ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
Index Copernicus Value: 68 . 16
PubMed - National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (*IJMSIR*)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 5, Issue –2, March - 2020, Page No. : 207 - 216

Morphometric evaluation of subaxial vertebrae, its orthopedic and neurosurgical implications: a cross-sectional study of dry bones in north India

[1]Dr. Vishal Verma, Asstt. Professor, Department of Anatomy, MMIMSR, MMDU, Mullana- Ambala

[2]Dr. Dinesh Kumar, Professor, Department of Anatomy, Maulana Azad Medical College, New Delhi

[3]Dr. Neelam Vasudeva, Director Professor, Department of Anatomy, Maulana Azad Medical College, New Delhi

Corresponding Author: Dr. Vishal Verma, Asstt. Professor, Department of Anatomy, MMIMSR, MMDU, Mullana-Ambala

Citation this Article: Dr. Vishal Verma, Dr. Dinesh Kumar, Dr. Neelam Vasudeva, "Morphometric evaluation of subaxial vertebrae, its orthopedic and neurosurgical implications: a cross-sectional study of dry bones in north India", IJMSIR- March - 2020, Vol – 5, Issue -2, P. No. 207– 216.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: The term "backbone" as used in modern day society has only one meaning stability. As a central focus of stability in our species, the spine is subjected to a great degree of trauma and mechanical forces. A variety of methods have been developed throughout history in the treatment of spinal column injury. Initial treatment involved the use of simple traction devices; these have evolved to the current insertion of spinal instrumentation. Morphometric database will help in the selection of the appropriate spinal instrumentation in Indian population for better post operative results.

Aim: This comprehensive study has been undertaken to serve as a reference database for spinal instrumentation.

Methods: The study was conducted in the Department of Anatomy, Maulana Azad Medical College, Lok Nayak Hospital, New Delhi. Vertebrae were obtained from the osteology museum of the Anatomy Department. Only intact vertebrae without any anomalies were included .150 vertebrae of each region i.e cervical (subaxial), thoracic and lumbar were studied for morphometry with the help of vernier caliper and goniometer. The data was expressed as Mean and Standard deviation. The average of the different partitions in the region was calculated and the difference between averages of measurements was observed by 'Mann Whitney test. SPSS version 17 was used for analysis of data.

Results: Cervical region:

Vertebral Body: The maximum transverse diameter was more than AP diameter and anterior vertebral body height (11.9mm) was found to be slightly more than posterior height (11.7mm).

Vertebral canal: The mean AP diameter was found to be lesser than transverse diameter.

Lateral mass: Maximum transverse diameter was almost similar in the right and left side although minimum transverse diameter in right side (10.8mm) was more than left (9.1mm)

Conclusion: A three-dimensional understanding of the anatomy is very important and must be brought into

play by the spine surgeon to pinpoint the exact location of the screw in the pedicle.

Keywords: backbone, spinal instrumentation, Indian population, Vernier caliper, Goniometer

Introduction

The term 'backbone' appears in many expressions used in modern day society. In any scenario, it has one meaning: stability. As a central focus of stability in our species, the spine is subjected to a great degree of trauma and mechanical forces. A variety of methods have been developed throughout history in the treatment of spinal column injury. Initial treatment involved the use of simple traction devices; these have evolved to the current insertion of spinal instrumentation. The use of instrumentation to reduce the need for postoperative external immobilization and bed rest through immediate stabilization of the spine is attractive.[1] Since1940's vertebral screw and pedicle screw fixation have evolved and become increasingly popular among spine surgeons. The technique of pedicle screw insertion is a mainstay of minimally invasive spine surgery and posterior spinal instrumentation. A three-dimensional understanding of the anatomy is very important and must be brought into play by the spine surgeon to pinpoint the exact location of the screw in the pedicle[2]. Pedicle targeting is the technique of identifying the appropriate location and pathway for the screw to take in order to stay within the pedicle itself and not penetrate through the pedicle into surrounding tissue. Vital structures such as the nerve roots and dural sac are present within millimeters of the pedicle at certain points. The close proximity of the spinal cord and major soft tissue structures like the vertebral artery in the cervical region, aorta and esophagus in the thoracolumbar region is also a cause for concern. It is essential to be aware of the pedicular and vertebral body dimensions which dictate the upper limit to the transpedicular screw diameter and length. There is a wide variability in the vertebral dimensions of various demographic groups[3,4]. Morphometric database will help in the selection of the appropriate spinal instrumentation in Indian population for better post operative results. The maximum screw diameter in different regions of spine will be accurately known. This would improve the strength of trans-pedicle screw fixation. Pedicle angle data will help us know direction of the insertion of the screw angle[5,6]. The lateral mass dimensions of cervical vertebrae will help us know the dimensions of the appropriate plating material. All these will improve post-operative outcomes success rate and reduce the intra-operative and post-operative complications and failure of spine surgeons[7,8].

