MORPHOMETRIC CHARACTERISTICS OF HUMAN VERTEBRAL COLUMN WHICH HAS NUMERICAL VARIATION

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ABSTRACT

Recent developments in surgical interventions and increasing popularity of using implants in lower thoracal and lumbar vertebrae have necessitated more detailed knowledge of anatomical and morphometric characteristics of these structures. Here we present a 22-year-old male skeleton that has 25 presacral vertebrae (PSV). The sceleton has thoraco-lumbar (TL) vertebrae with a numerical variation of vertebral column, and we discuss morphometric characteristics of his lower thoracal and lumbar vertebrae.

Key words: Human vertebral column, Numerical variaton, Vertebral morphometry

ÖZET

SAYISAL VARYASYON GÖSTEREN İNSAN VERTEBRAL KOLONUNDA MORFOMETRİK BİR ÇALIŞMA

Alt torakal ve lumbar vertebral cerrahideki gelişmeler ve implantasyon sayısındaki artma, bu bölgelerin anatomik ve morfometrik özellikleri hakkında daha çok bilgiyi gerektirmektedir. Bu olguda, 25 Presakral vertebra (PSV)'ya sahip 22 yaşında bir erkek iskelete ait vertebral kolonun sayısal varyasyon (artış) gösteren Thoracolumbar (TL) vertebrasi ile, alt torakal ve lumbar vertebraların morfometrik özellikleri ortaya konmuştur.

Anahtar Sözcükler : İnsan omurgası, Sayısal varyasyon, Omur morfometrisi.

INTRODUCTION

For improvement of spinal instrumentation and implantable devices, accurate description of anatomical shape of vertebrae is required. As the authors' take interest in spinal instrumentation and fixation devices, need for more detailed morphometric and anthropometric data other than existing literature has appeared. As vertebrae have variable characteristics, it is especially important to have detailed knowledge of vertebral anatomy and morphometry in choosing appropriate surgical technique and implant (1,2,3,15).

The popularity of the instrumentation techniques of vertebral column, especially of lower thoracal and lumbar vertebrae increased greatly (8,16,17,18,19). Presenting this case here, we aimed at describing the morphometric characteristics of the vertebrae with numerical variation (increase), and lower thoracal and lumbar vertebrae in a vertebral column with 25 PSV (C7,T12,TL,L5) (4). As far as we know, this is an

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extremely rare case as morphometric values presented in the literature are about vertebral columns with 24 PSV (C7,T12,L5).

MATERIAL AND METHOD

In this case, a 22-year-old male skeleton, which was transferred to the Bone Laboratory at Cumhuriyet University Faculty of Medicine Department of Anatomy, was determined to have 25 PSV in his vertebral column, and morphometric characteristics of his lower thoracal (T11-12), thoraco-lumbar (TL) and lumbar (L1-5) vertebrae are elucidated (Figure1).

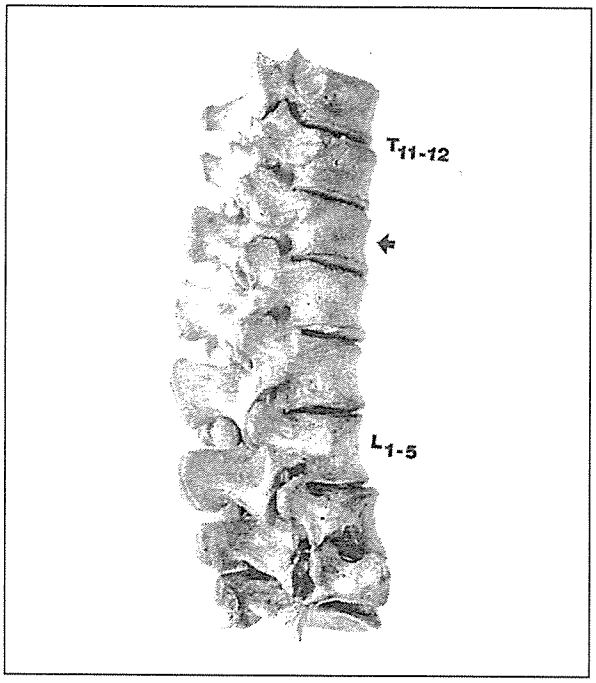

Figure 1. The right lateral aspect of the lower thoracal (T11-12), thoraco-lumbar (arrrow) and lumbar vertebrae (L1-5).

By using methods developed by Berry et al.(3), and Şakul et al.(20), 30 measurements of each vertebra were performed (Figure. 2, 3 and 4).

A digital vernier calliper took length measurements, and the measurements were recorded in milimeters. Angular measurements were taken with a goniometer. The measures were determined in the Laboratory of Sivas Technical Training College (TTC).

