

Analysis of Aortic Passage in the Thoracic Region by Magnetic Resonance Imaging

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– Abstract –

Study Design : The relationships between aorta and thoracic vertebrae were analyzed by using MR images.

Objectives : The purpose of this study was to provide information upon the thoracic aortic passage to prevent vascular complications during anterior and posterior instrumentations for various spinal disorders and traumas.

Summary of Background Data: A number of morphometric investigations have been performed on the thoracic vertebrae, but the anatomical relationship between aorta and the thoracic vertebral body has not been analyzed.

Methods : The MR images of 32 patients with normal thoracic vertebral column were obtained. The angle between the transverse axis of the thoracic vertebral body and the thoracic aorta, the diameter of the thoracic aorta and the closest distance between the thoracic vertebral body and the thoracic aorta from T2 to T12 were measured on axial MR images.

Results : The smallest angle between the transverse axis of the thoracic vertebral body and the line connecting the centers of the vertebral body and aorta was $6.8 \pm 3.7^\circ$ (male/female) in the T5-6 region and highest angle observed was $56.3 \pm 5.5^\circ$ in the T12 region. The angle decreased between T2 and T5-6 and then increased after T6. The mean external diameter of the thoracic aorta was 32.8 mm, and the largest diameter of the thoracic aorta was 24.7/25.4 mm (M/F) in the T4-5 region. The aortic arch was first seen in the T2 region and it formed an arch in the T3-4 region. The shortest distance between the thoracic vertebral body and the thoracic aorta wall was 0.8/0.7 mm in the T12 region and the greatest distance between the vertebral body and the aorta was 11.84/6.75 mm in the T2-3 region.

Conclusion : From T4 to T8, the aorta is located just left lateral to the vertebral body. In this area, the aorta is jeopardized by a screw penetrating the vertebral body during anterior instrumentation, if the screw protrudes beyond the pedicle during posterior instrumentation. The surgeon should be familiar with the anatomical relationship between aorta and the vertebral column when planning a surgical procedure or the use of instrumentation in this region.

Key Words : Aorta, Thoracic spine, Anatomical relationship, Magnetic resonance image.

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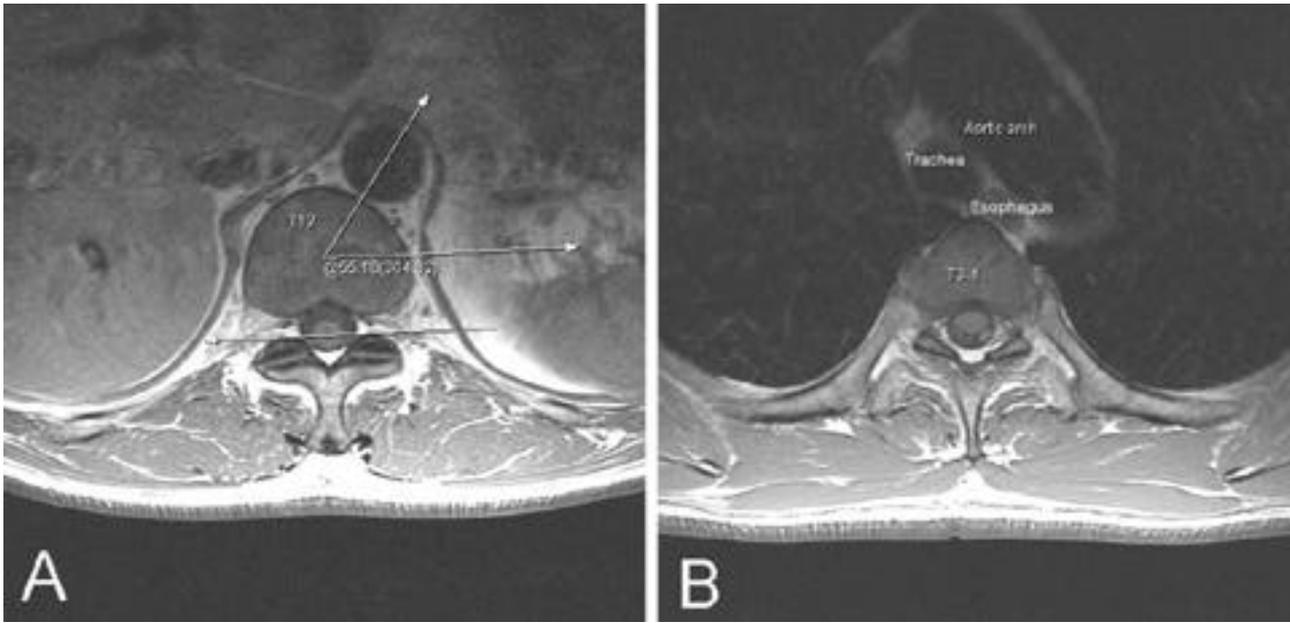