Material and methods

The study was conducted in the Department of Anatomy, Maulana Azad Medical College, New Delhi.

Study Design

Vertebrae were obtained from the osteology museum of the Anatomy Department. 150 vertebrae of each region i.e cervical (subaxial), thoracic and lumbar were studied for morphometry. Only intact vertebrae, without anomalies were selected and included.

Study Method

A) **Direct measurement of Dry bones**:

The lower 5 cervical, 12 thoracic and 5 lumbar vertebrae were studied on the following parameters:

a) Vertebral Body
- Maximum Antero-Posterior diameter,
- Maximum Transverse diameter,
- Midline Height-Anterior and Posterior

b) Pedicle (Bilateral)
- Sagittal Isthmus Height
- Transverse isthmus Width

© 2020 IJMSIR, All Rights Reserved

c) Pedicle Angle (bilateral)

Angle between the midpoint of the anterior border of the upper surface of the vertebra to the long axis of pedicle.

d) Vertebral Canal

- Maximum Antero-Posterior diameter
- Maximum Transverse diameter

e) Lateral mass (Only for cervical vertebrae C3-C7)

- Maximum Transverse diameters
- Minimum Transverse diameter

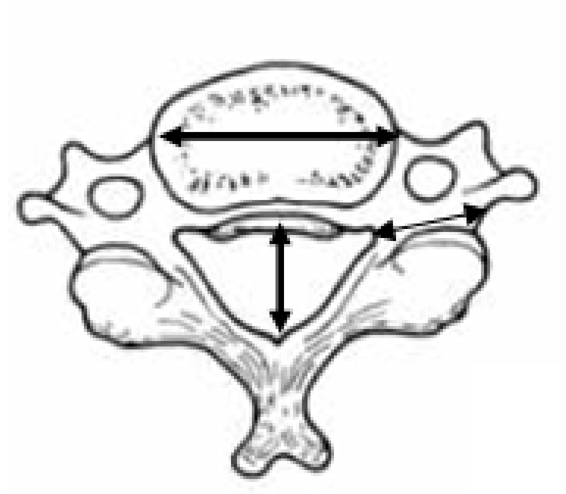

Figure 1: Vertebral body Transverse diameter Canal AP diameter.

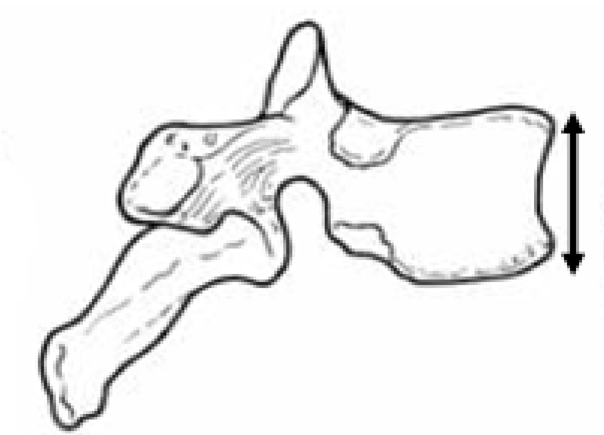

Figure 2: Vertebral body Anterior Height

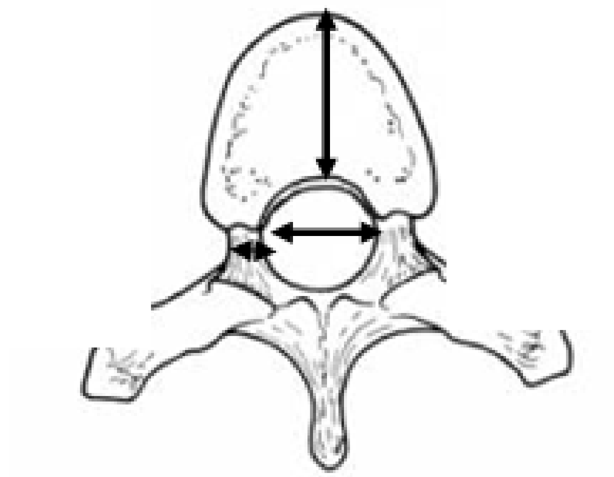

Figure 3: Vertebral body AP diameter Canal Transverse diameter Pedicle transverse isthmus width

