Original Article

Indian Journal of Anatomy
Volume 8 Number 4, October – December 2019
DOI: http://dx.doi.org/10.21088/ija.2320.0022.8419.2

A Morphometric Study of the Vertebral Body in Dry Human Typical Lumbar Vertebrae

Dhaval K Patil[1], Vaishali S Anturlikar[2]

Abstract

Background: The knowledge of various morphometric measurements of the vertebral body is essential for neurosurgeons and spinal surgeons for performing various operative procedures on the lumbar spine. The present study aims to create a morphometric database pertaining to the bodies of typical lumbar vertebrae. *Objective:* To measure the various dimensions of vertebral body in typical lumbar vertebrae. *Material and methods*: Two hundred dry human typical lumbar vertebrae of undetermined gender and age were selected for the study. The various parameters of vertebral body were measured. *Results:* The anteroposterior distance of the vertebral body in typical lumbar vertebrae ranged from 23.44 to 36.74 mm with a mean of 29.55 ± 2.93 mm. The transverse diameter of the vertebral body ranged from 33.54 to 54.06 mm with a mean of 42.37 ± 3.99 mm. The vertebral body width ranged from 29.26 to 48.98 mm with a mean of 37.23 ± 3.68 mm. The anterior height of the body ranged from 17.06 to 29.26 mm with a mean of 24.03 ± 2.14 mm. The posterior height of the body ranged from 17.84 to 31.42 mm with a mean of 25.28 ± 2.16 mm. *Conclusion:* The results provide a comprehensive database which will be helpful for designing of vertebral body instrumentations for Indian population.

Keywords: Vertebral body; Typical lumbar vertebra; Anterior height; Posterior height; Vertebral body width.

How to cite this article:
Dhaval K Patil, Vaishali S Anturlikar. A Morphometric Study of the Vertebral Body in Dry Human Typical Lumbar Vertebrae. Indian J Anat. 2019;8(4):261–264.

Introduction

The lumbar vertebrae perform the function of supporting the weight of the upper body. Vertebral body is the key element in load bearing system of the spine. So, the vertebral bodies are subjected to significant loading stress which may be a contributing factor in low-back pain seen commonly in the Indian population. Besides this, the lumbar spine is involved in various other conditions such as degenerative changes, infections, congenital defects, neoplastic metastases and accidents.

Anterior access to the lumbar vertebrae and disc spaces is increasingly used for lesion excision, corpectomy, vertebral body reconstruction with cages, realignment, and/or plating or screwing. Such approach provides direct access to most spine diseases and allows optimal neural decompression. Thus the possibility of adequate realignment and strong reconstruction/fixation is increased. In recent years, anterior lumbar interbody fusion for stabilization of spine has gained popularity. Expandable vertebral body replacement material is used to provide solid anterior column constructs along with restoration of height and sagittal alignment of the vertebrae. For a successful anterior approach and a suitable instrumental design, adequate morphometric knowledge about body of lumbar vertebrae is essential.[1]

In a computerized medical robot-assisted surgery system, the morphometric data of the lumbar spine is needed to define the operational

Author's Affiliation: [1]Assistant Professor, Department of Anatomy, Seth GS Medical College, Parel, Mumbai, Maharashtra 400012, India. [2]Assistant Professor, Department of Anatomy, S.M.B.T. Institute of Medical Sciences and Research Center, Dhamangaon, Tal. Igatpuri, Dist. Nashik, Maharashtra 422403, India.

Corresponding Author: Vaishali S Anturlikar, Assistant Professor, Department of Anatomy, Seth GS Medical College, Parel, Mumbai, Maharashtra 400012, India.

E-mail: vaishali.ahire@gmail.com

Received 26.08.2019 | **Accepted** 04.10.2019

workspace for various surgical procedures on the spine.[2] The knowledge of measurements of the bodies of lumbar vertebrae is also helpful in diagnosing various pathological conditions and management of lower backache. It will also be helpful in various stabilization and correction procedures for deformities of spine. Hence, the present study measured the various dimensions of vertebral body.