Fig. 1. Angle measurement for describing relationship between vertebral body and aorta in axial MR images.

- A.** Angle between the transverse axis of the vertebral body and the line connecting centers of the vertebral body and aorta is measured by angle tool of PiView program. (Transverse axis of vertebral body is drawn parallel to the line connecting the both anterior margin of posterior facet. The axis also passes the center of vertebral body.) A maximal angle is obtained at T12 level.
- B.** Aortic arch was first seen at the level of T2 and form arch at T3-4 level.

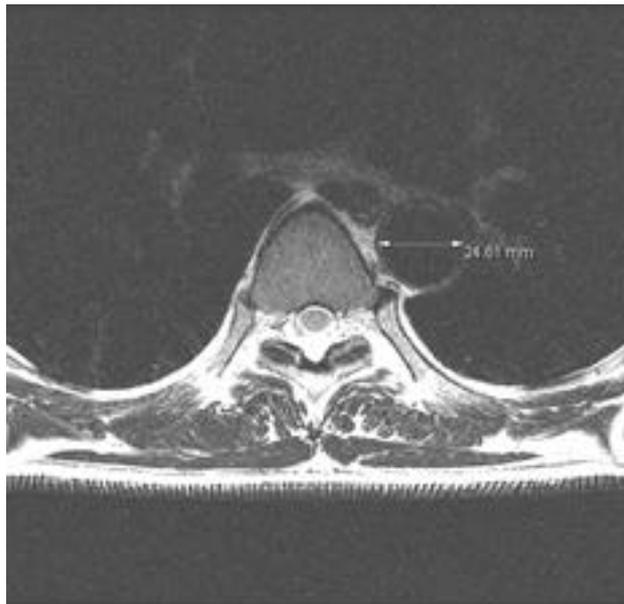


Fig. 2. Diameter of thoracic aorta at T4-5 level.