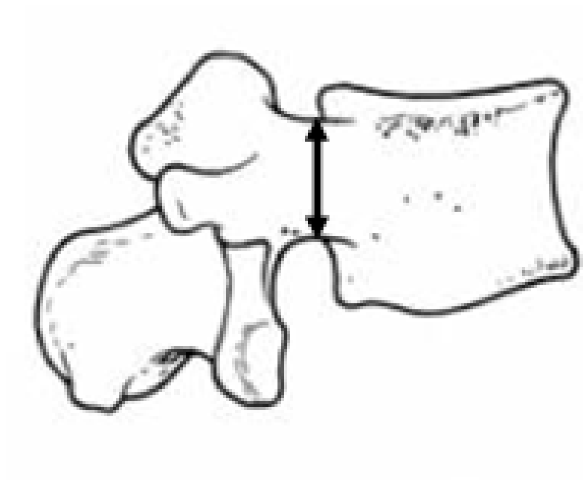

Figure 4: Pedicle Sagittal Isthmus height

All linear measurements were recorded by using a sliding vernier caliper (manual version). Angular measurements were done using a goniometer.

Methodology of using the vernier caliper

The jaws of the calliper were closed lightly on the pedicle to measure the transverse isthmus width and sagittal isthmus height. The same process was adopted to measure the maximum antero-posterior, maximum transverse diameter and anterior and posterior height of vertebral body.

© 2020 IJMSIR, All Rights Reserved

To measure the antero-posterior and transverse diameter of vertebral canal, the small prongs on the other side are fitted in the interior of the canal.

Goniometer

We used the stainless steel two pronged 180^0version. Precision of measurement possible by this version was up to 1^0.

Methodology of using the goniometer

The fixed arm of the goniometer was kept horizontal by keeping it along the line of vertebral body and the mobile arm along the line of axis of pedicle. Reading of angle was then recorded from the slit on the other side of mobile prong towards which the pointer is projecting. Pedicle angle was then calculated by subtracting this reading from 90^0

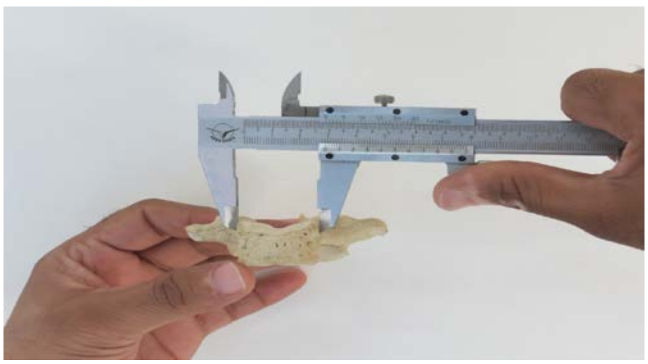

Figure 5: showing the vertebral body morphometric: Transverse diameter using vernier caliper

Figure 6: showing the vertebral canal morphometry: Antero-Posterior diameter

Figure 7: showing the pedicle angle measurement using Goniometer.

- Maximum A-P diameter of vertebral body was measured by the vernier calliper, which usually is in the middle of vertebral body. Measurements were recorded according to the method described above.
- Maximum transverse diameter of vertebral body was measured. Three readings were taken by shifting vernier calliper slightly anterior and posterior to the first reading and then average of these three measurements was taken as the maximum transverse diameter, to eliminate observer's visual bias.
- Vertebral body height, Anterior and posterior were also measured the same way.
- Sagittal isthmus height, Transverse isthmus width of pedicle were also measured by adopting the same method.
- Antero-posterior and Transverse diameter of vertebral canal were measured by fitting the opposite side prongs of the vernier calliper within the canal. Readings were taken by the same method as described above.
- Maximum and minimum transverse diameter of Lateral mass, were also recorded in case of cervical vertebrae.

© 2020 IJMSIR, All Rights Reserved

- Measurement of pedicle angle on both right and left side were observed and recorded with the help of Goniometer.

