

ANATOMIC RELATIONSHIP BETWEEN MAJOR ARTERIES AND LUMBAR VERTEBRAE ON CT SCANS FOR INTERBODY FUSION USING THREADED CAGES

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ABSTRACT

Purpose: To determine the anatomical landmarks of lumbar vertebrae for the application of threaded intervertebral cages.

Methods: We measured the distance between bone and arteries on CT scan in 50 cases who were operated for lumbar disc disease.

Results: The mean anterior-posterior diameter of L3, L4, L5, S1 vertebral bodies were found to be 50.4 mm, 51.2 mm, 53 mm, 54.3 mm respectively. The aorta diameter was 16.2 mm at L3 level. The distance between aorta and anterior margin of vertebral body was 0.58 mm. The aortic bifurcation level was found to be at L4-5 in 80% of cases. The distance between iliac arteries at the levels of L4-5 and S1 were 11.04 mm, 17.06 mm and, 39.88 mm, respectively.

Conclusion: It's concluded that (1) the threaded cages should be less than 25 mm in length, (2) the aorta is located just anterior to the vertebral body, and surgeon should take this fact into consideration during posterior application, (3) because of the location of aortic bifurcation at L3-4 and L4-5 levels and the distance between iliac arteries is safe enough at L5-S1 level, anterior application of threaded cages can be appropriate at L5-S1 level.

Key words: Lumbar vertebra, Threaded interbody cage, Vascular anatomy

ÖZET

BİLGİSAYARLI TOMOGRAFİ GÖRÜNTÜLEMESİNDE, LÖMBER İNTERKORPORAL KAFES UYGULAMASINA YÖNELİK, MAJÖR ARTERLER VE LÖMBER OMURLARIN ANATOMİK İLİŞKİSİ

Amaç : Kafes uygulamasında faydalanmak üzere lomber omurga anatomik landmarklarını belirlemek.

Metod : Lomber disk hastalığı nedeni ile opere olan 50 hastanın BT tetkiklerinde, kemik-arter mesafeleri ölçülmüştür.

Bulgular : Ortalama L3, L4, L5, S1 omurgaları ön-arka çapları 50.4 mm, 51.2 mm, 53 mm, 54.3 mm ölçüldü. L3 seviyesinde aort çapı 16.2 mm olarak saptandı. Aortun vertebra gövdesi ön sınırına uzaklığı 0.58 mm bulundu. % 80 olguda aort bifurkasyonu L4-5 seviyesindeydi. İliak arterler arasındaki mesafe L4, L5 ve S1 düzeylerinde 11.04 mm, 17.06 mm ve 39.88 mm ölçüldü.

Sonuç: 1) kafeslerin uzunluğunun 25 mm'den az olması gerekir 2) aorta omurga gövdesi anteriorunda, çok yakın mesafe yerleşimlidir ve cerrahın çok dikkatli olması gerekir, 3) L5-S1 düzeyinde, iliak arterlerin arasındaki mesafe, anterior yaklaşımla kafes yerleştirmek için yeterli ve güvenlidir.

Anahtar Kelimeler : İnterkorporal kafes, Lomber vertebra, Vasküler anatomi.

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INTRODUCTION

Interbody fusion using threaded cages is an important procedure for the treatment of spinal instability (1, 3, 4). The method can be performed both anteriorly and posteriorly (4). The aim of spinal reconstructive surgery is to maintain neural tissue decompression and bony fusion. In the last 50 years, there are ongoing studies to get better results to form good spinal stability. Cloward was the first surgeon to apply PLIF (posterior lumbar interbody fusion) and ALIF (anterior lumbar interbody fusion). He reported successful results of these techniques however the procedures he described were difficult and demanding so they weren't used widely (3). Kuslich and Bagby introduced BAK device in 1980s, which was a hollow, fenestrated, titanium cylinder used for interbody fusion (1). There are now different cages with modifications in shape, material, fenestrations and mechanical properties. Today surgery for spinal stabilization is done worldwide and because of the close relationship between major vessels and vertebrae, the anatomic landmarks must be known clearly.

MATERIALS AND METHODS

Patients: Fifty patients who admitted to our clinic because of lumbar disc herniation were included in this study. There were 28 female and 22 male cases with ages ranging from 30 to 54 years with a median of 44 years of age.

Measurements: The relationship between bone and arteries were determined on CT scans in 50 cases. Each patient was evaluated by routine L3-S1 lumbar CT scan, lumbar lateral, anterior posterior radiograms, lumbar lateral flexion-extension radiograms. The patients with idiopathic lumbar disc disease without spinal instability and prior surgery were chosen and lumbar CT scans with 3 mm slice thickness between levels of L2 and S2 were administered preoperatively. The double-blind measurements were done by the radiologist and neurosurgeon separately. Mean values for each measurement were taken into consideration. The mean

antero-posterior (A) and transverse (B) diameters of the L3, L4, L5, and S1 vertebrae, the aorta diameter (C), the distance between the aorta and anterior margin of vertebral body (D), the distance between iliac arteries and midline (E and F) were calculated. The abdominal aorta bifurcation level was also determined.

