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MORPHOMETRIC STUDY OF LENGTH AND HEIGHT OF LUMBAR VERTEBRAL BODIES IN NORTH INDIAN ADULT MALE POPULATION AND ITS CLINICAL RELEVANCE.

Anatomy

Dr Rimpi Gupta* Associate Professor, Dept Of Anatomy, Kalpana Chawla GMC, Karnal. *Corresponding Author

Dr Rajan Singla Professor, Dept Of Anatomy, GMC, Patiala.

Dr Rakhi Rastogi Professor, Dept Of Anatomy, Saraswathi institute of medical sciences, Hapur.

ABSTRACT

Background: Human lumbar vertebrae support the weight of the upper body. Weight bearing and mechanical factors appear to play important roles in morphological adaptation of the vertebral column . The anterior lumbar interbody fusion approach is used for lesion excision, corpectomy, vertebral body reconstruction with cages etc. Adequate morphometric knowledge about body of lumbar vertebrae is mandatory for a neurosurgeon for diagnostic and therapeutic purposes like vertical compression of vertebral bodies, for screw fixation to avoid injury of vascular and neural structures during spinal instrumentation involving the lumbar vertebrae.

Aim: To provide a baseline data for mathematical modeling and biomechanical studies of human spine in North Indian adult male population.

Material And Method: The study was conducted upon 150 lumbar vertebral bodies belonging to 30 vertebral columns. The length and height on the anterior surface, posterior surface and lateral surface of the vertebral bodies were measured with the help of vernier caliper.

Results: Length and height of posterior surface of lumbar vertebral body (LBV) increased gradually from L1 to L3 and then decreased at L5. The length was slightly more on left side as compared with right side at all levels except L1. The Height of anterior surface and right lateral surface of LBV increased gradually from L1 to L5. However, the height of left lateral surface of LBV increased gradually from L1 to L4 and showed a slight decline at L5.

Conclusion: The height on anterior surface was less as compared with that on posterior surface from L1-L2; almost same at L3 and more at L4-5 due to the thoracic kyphosis and lumbar lordosis. The height of lateral surface was slightly more on left side at all levels except L5 where it was almost equal on both sides.

KEYWORDS

Height, Length, Vertebral Bodies, compression forces.

INTRODUCTION:

Human lumbar vertebrae support the weight of the upper body. Weight bearing and mechanical factors appear to play important roles in morphological and functional adaptation of the lumbar vertebral column to the changing demands associated with growth. Loads lifted and carried by the upper extremities cause significant loading stress to the vertebral bodies[1]. Wide individual variations in the dimensions of the vertebral body may appear which force the surgeon to understand the individual anatomy of the patient to achieve clinical success. In recent years, anterior lumbar interbody fusion, in association with a variety of methods to stabilize both the implant and motion segment, has gained popularity[2]. The anterior route provides direct access to most spine diseases and used for lesion excision, corpectomy, vertebral body reconstruction with cages etc. Stability of the vertebral column is achieved, resolution of clinical pain is rapid and almost complete, and the rate of surgical complications is very low[3].

Aim & Objective:

In spite of the immense clinical value of lumbar vertebral column, there is paucity of metrical data. This gave us an impetus to conduct the present study with following objectives:

1 To provide a baseline data for mathematical modeling and biomechanical studies of human spine in North Indian adult male population.

2. To compare the results and explain the variations observed on the basis of anthropometric studies already available in accessible literature.

MATERIALAND METHOD:

The present study was conducted in the Department of Anatomy, Govt. Medical College, Amritsar after getting approval from Institutional ethical committee. The material comprised of 30 human adult male lumbar vertebral columns i.e 150 lumbar vertebrae. The vertebrae were thoroughly cleaned and boiled. All the vertebrae were without any gross abnormality. These were labeled from L1 to L5 depending upon the vertebra and bound in a wire in the correct sequence. In toto 30 such columns were prepared and labeled 1-30.

Following parameters were measured with vernier callipers with least count of 0.02mm.:

1. **Vertebral Body Length:** It was measured as the distance from the posterior cortex of the vertebral body to its anterior cortex along the extension of pedicle axis on both sides[4]. (CD in Fig. 2).