Statistical Analysis

The data was expressed as Mean and Standard deviation. The average of the different partitions in the region was calculated and the difference between averages of measurements was observed by 'Mann Whitney test. SPSS version 17 was used for analysis of data.

Results:

Cervical region (Table 1**)**

Vertebral Body Morphometry: In the typical cervical vertebrae, the maximum transverse diameter was more than AP diameter and anterior vertebral body height (11.9mm) was found to be slightly more than posterior height (11.7mm).

Vertebral canal Morphometry: The mean AP diameter was found to be lesser than transverse diameter.

Lateral mass morphometry: Maximum transverse diameter was almost similar in the right and left side although minimum transverse diameter in right side (10.8mm) was more than left (9.1mm).

Thoracic region (Table 2**)**

Vertebral Body Morphometry: The AP diameter was more in typical thoracic vertebrae but it was lesser at T9. It starts to increase gradually till T12. The transverse diameter showed a consistent increase from T1 to T12.

Vertebral canal Morphometry: Mean AP diameter between T1 to T8 was 14.3 mm. A uniform increase from T10 to T12 vertebrae in both AP and transverse diameter was observed.

Vertebral Pedicle morphometry: The maximum and minimum dimensions of pedicle showed a gradual increase from T1 to T12

Pedicle angle: Mean right pedicle angle was observed to be 10.6^0 between T1 to T8 vertebrae.

Mean left pedicle angle was observed to be 11.6^0

Lumbar region (Table 4**)**

Vertebral Body Morphometry: Transverse diameter was greater than AP diameter at all lumbar vertebral levels.

The anterior height was more than posterior height at all levels.

Verebral canal: The transverse diameter was more than AP diameter at all levels.

Pedicle morphometry: The sagittal isthmus height as well as transverse isthmus width were higher in L5 vertebra as comparison to typical lumbar vertebrae in both the sides.

Pedicle angle: The mean pedicle angle was also more in L5 vertebra as comparison to other typical lumbar vertebrae.

Discussion

This anatomic study of a large series (total 450) of human dry bone specimens was undertaken to obtain detailed anatomical data of the subaxial cervical, thoracic and lumbar vertebrae. Morphometric analysis of vertebral body, vertebral canal and pedicle dimensions was done.

Vertebral body morphometry: This is useful for spine surgeons while performing anterior cervical reconstruction using plate fixation. The AP diameter of vertebral bodies is an important parameter for anterior fixation of bicortical screws. The measurement of AP diameter allows prediction of chord length i.e the screw path length[8]. This is needed to estimate screw length for surgical implant placement[9]. The anterior and the

© 2020 IJMSIR, All Rights Reserved

posterior vertebral body heights determine the shape of the vertebra which defines the kyphotic curve in the thoracic spine and lardotic curvature[10] in the lumbar region.

Vertebral Canal morphometry: The anterior and posterior diameter of the canal is important because of the spinal cord with its meninges being present here. Decrease of these parameters will result in stenosis of the canal resulting in impingement of the dura mater[9].

Pedicle Morphometry: The most important dimensions for pedicle fixation are those of pedicle width and chord length, Because these dictate the upper limit to transpedicular screw diameter and length, screw diameter is important as it limits screw strength and influence screw bone interface strength. The larger the screw diameter the greater the surgical fixation strength. Screws of smaller diameter may break and there has been some concern over screw breakage[8,9,10].

Cervical region

Vertebral body: The anterior height was greater than the posterior height at all levels. The transverse diameter was more than AP diameter at all the levels. These findings are consistent with other workers.[7,8,10]

Vertebral canal: Transverse diameter was more than AP diameter in keeping with vertebral body measurements.

Lateral mass: The maximum as well as minimum transverse diameter were more on right side as comparison to left.

These findings are consistent with the findings of Gulgun et al [7] and Tan et al [10]

Thorax

Vertebral body: The AP diameter increased in a linear manner from T1 to T12. A transition zone from thoracic to lumbar at T12, displaying a marked rise in AP diameter. The transverse diameter followed a similar trend but was more than AP diameter at all levels .The posterior height was more than anterior height and kept on increasing in the caudal direction. The posterior body height was more than the anterior height due to the wedge shape of the thoracic vertebra, which defines the kyphotic curve in the thoracic spine.

Vertebral canal: Vertebral canal showed a gradual increase in AP diameter from T1 to T12.