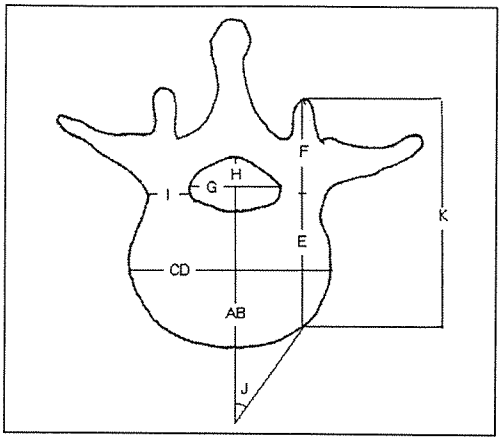

Figure 2. Description of vertebral measurements from the superior-inferior aspect. Sagital body lengths (A=upper, B=lower); transverse body lengths (C=upper, D=lower); vertebral body length along the pedicle angle (E_1=right, E_2=left); pedicle lenghts along the pedicle angle (F_1=right, F_2=left); vertebral canal diameters (G=transverse, H=sagittal);transverse diameter of pedicle (I_1=right, I_2=left); pediculer angles (J_1=right, J_2=left); vertebral lenghts along the pedicle angle (K_1=right, K_2=left).

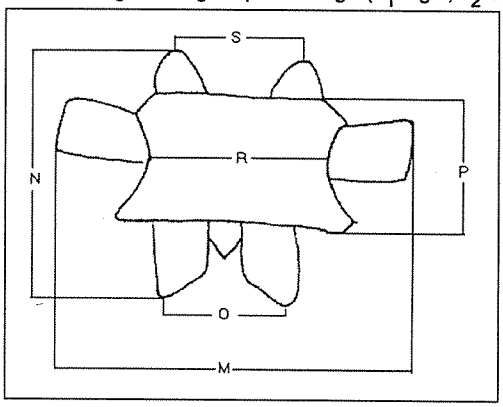

Figure 3. Description of vertebral measurements taken from antero-posterior aspect. Transverse vertebral lenght (M); vertebral heights (N_1=right, N_2=left); distance between inferior articular processes (O); lateral heights (P_1=right, P_2=left); transverse body lenght on midline (R); distance between superior articular processes (S).

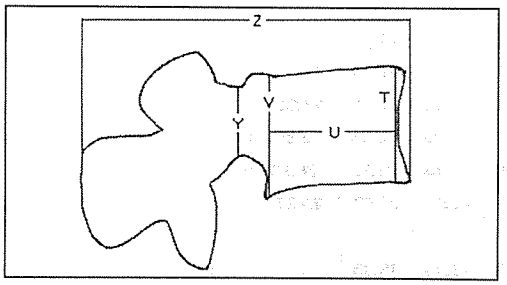

Figure 4. Description of vertebral measurements taken from sagittal aspect. Anterior height (T); sagittal body lenght on midline (U); posterior height (V); vertical diameter of pedicle (Y); sagittal vertebral length (Z).

RESULTS

The morphometric characteristics of lower thoracal (T11-T12), thoraco-lumbar (TL), and lumbar (L1-5) vertebrae are shown in Table 1.

Table 1. The morphometric characteristics of lower thoracal (T11-T12), thoraco-lumbar (TL), and lumbar (L1-5) vertebrae (as milimeters)

	T11	T12	TL	L1	L2	L3	L4	L5
A	26.27	27.24	28.63	30.37	30.64	30.81	31.39	30.14
B	26.78	28.12	29.45	29.93	30.54	32.03	31.82	32.42
C	35.00	38.57	40.59	42.42	43.30	47.39	49.41	53.13
D	38.48	40.51	42.85	46.18	50.04	51.41	51.93	50.81
E								
E_1	28.31	29.91	30.40	31.66	33.85	32.43	32.03	32.38
E_2	29.48	31.46	31.31	32.81	32.31	31.34	32.26	31.26
F								
F_1	27.93	24.13	24.02	23.62	25.70	25.76	22.42	20.38
F_2	28.10	25.33	23.67	23.24	25.94	25.61	24.21	20.76
G	18.01	20.01	21.95	21.50	20.85	21.81	23.60	28.06
H	16.49	17.16	16.40	15.06	13.97	13.31	14.66	14.57
I								
I_1	7.51	7.04	9.87	8.60	10.28	13.82	14.84	22.80
I_2	6.68	6.37	9.80	9.05	9.51	12.48	14.16	20.07
J								
J_1	18.50	19.50	20.00	20.00	20.00	21.00	20.00	21.00
J_2	19.00	19.50	20.00	19.50	19.50	21.00	20.00	21.00
K								
K_1	56.24	54.07	54.42	55.28	59.55	58.19	54.45	52.76
K_2	57.58	56.79	54.98	56.05	58.25	56.95	56.47	52.02
M	53.06	47.37	45.67	70.21	83.81	95.44	83.29	92.52
N								
N_1	37.99	41.87	44.37	47.55	47.65	43.48	41.73	38.49
N_2	37.82	41.86	43.26	47.57	45.49	43.08	37.83	37.19
O	34.96	25.56	24.99	24.16	26.46	34.51	45.36	50.79
P								
P_1	22.66	23.21	23.58	23.94	24.02	24.81	27.21	24.18
P_2	21.42	22.74	24.52	24.18	24.76	26.57	27.09	24.42
R	32.66	35.31	37.18	39.37	41.01	42.42	43.64	45.36
S	27.21	27.69	28.70	27.35	27.51	30.48	37.55	42.91
T	22.87	20.95	22.38	23.88	25.27	26.32	25.74	25.81
U	25.26	26.23	26.00	26.90	28.14	29.08	29.99	28.57
V	21.90	23.63	24.97	26.25	27.56	25.57	24.96	20.74
Y								
Y_1	16.45	15.33	15.33	14.80	14.69	13.77	12.44	11.60
Y_2	15.68	17.47	15.17	15.14	14.08	14.28	12.45	16.89
Z	67.54	67.43	70.09	77.24	77.73	77.29	74.42	70.31

