebrae in male & female in mm

	Pedicle width		
Sex	**Left Mean + SD**	**Right Mean + SD**	**Comb. Total Mean + SD**
Male (n=74)	16 ± 2 (10.82 -20.88)	15.3 ± 2 (9.9 - 20.38)	15.6± 2.0
Female (n=79)	13.5 ± 2.2 (7.51-17.23)	13.3 ± 2.5 (7.4 -18.59)	13.4 ±2.4
p value	<0.001***<0.001***		

Figure in parentheses indicate range. Comparison between sex was done by unpaired Student's 't' test, *** = significant, Comb. = Combined.

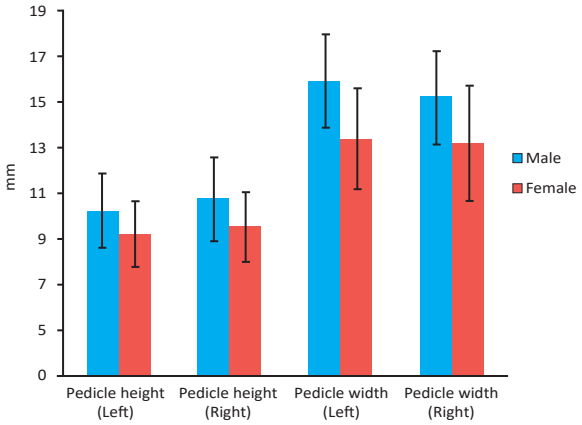

Figure 3: Bardiagram showing pedicle height and pediclewidth of 5th lumbar vertebrae of left and right side in male and female

Discussion:

This study was carried out with an aim to establish the normal ranges of diameters of the pedicle height & width of 153 adult human dry fifth lumbar vertebrae.These bones of unknown sex were subjected to discriminant function analysis for determination of sex & morphological measurements. The results of the current study were compared withthe results of different researchers of abroad.

The calculated results of the present study showed greater mean +SD of pedicle height in male than that of female in both left and right side which were statistically significant (p<0.001).The mean of both left and right sided values of the present study were significantly dissimilar (0.001) with that of Nojiri[15], Singe[17] and Jariyapong[16] conducting the study on the Japanese, Gujaratian and Thai population respectively. The observed differences might be due to different food habits and cultures which exhibit different patterns of stress on skeleton. The results of the present study was also in contrary with that of cadaveric study by Attar et al.[17]on Turkish (male p<0.001, female p= 0.080), MRI study by Karabekir et al.[18] on Turkish (p<0.001) and Radiological study by Amaza et al.[19] on Nigerian (p<0.001) &Amonoo-Kuofi[20] on Saudi people. Different measurement techniques might

be the cause of this dissimilarity.

In the present study, the mean + SD of pedicle width of both left & right side were greater in male than that of female which were statistically significant (p<0.001). Singe[17] and Jariyapong[16] found significant dissimilarity with that of the present study by conducting the study on the people of Gujarat (male p<0.01, female p<0.001) and Thailand (p<0.001). In cadaveric study on Turkish, Attar et al.[17]found significant dissimilarity (p<0.001) than that of the present study in case of male and similarity (p=1.000) in case of female. Amonoo-Kuofi[20] on Saudi &Amaza et al.[19] on Nigerian (p<0.001)by radiological study, Sugisaki et al.[9]by computed tomographic study on the people of Chicago and Karabekir et al.[18]by MRI study on Turkish (p<0.001) people found dissimilarity to that of the present study. Difference in the properties between dry and living bones might be the cause of this variation.

Conclusion

A comparison of the present study with the published data supports the view that there are ethnic as well as racial variations in the size of pedicle of fifth lumbar vertebrae. So, it is necessary to compile tables that are applicable to every population. This study showed that height & width of the lumbar pedicle were higher in males than in females & this can be explained in terms of the greater upper body weight of males. There are also significant differences in pedicular morphology in Bangladeshi population when compared with western people. This may be due to ethnic related morphologic differences as Bangladeshi have noticeably smaller body build than their western counterparts. The results of the present study provide useful information for safe surgery of posterior segmental screw fixation & for the development of new spinal implant system.Further progressive study with larger sample size with known age, sex, stature, ethnicity & comparative study between dry bone and living bone by radiological methods are recommended.

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