The transverse diameter was more than AP diameter at all levels.

The dimensions of the vertebral canal followed the dimensions of the vertebral body.

Pedicle Morphometry:

The maximum and minimum dimensions of pedicle increased gradually from T9 to T12 on both the sides. These finding are consistent with various investigators[3,6,9,11,12,13,14,15,16,17,18].

Pedicle angle:

The right and left pedicle angles remained almost the same from Typical thoracic to T9. From T10 to T12 levels there is sudden decline with an abrupt fall at T12 level.

The right and left transpedicular screws at each vertebral level may be placed along this oblique axis thus producing a toe-nailing effect, this substantially increases the resistance of the pair of screws against posterior pull out. It also increases the resistance to translation of one vertebra to subjacent one[10].

Lumbar

Vertebral body: AP diameter was observed to be less than transverse diameters at all levels. AP diameter increased from L1 to L5 and the same pattern was followed by transverse diameter.

Anterior height was seen to be more than posterior height at all levels. Similar findings have been reported by Tan al[10] in their study on Chinese population.

© 2020 IJMSIR, All Rights Reserved

The lordotic curvature in the lumbar region is actually defined by the intervertebral discs[19].

Vertebral canal: The transverse diameter was more than AP diameter at all levels. The AP and transverse diameters were maximum at L5vertbra.

Pedicle Morphometery: Pedicle height gradually increased from L1 to L4 in typical lumbar vertebrae with an abrupt increase at L5.

Pedicle angle: The pedicle angle was small at L1 showing a gradual increase from L1 to L4 and then an abrupt increase and very high values at L5.

These finding are consistent with results of other investigators[5,6,9,10,12,17,20,21,22,23,24].

Transition zones: In the vertebral column, two transitional regions were identified.

Cervico-thoracic and 2) thoraco-lumbar transition zones.

The bodies of upper thoracic vertebrae gradually change from cervical to thoracic in type, while the lower change from thoracic to lumbar. Geometric analysis suggests that these modifications are also adaptations to a greater range of flexion – extensions at the cervical and lumbar ends.

Thoracolumbar: Abrupt increase in transverse diameter of vertebral body at T11

Dip in transverse diameter at L4 and abrupt increase at L5

Conclusions

The technique of pedicle screw insertion is a mainstay of minimally invasive spine surgery and posterior spinal instrumentation, hence understanding of the anatomy in a three dimensional perspective is very important and helpful for spine surgeon to pinpoint the exact location, length and angle of the screw in the pedicle.

References

1. Kabins MB, Weinstein JN.The History of Vertebral Screw and Pedicle Screw Fixation. The Iowa Orthopaedic Journal 1991;11:127-136.
2. Zeiller SC, Lee J, Lim M, Vaccaro AR. Posterior thoracic segmental pedicle screw instrumentation: Evolving methods of safe and effective placement. Neurology India 2005; 53:458-65.
3. McLain, Robert F. MD, Ferrara, Lisa MS, Kabins, Mark MD. Pedicle Morphometry in the Upper Thoracic Spine: Limits to Safe Screw Placement in Older Patients. Spine 2002; 27(22):2467-2471.
4. Shetty AS, Avadhani R, Mahesha B, Shantaram M. Pedicle morphometry: a radiological assessment using computerized tomographic (ct) scan. International Journal of Basic and Applied Medical Sciences ISSN: 2277-2103 (Online) An Online International Journal Available at http://www.cibtech.org/jms.htm 2011 Vol. 1 (1) September-December, pp.23-25
5. Zindrick MR, Wiltse LL, Doornik A, Widell EH, Knight GW, Patwardhan AG. Analysis of the morphometric characteristics of the thoracic and lumbar pedicles. Spine 1987; 12(2):160-6.
6. Chadha M, Balain B, Maini L, Dhaon BK. Pedicle morphology of the lower thoracic, lumbar, and S1 vertebrae: an Indian perspective. Spine 2003; 28(8):744-9.
7. Gulgun K, Mete E, Tuncay V, Enis C. Morphometry of the Cervical Vertebral Pedicles as a Guide for Transpedicular Screw Fixation. Neurol Med Chir Tokyo2007; 47:102-108.
8. Bazaldua CJJ, Gonzalez LA, Gomez SA, Villarreal SEE, Velazquez GSE, Sanchez UA et al. Morphometric study of cervical vertebrae C3-C7 in