2. **Height of the anterior surface of the lumbar vertebral body (LBV):** It was measured along the midsagittal plane anteriorly[5]. (AB in Fig. 1).

3. **Height Of The Posterior Surface Of The Lumbar Vertebral Body (LBV):** It was measured along the midsagittal plane posteriorly[5]. For measuring this height, a scale was kept touching the superior surface of the vertebral body and projecting into the vertebral foramen. Then depth bar of vernier callipers was pushed in the vertebral foramen along the midsagittal plane from inferior side and made to touch the scale (See the photograph). Then the reading was noted from the main scale of vernier callipers (GH in Fig.3).

4. **Height Of The Lateral Surface Of Lumbar Vertebral Body (LBV):** It was measured along the frontal plane through the widest part of the vertebral body at the right and left lateral surfaces[5]. (EF in Fig.3).

RESULTS/OBSERVATION:

Length And Height Of Posterior Surface Of Lumbar Vertebral Body (LBV) increased gradually from L1 to L3 and then decreased at L5 (See the table). The length was slightly more on left side as compared with right side at all levels except L1.

Height Of Anterior Surface And Right Lateral Surface Of LBV increased gradually from L1 to L5 (See the table). However, the height of left lateral surface of LBV increased gradually from L1 to L4 and showed a slight decline at L5.

DISCUSSION:

Earlier many authors have studied these parameters on different populations. It was seen that the height of anterior surface of LBV is less at all levels in North Indians as compared with Israel population (1.5-2.5mm)[6] and American population (0.5-4mm)[5]. However, the height of posterior surface of LBV was almost same in North Indians as that of Americans[5] whereas a difference of 1-3mm was seen when compared with data of **Gilad and Nissan**[6].

On comparing the heights of anterior and posterior surfaces of lumbar vertebral bodies, it was observed that the height at anterior surface was less as compared with that at posterior surface from L1-L2; almost same at L3 and more at L4-5. It may be attributed in part to the thoracic kyphosis (between T1-L2) and lumbar lordosis (between L4-S1).

The height of lateral surface was slightly more on left side as compared

with right side at all levels except L5 where it was almost equal on both sides. Earlier only **Berry et al**[5] measured this parameter in American population where it was more by 0.5-2.5mm at all levels (except L4) than the present study.

An increasing trend of length of LBV was attributed to more weight borne by the lumbar spine which subjects it to vertebral compression forces whose magnitude increase craniocaudally i.e. L1-L5. But it is actually so only upto L3. Beyond L3 i.e. at L4 & L5, the dimensions are less which means a comparatively less compressive force is exerted on L5 as compared with L4 or L3. This is because the force is transmitted to the pelvis via neural arches, transverse processes or iliolumbar ligaments[7]. Similarly, the body surface area gradually increases from L1 to L4, indicating that from above downwards more is borne by the anterior column[8].

CONCLUSION:

The length of LBV showed an increasing trend from L1-L3 and then decreased to L5 which was attributed to more weight borne by the lumbar spine which subjects it to vertebral compression forces whose magnitude increase craniocaudally i.e. L1-L5. But it is actually so only upto L3. Beyond L3 i.e. at L4 & L5, the dimensions are less which means a comparatively less compressive force is exerted on L5 as compared with L4 or L3. This is because the force is transmitted to the pelvis via neural arches, transverse processes or iliolumbar ligaments[7]. The height of LBV along anterior, posterior and lateral surfaces also increased gradually from L1 to L4-5 except height along anterior surface was less as compared with posterior surface between L1-L2, same at L3 and more at L4-5. This may be because of thoracic kyphosis and lumbar lordosis.