Materials and Methods

The study was conducted on dry human typical lumbar vertebrae. The vertebrae were obtained from the bone collection of the department of Anatomy of a tertiary care hospital. Of the total collection of lumbar vertebrae in the department, 200 undamaged typical lumbar vertebrae were selected for the study. The vertebrae were of undetermined gender and age. Each vertebra was assigned a serial number. Anatomical measurements were taken on these specimens using a vernier caliper (0–150 mm with a precision of 0.02 mm) (Fig. 1). The following parameters were recorded in a pro forma:

1. *Anteroposterior distance of the vertebral body*: It is the distance between anterior border and posterior border of the superior surface of vertebral body in midline.
2. *Transverse diameter of the vertebral body*: It is the maximum transverse diameter of the vertebral body at the superior surface.
3. *Vertebral body width*: It is the minimum transverse distance across the sides of vertebra in anterior view of the body.
4. *Anterior height of the body*: It is the vertical distance between superior and inferior surface of body in the midline anteriorly.
5. *Posterior height of the body*: It is the vertical distance between superior and inferior surface of body in the midline posteriorly.

The findings were recorded in tabulated form and statistical analysis was done using Microsoft Excel.

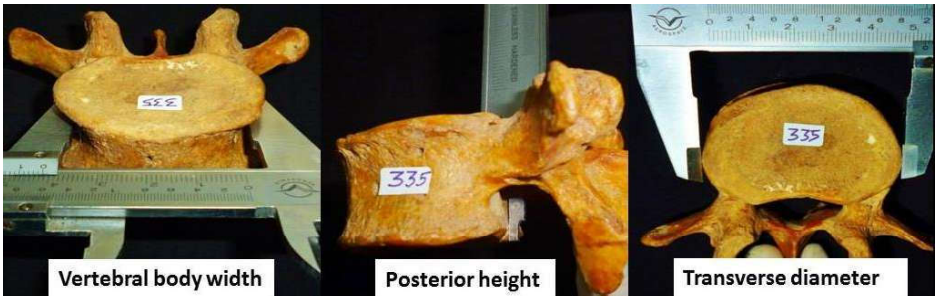

Fig. 1:

Results

1. The anteroposterior distance of the vertebral body in typical lumbar vertebrae ranged from 23.44 to 36.74 mm with a mean of 29.55 ± 2.93 mm.
2. The transverse diameter of the vertebral body in typical lumbar vertebrae ranged from 33.54 to 54.06 mm with a mean of 42.37 ± 3.99 mm.
3. The vertebral body width in typical lumbar vertebrae ranged from 29.26 to 48.98 mm with a mean of 37.23 ± 3.68 mm.
4. The anterior height of the body in typical lumbar vertebrae ranged from 17.06 to 29.26 mm with a mean of 24.03 ± 2.14 mm.
5. The posterior height of the body in typical lumbar vertebrae ranged from 17.84 to 31.42 mm with a mean of 25.28 ± 2.16 mm.

Discussion

Several quantitative anatomical studies have been carried out for lumbar vertebrae in different countries. Many authors have studied the vertebrae using different methods such as direct specimen measurements, plain radiographs, CT scans and MRI scans. The studies which have focused on parameters pertaining to vertebral bodies include Issachar Gilad *et al.*,[3] Alon Wolf *et al.*,[2] Tan *et al.*,[4] Urrutia VE *et al.*,[5] Gocmen-Mas N *et al.*,[1] Karabekir HS *et al.*,[6] Alam MM *et al.*,[7] Eisenstein S,[8] Amonoo-Kuofi HS,[9] Berry JL *et al.*,[10] Nirvan AB *et al.*,[11] Gupta R *et al.*,[12] and Kanani SD *et al.*[13] The following tables (Tables 1 to 4) present the comparison of means

of the various parameters obtained from previous studies with that of the present study.

Table 1 shows that the value reported by Tan *et al.*[4] is similar to the value of the present study. The mean anteroposterior distance of the vertebral body determined by the present study is lower than that of the other studies.