© 2020 IJMSIR, All Rights Reserved

a population from northeastern Mexico. Int.J. Morphol.2011;29(2):325-330.
9. Krag MH, Weaver DL, Beynnon BD, Haugh LD. Morphometry of the thoracic and lumbar spine related to transpedicular screw placement for surgical spinal fixation. Spine 1988 Jan; 13(1):27-32.
10. Tan SH, Teo EC, Chua HC. Quantitative three-dimensional anatomy of cervical, thoracic and lumbar vertebrae of Chinese Singaporeans. Eur Spine J (2004); 13(2) : 137-146.
11. Berry JL, Moran JM, Berg WS, Steffee AD. A Morphometric Study of Human Lumbar and Selected Thoracic Vertebrae. Spine 1987; 12(4):362-367.
12. Lien SB, Liou NH , Wu SS. Analysis of anatomic morphometry of the pedicles and the safe zone for through-pedicle procedures in the thoracic and lumbar spine. Eur Spine J 2007; 16:1215–1222.
13. Singh R, Srivastva SK, Prasath CS, Rohilla RK, Siwach R, Magu NK. Morphometric Measurements of Cadaveric Thoracic Spine in Indian Population and Its Clinical Applications.Asian Spine Journal 2011; 5(1) : 20-34.
14. Panjabi MM, Takata K, Goel V, Dale F, Thomas O, Joanne D et al. Thoracic Human Vertebrae: Quantitative Three dimensional Anatomy. Spine 1991; 16(8):888-901.
15. Datir SP, Mitra SR. Morphometric study of the thoracic vertebral pedicle in an Indian population. Spine 2004; 29(11):1174-81.
16. Pai BS; Gangadhara, Nirmala S, Muralimohan S, Varsha SM. Morphometric analysis of the thoracic pedicle: an anatomico-radiological study. Neurol India. 2010; 58(2):253-8.
17. Acharya S, Dorje T, Srivastava A. Lower dorsal and lumbar pedicle morphometry in Indian population: a study of four hundred fifty vertebrae. Spine 2010; 35(10):378-84.
18. Kang KS , Song KS , Lee JS, Yang JJ, Song IS. Comparison of radiographic and computed tomographic measurement of pedicle and vertebral body dimensions in Koreans: the ratio of pedicle transverse diameter to vertebral body transverse diameter. Eur Spine J 2011; 20:414–421.
19. Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE, editors.
Gray's Anatomy 38th edition; Elsevier Churchill Livingston ; Skeletal system :516-28
20. Postacchini F, Ripani M, Carpano S. Morphometry of the lumbar vertebrae. An anatomic study in two Caucasoid Ethnic Groups. Clinical Orthopaedics and related research1983; 172:296-303.
21. Singel TC, Patel MM, Gohil DV.A study of width and height of lumbar pedicles in Saurashtra region. J.Anat.Soc.India.2004; 53 (1):4-9.
22. Olsewski JM, Simmons EH, Kallen FC, Mendel F, Severin CM, Berens DL. Morphometry of the Lumbar spine: Anatomical Perspectives Related to Transpedicular Fixation. The Journal of Bone and Joint Surgery1990; 72A(4):541-49.
23. Mitra SR, Datir SP, Jadhav SO. Morphometric study of the lumbar pedicle in the Indian population as related to pedicular screw fixation. Spine 2002; 27(5):453-9.
24. Chandanwale AS, Giripunje NB, Rajput Y, Loganathan B, Jadhao AB, Nawale SN. Morphometric study of lumbar pedicles in Indian Population. J. Orthopaedics 2009; 6(4): 9.

© 2020 IJMSIR, All Rights Reserved

Legends Tables

Table: 1 Cervical Vertebrae Morphometry

		Vertebral Body				Vertebral canal		Lateral Mass			
								TRANS DIA - RIGHT		TRANS DIA -LEFT	
		Max AP Dia	Max Trans Dia	Height (ANT)	Height (POST)	AP	TRANS	MAX	MIN	MAX	MIN
Typical Cervical	Range	12.4-20	11 -25	7.2-18	8 -11	9.7-18	19.5-26.7	9.2-22.5	8.3-20.2	8.2-19	6.1-14
	Mean	15.3	19.8	11.9	11.7	13.4	23	13.2	10.8	13.1	9.1
	S.D	1.5	2	1.5	1.7	1.4	2	1.6	1.5	1.5	1.5