1= right 2= left

DISCUSSION

Regarding these characteristics, some morphometric measures used in vertebral surgery are discussed below.

In some vertebrae (T11, L3-5) the anterior height of the corpus (T) was greater than the posterior height (V). On the contrary, in other vertebrae (T12, TL, L1,2) the posterior height (V) was greater than the anterior height (T). That, the anterior height of the L5 (T) was greater than the posterior height of it (V) was consistent with the results of Nissan and Gilad (12,13), Gilad and Nissan (5), Berry et al. (3), and Şakul et al. (20). On the other hand, the characteristics of T11 was antipodal to the one stated in the previous papers as they have found the posterior height to be greater than the anterior height.

In vertebral surgery, as pedicles may be involved in screw fixation, a detailed knowledge of pedicular morphometry and a perfect match between the screw and the pedicle is very important (6,7,10). From this starting point, we evaluated these characteristics below.

The pedicular vertical diameters (Y_1,Y_2) decreased regularly towards downward from T11 to L5. This finding is consistent with the result of Zindrick et al.(21,22), whereas it contradicts to the studies of Berry et al. (3), and Şakul et al (20).

The pedicular transverse diameters (I_1,I_2) were irregular at the levels of lower thoracal vertebrae and L1, being the least at T12. The transverse diameters gradually increased from L2 to L5, being the maximum at the L5 level. This gradual increase at the lumbar levels was consistent with the findings of Krag et al. (8,9), Berry et al (3), Moran et al (11), and Şakul et al (20). Transverse pedicular diameter was found to be decreased from T11 to L1, however in our case, there was an irregularity.

That the transverse diameter (G) of the vertebral

canal increased from T11 to L5, while the sagittal diameter (H) remained unchanged was reported in the study of Şakul et al (20), which is almost identical to the results of Amonoo-Kuofi (1,2). In this case, it could also be possible to talk about an increase in the transverse diameter excluding the TL vertebrae. However, this was disturbed by the TL vertebrae, which in turn emphasises the importance of discussing this case. Pineau and Delmas (14) have reported that the sagittal diameter of vertebral canal decreased from L1 to L4 and increased at the level of L5 vertebrae. The sagittal diameter was irregular in our case.

Transverse vertebral length (M) was another point, where another characteristic affected by the presence of TL vertebra, was observed. Şakul et al (20) reported this value to be the lowest at T12, a significant increase at L1 and a steady increase from L1 to L5. Our case was consistent with the others excluding the TL vertebra. TL vertebra perverted the consistency by the shortest transvers length, however other characteristics except this were parallel with Şakul et al's (20) study results.

Pedicular angle (J_1, J_2) values were measured to be the lowest at T12 and the biggest at L5 by Şakul et al (20) in the same way. Excluding the TL vertebra, measurements of our case was parallel to these. However presence of TL vertebra discorded with this.

There was an increase in upper (C) and middle (R) transverse diameters of the corpus (CRD) from T11 to L5, while the lower diameter (D) was decreasing at L5. Upper (A) and middle (U) values of the sagittal diameter (AUB) were progressing as the lower (B) transverse diameter. The lower part of the sagittal diameter (B) was observed to increase from T11 to L5 except the TL vertebra. This is also one of the striking differences between the normal and abnormal vertebra with numerical variation. Şakul and et al. (20) also determined an increase in transverse and sagittal diameters of the corpus from T11 to L5.

In conclusion, the previous studies related to morphometry of the vertebrae were thought to be useful in cases like tumours, trauma and vertebral destruction, which can give harm to the integrity of the vertebrae. However, these reports are about vertebral columns with 24 PSV (C7, T12, L5). This extremely rare case has brought up the necessity of taking into consideration the existence of a vertebra which shows numerical variation in a vertebral column with 25 PSV (C7, T12, TL, L5). So we are of the opinion that this case will contribute further to the previous studies on this subject.

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