CLINICAL RELEVANCE:

Adequate morphometric knowledge about body of lumbar vertebrae is mandatory for diagnostic as well as therapeutic purposes. A knowledge of heights of anterior and posterior surfaces of vertebral bodies may be useful in detection of clinical conditions like vertical compression of vertebral bodies[9]. Similarly, other parameters or dimensions are essential for a safe anterior approach to lumbar spine for a neurosurgeon as it allows optimal neural decompression and the possibility of adequate realignment and strong reconstruction/ fixation[3]. The observations presented here have defined many of the anatomical parameters that should be taken into consideration for screw fixation to avoid injury of vascular and neural structures during spinal instrumentation involving the lumbar vertebrae and intervertebral discs. At the same time, these serve as an anthropometric reference for mathematical modelling, anatomical and biomechanical studies of lumbar spine[6].

Table : Comparison Of Length And Height Of Anterior Surface Of Lumbar Vertebral Body

Paramt		*Length*		*Height of anterior surface*				*Height of posterior surface*				*Height of lateral surface*		
Author		*Present study*		*Gilad and Nissan[41],1985*	*Berry et al[4], 1987*	*Present study*		*Gilad and Nissan[41], 1985*	*Berry et al[4], 1987*	*Present study*		*Berry et al[4], 1987*	*Present study*	
Population		*North Indian*		*Israel*	*Ohio, USA*	*North Indian*		*Israel*	*Ohio, USA*	*North Indian*		*Ohio, USA*	*North Indian*	
(mm)		*Mean*	*Range*	*Mean*	*Mean*	*Mean*	*Range*	*Mean*	*Mean*	*Mean*	*Range*	*Mean*	*Mean*	*Range*
L1	*R*	*29.46*	*18.04-39.94*	*25.4*	*25.0*	*23.82*	*16.73-29.74*	*27.1*	*25.8*	*25.18*	*17.91-29.74*	*25.6*	*24.22*	*17.57-28.42*
	L	*29.42*	*18.64-41.46*									*24.9*	*24.74*	*17.25-28.97*
L2	*R*	*29.66*	*18.52-42.34*	*27.2*	*27.9*	*24.56*	*18.04-32.50*	*27.0*	*25.2*	*25.45*	*18.32-29.46*	*27.3*	*24.75*	*17.58-29.18*
	L	*30.31*	*17.84-43.94*									*27.7*	*25.07*	*17.98-30.60*
L3	*R*	*30.50*	*18.00-45.01*	*27.9*	*27.4*	*25.97*	*19.90-32.50*	*27.9*	*26.0*	*25.99*	*18.56-30.85*	*26.5*	*25.95*	*20.08-30.59*
	L	*30.61*	*18.16-45.23*									*26.5*	*26.09*	*20.84-32.10*
L4	*R*	*30.40*	*16.92-46.64*	*27.4*	*26.7*	*26.24*	*20.35-29.90*	*27.1*	*26.4*	*25.57*	*19.22-29.72*	*25.7*	*26.40*	*18.76-32.05*
	L	*30.42*	*17.44-45.78*									*25.7*	*26.76*	*21.44-31.58*
L5	*R*	*29.47*	*16.20-43.75*	*28.3*	*28.7*	*26.43*	*21.23-30.66*	*25.7*	*23.1*	*24.14*	*17.25-27.10*	*27.0*	*26.56*	*19.12-30.90*
	L	*29.64*	*16.45-44.60*									*27.0*	*26.53*	*21.27-30.28*

Photograpgh 1: Measurement Of Posterior Height Of LBV.

FIG 1: AB: Height Of Anterior Surace Of LBV

Fig 2: CD: Length Of LBV

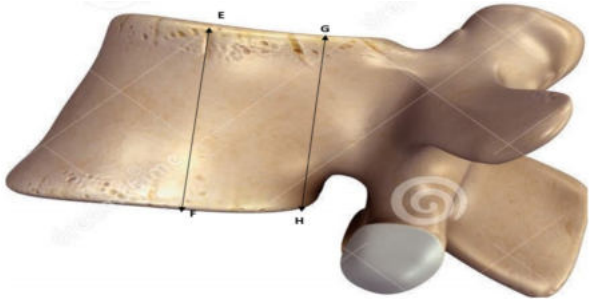

Fig 3: EF: HEIGHT OF LATERAL SURFACE OF LBV

GH: HEIGHT OF POSTERIOR SURFACE OF LBV

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