The mean transverse diameter of the vertebral body in the present study is in consonance with that of Alon Wolf *et al.*,[2] Urrutia VE *et al.*,[5] Tan *et al.*,[4] Alam MM *et al.*,[7] and Karabekir HS *et al.*,[6] but is lower than that of Gocmen-Mas N *et al.*,[1] (Table 2).

Table 1: Comparison of Mean Anteroposterior Distance of The Vertebral Body in Typical Lumbar Vertebrae with Other Studies

Study	Year	Country	Material for study	Mean (in mm)
Issachar Gilad *et al.*[3]	1985	Israel	Radiographs	34.22
Alon Wolf *et al.*[2]	2001	Israel	CT scans	30.68
Tan *et al.*[4]	2004	Singapore	Dry bones	29.13
Urrutia VE *et al.*[5]	2009	Mexico	CT scans	32.06
Gocmen-Mas N *et al.*[1]	2010	Turkey	MRI scans	35.52
Karabekir HS *et al.*[6]	2011	Turkey	Dry bones	33.92 (L1 to L5)
Alam MM *et al.*[7]	2014	Pakistan	CT scans	31.39
Present study		India	Dry bones	29.55

Table 2: Comparison of Mean Transverse Diameter of The Vertebral Body in Typical Lumbar Vertebrae with Other Studies

Study	Year	Country	Material for study	Mean (in mm)
Alon Wolf *et al.*[2]	2001	Israel	CT scans	41.93
Tan *et al.*[4]	2004	Singapore	Dry bones	39.1
Urrutia VE *et al.*[5]	2009	Mexico	CT scans	41.6
Gocmen-Mas N *et al.*[1]	2010	Turkey	MRI scans	52.68
Karabekir HS *et al.*[6]	2011	Turkey	Dry bones	42.72
Alam MM *et al.*[7]	2014	Pakistan	CT scans	43.16
Present study		India	Dry bones	42.37

The mean vertebral body width in the present study is comparable with that of Eisenstein S,[8] Gupta R *et al.*[12] and Kanani SD *et al.*[13] The mean is lesser than that found by Amonoo-Kuofi HS,[9] Berry JL *et al.*,[10] and Nirvan AB *et al.*[11] (Table 3). Gupta R *et al.*,[12] mention that the vertebral body width ranged between 27.06 and 48.32 mm for typical lumbar vertebrae as compared to 29.26–48.98 mm in the present study.

Table 3: Comparison of mean vertebral body width in typical lumbar vertebrae with other studies

Study	Year	Country/ Race	Material for study	Mean (in mm)
Eisenstein S[8]	1977	Caucasoid	Dry bones	38.88
		Negroid	Dry bones	39.06
Amonoo-Kuofi HS[9]	1982	Nigeria	Radiographs	43.19
Berry JL *et al.*[10]	1987	USA	Dry bones	41.85
Amonoo-Kuofi HS *et al.*[14]	1990	Saudi Arabia	Radiographs	48.65
Nirvan AB *et al.*[11]	2005	India	Radiographs	42.45
Gupta R *et al.*[12]	2011	India	Dry bones	38.9
Kanani SD *et al.*[13]	2012	India	Dry bones	36.62
Present study		India	Dry bones	37.23

The mean anterior height of the body in the present study is greater than that found by Tan *et al.*[4] but is slightly lower than other studies (Table 4). Table 4 shows that the mean posterior height of the body in the present study resembles with that of Alon Wolf *et al.*[2] The value is slightly lower than that of Issachar Gilad *et al.*,[3] Alan MM *et al.*[7] and Karabekir HS *et al.*[6] but is greater than the finding of Tan *et al.*[4]

Table 4: Comparison of mean anterior height and posterior height of the body in typical lumbar vertebrae with other studies