Table: 2 Thoracic Vertebrae Morphometry

		Vertebral Body				Vertebral canal		Pedicle angle		Pedicle			
										RIGHT		LEFT	
		Max AP Dia	Max Trans Dia	Height (ANT)	Height (POST)	AP	TRANS	ANGLE-R (Degrees)	ANGLE-L (Degrees)	MAX	MIN	MAX	MIN
Typical Thoracic	Range	10-29.2	21.6-31.7	13 -20.9	13.8 -21.6	12.1 - 18.2	12.9 - 22	0-35	0-40	6.2-13.6	1.7 - 8.1	1.6-13.7	2.0 – 10.6
	Mean	20.4	27.1	17.3	18.1	14.3	16.4	10.6	11.6	10.5	4.8	10.4	4.9
	S.D	3.6	2.4	1.7	1.6	1.1	1.7	10	10.7	1.2	1.3	1.5	1.4
T9	Range	13.6 - 27.5	23.8 - 35	13.2-24	14.5-24	12.4-16.0	13.5-19.8	0-25	2-30	8.4-13.6	6.4-5	8.1-13	4.7-8
	Mean	19.8	28.6	17.7	18.5	14.5	16.5	12.8	14.3	10.9	5	10.8	5.8
	S.D	5.7	3.6	3.6	3.2	1.2	1.9	8.7	10.0	1.7	0.9	1.9	1.2
T10	Range	22-30.3	27-36	19-22.2	18.8 -24.5	13-15.4	15-18.7	0-10	0-6	11.4-14.6	3.8 - 7.5	10.7-14.1	4.3-8.6
	Mean	25.4	31.6	20.2	20.8	14.3	16.7	2.2	2	13	5.5	12.6	5.9
	S.D	2.4	2.8	1.2	1.8	0.9	1.4	3.6	2.6	1.1	1.1	1.1	1.5
T11	Range	23-30	29.9-41	18.2-23	17-24.4	12-16.2	15-19.1	0 -12	0-15	13.3-16.4	5.3-8.3	13-16.3	4.9-9.2
	Mean	26.3	33.2	20.3	20.1	14.1	17.05	2.7	3.6	14.9	6.8	14.6	7
	S.D	1.8	2.7	1.3	1.7	1.1	1.5	4	4.3	6.2	2.5	5.9	2.6
T12	Range	21.2-32.1	29.1-46	18.4- 24	21.9 -28.4	11.7 - 17.2	15-20.9	0 -2	0 -2	12 - 17.4	5.7 - 11.7	12.5 - 16.6	5.2-13
	Mean	26.3	36.7	21.3	23.8	14.3	18	0.2	0.1	15.4	8.3	15.2	8.8
	S.D	2.4	3.5	1.5	1.6	1.3	1.6	0.5	0.4	1.2	1.5	1.2	2

© 2020 IJMSIR, All Rights Reserved

Table: 3 Lumbar Vertebrae Morphometry

		Vertebral Body				**Vertebral canal**		**Pedicle angle**		**Pedicle**			
										RIGHT		**LEFT**	
		Max AP Dia	**Max Trans Dia**	**Height (ANT)**	**Height (POST)**	**AP**	**TRANS**	**ANGLE-R (Degrees)**	**ANGLE-L (Degrees)**	**SIH**	**TIW**	**SIH**	**TIW**
Typical Lumbar	Range	25.5 -36.5	36 -57	15.1 - 28.7	20-29	11.8-18	17.7 - 26.6	0-30	0-30	12.1-18.2	3.7-12	12-18.5	3.3-13
	Mean	30.7	44.5	24.7	24.6	14.8	21.2	11.6	11.9	14.4	7.9	14.3	8.1
	S.D	2.8	5.5	2.2	1.8	1.4	2	8.8	8.7	1.3	1.8	1.5	2
L5	Range	24.4-37.6	41-56	21.6-27.8	18-26	11.2-20	21-30	30-45	30-45	15.3-26	8-13.2	16.3-25.2	6.8-15.7
	Mean	32.1	48.1	25.4	21.3	15.4	25.7	39.3	39.3	20.2	10.8	19.9	10.9
	S.D	3	3.5	1.6	2.2	2.4	2.8	3.9	3.9	2.3	1.5	2.4	1.9

© 2020 IJMSIR, All Rights Reserved