Statistical analysis: The measurements of the distance between bone arteries were compared using chi square test.

RESULTS

The average A-P (anterior-posterior) and transverse diameters of L3 to S1 vertebrae of the patients varied between 35.77 mm to 38.45 mm and 49.91 mm to 53.81 mm respectively. The values are shown in Table 1 in detail.

The abdominal aorta diameter at L3 level, aorta-vertebral body distance which was approximately 0.5 mm and distance between iliac artery and midline from L4 to S1 levels showed significant increase (Table 2). Bifurcation of abdominal aorta was at L4 level in 80% of cases and at L5 level in 20%. There was no significant difference in male and female measurements in all parameters ($p < 0.05$).

DISCUSSION

The objectives in placing an interbody fusion cage include spinal stabilization, maintenance of intervertebral disc height and supporting the spine against axial loads (3, 4). The cages are made of titanium alloy and they have fenestrations which facilitate bone fusion. The cages are generally round in shape but there are also square designed ones in surgical use.

Indications for lumbar interbody cage implantation include; 1) degenerative disc disease group which consists of segmental disc degeneration and foraminal stenosis, 2) degenerative lumbar instability group which consists of grade I degenerative spondylolisthesis, 3) postlaminectomy, postfacetectomy, postdiscectomy spinal instability group, 4) pseudoarthrosis of posterior lumbar fusion, and 5) grade I-II congenital spondylolisthesis.

Lumbar threaded cages can be applied with anterior or posterior approaches. Anterior approach is generally limited to L5-S1 level because of close relationship of major vessels to L4-5 and L3-4 level. While doing PLIF, care must be taken to avoid injury to major anatomical structures just anterior to vertebral body. These important structures are abdominal aorta, inferior vena cava, iliac arteries and veins, pudendal vessels, presacral autonomic plexus (5, 6, 7). Abdominal aorta and iliac vessels are in scope of this article. While it is possible to spot abdominal aorta and iliac arteries on CT scans, inferior vena cava and iliac veins are not visible with this imaging technique. A magnetic resonance imaging is needed to see the anatomical position of iliac veins and inferior vena cava. Kawahara et al. states that iliac veins confluence at L4-5 level to form inferior vena cava, and this vessel ascends in tight contact to vertebral column(5).

Care should also be taken while placing threaded cages into the intervertebral space. A cage should have 2 mm space to anterior and posterior borders of vertebral body and should be embedded into superior and inferior vertebral bodies by 2 mm height. In our study, the smallest vertebral body AP diameter was 28 mm which belonged to a female L4 corpus. The safest maximum length of a cage is proposed to be 25 mm by the authors. If a cage overrides the vertebral corpus, there is possibility of injuring abdominal aorta, inferior vena cava, iliac vessels, pudendal vessels, presacral autonomic plexus and emerging nerve roots.

CONCLUSION

In this article, it is concluded that; 1) the threaded cages can be safely used in grade I spondylolisthesis, 2) the threaded cages should be less than 25 mm in length, 3) the aorta is located just anterior to the vertebrae, and surgeon should consider this fact during posterior cage application, 4) the high bifurcation level of aorta at the L3-4 and L4-5, as well as the wide distance between iliac arteries at L5-S1 allows for the safe anterior application of threaded cages at L5-S1 level

Table 1. Vertebral corpus measurements, scale in mm (millimeter)

	A-P Diameter (A)	Transverse Diameter (B)
L3	35.77 ± 5.31 (30-50)	49.91 ± 7.22 (35-60)
L4	36.45 ± 5.33 (28-48)	50.85 ± 7.70 (34-65)
L5	37.91 ± 4.49 (31-50)	52.47 ± 7.27 (37-64)
S1	38.45 ± 4.60 (32-51)	53.81 ± 7.01 (40-65)



Figure 1. The mean antero-posterior (A) and transverse (B) diameters, the aorta diameter (C), the distance between the aorta and anterior margin of vertebra body (D), the distance between iliac arteries and midline (E and F) of the L3, L4, L5, and S1 vertebrae were calculated. The aorta bifurcation level was also detected.

Table 2. Arterial vascular measurements, scale in mm.(millimeters)

Distance between Anterior margin of Corpus and aorta (D)	L3	0.51 ± 0.93 (0-3)
	L4	0.52 ± 0.94 (0-3)
Iliac artery-midline (E-F)	L4 right	4.62 ± 2.70 (0-10)
	left	4.89 ± 2.83 (0-10)
	L5 right	8.77 ± 3.45 (0-15)
	Left	8.89 ± 3.91 (0-16)
S1	right	19.49 ± 1.78 (14-23)
	left	19.60 ± 2.00 (15-23)

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