Study	Year	Country	Material for study	Mean Anterior Height (in mm)	Mean Posterior Height (in mm)
Issachar Gilad *et al.*[3]	1985	Israel	Radiographs	26.98	27.28
Tan *et al.*[4]	2004	Singapore	Dry bones	21	22.3
Gocmen-Mas N *et al.*[1]	2010	Turkey	MRI scans	25.1	–
Alon Wolf *et al.*[2]	2001	Israel	CT scans	–	25.6
Karabekir HS *et al.*[6]	2011	Turkey	Dry bones	26.52 (L1 to L5)	26.44 (L1 to L5)
Alam MM *et al.*[7]	2014	Pakistan	CT scans	26.28	27.69
Present study		India	Dry bones	24.03	25.28

Conclusion

Thus, a comprehensive data set has been presented which provides quantitative anatomy of vertebral body of typical lumbar vertebrae. The differences in the results of the present study and those of the previous studies with respect to some of the parameters may be due to differences in race, ethnicity, environmental factors as well as methods used for the studies. These findings can be used for various comparative studies with respect to Indian population. The data will also help in designing various implants and selecting appropriate size for instruments for various procedures on the lumbar spine for Indian population. It also establishes the need for preoperative radiographic evaluation before planning a surgical intervention of the lumbar spine. In the future, the scope of the study can be further extended to study the vertebral column with respect to individual vertebral levels.

References

1. Gocmen-Mas N, Karabekir H, *et al.* Evaluation of lumbar vertebral body and disc: a stereological morphometric study. Int J Morphol. 2010;28(3):841–47.
2. Wolf A, Shoham M, Michael S, *et al.* Morphometric study of the human lumbar spine for operation–workspace specifications. Spine 2001;26(22):2472–77.
3. Gilad I, Nissan M. Sagittal evaluation of elemental geometrical dimensions of human vertebrae. J Anat. 1985;143:115–20.
4. Tan SH, Teo EC, Chua HC. Quantitative three-dimensional anatomy of cervical, thoracic and lumbar vertebrae of Chinese Singaporeans. Eur Spine J. 2004;13:137–46.
5. Urrutia VE, Elizondo OR, De la Garza CO, *et al.* Morphometry of pedicle and vertebral body in a Mexican population by CT and Fluoroscopy. Int J Morphol. 2009;27(4):1299–1303.
6. Karabekir HS, Gocmen-Mas N, Edizer M, *et al.* Lumbar vertebra morphometry and stereological assesment of intervertebral space volumetry: a methodological study. Ann Anat. 2011;193(3):231–36.
7. Alam MM, Waqas M, Shallwani H, *et al.* Lumbar morphometry: a study of lumbar vertebrae from a Pakistani population using computed tomography scans. Asian Spine J. 2014;8(4):421–26.
8. Eisenstein S. The morphometery and pathological anatomy of lumbar spine in South African Negroes and Caucasoid with special reference to spinal stenosis. J Bone Joint Surg. 1977;59-B(2):173–80.
9. Amonoo-Kuofi HS. Maximum and minimum lumbar interpedicular distances in normal adult Nigerians. J Anat. 1982;135:225–33.
10. Berry JL, Moran JM, Berg WS, *et al.* A morphometric study of human lumbar and selected thoracic vertebrae. Spine (Phila Pa 1976) 1987;12:362–67.
11. Nirvan AB, Pensi CA, Patel JP, *et al.* A study of interpedicular distances of the lumbar vertebrae measured in plain anteroposterior radiograph in Gujaratis. J Anat Soc Ind. 2005;54(2):58–61.
12. Gupta R, Singla RK. Thoracolumbar neural canal—a morphometric and morphological study in North Indian population. J Pharm Biomed Sci. 2011;11 (11):1–7.
13. Kanani SD, Nirvan AB, Patel JP, *et al.* Calculation of canal/body ratio for lumbar spinal canal in dried vertebrae in Gujarat. Indian Journal of Applied Basic Medical Sciences. 2012;14(19):71–76.
14. Amonoo-Kuofi HS, Patel PJ, Fatani JA. Transverse diameter of the lumbar spinal canal in normal adult Saudis. Acta Anat. 1990;137:124–28.