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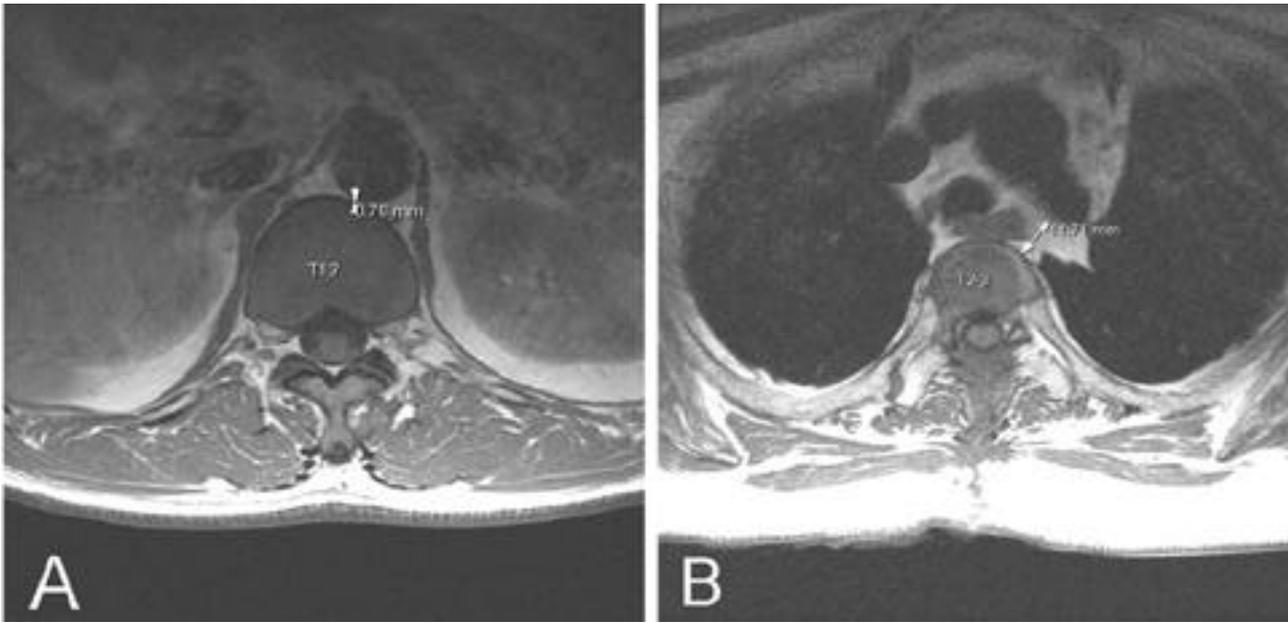


Fig. 3. A. The shortest distance between vertebral body and aorta at T12 level.
 B. The longest distance between vertebral body and aorta at T2-3 level.

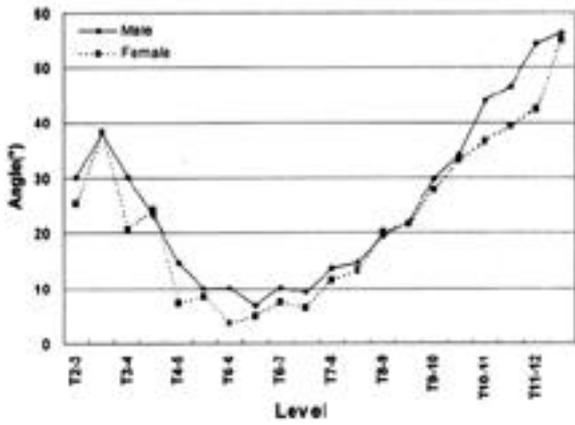


Fig. 4. Graph showing the variation of angles between the transverse axis of thoracic vertebral body and thoracic aorta(°).

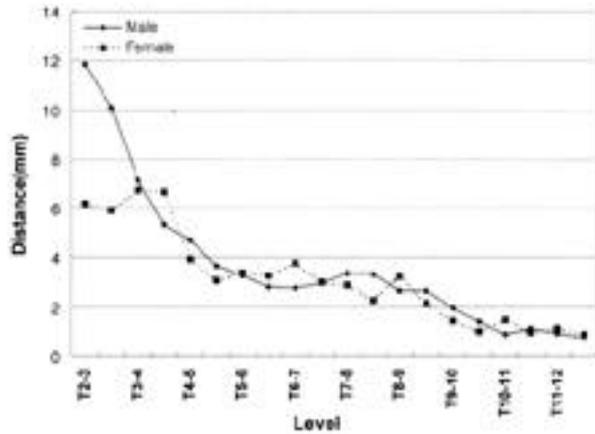


Fig. 5. Changes of distance between vertebral body and aorta

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 (GE Medical Systems, Milwaukee, WI, USA)

Table 1. Angle between transverse axis of thoracic vertebral body and thoracic aorta (°).

Level	Angle between transverse axis of thoracic vertebral body and aorta (M* / F†) ± SD (M* / F†)(°)
T2-3	30.1 / 25.3 ± (6.0 / 5.4)
T3	38.2 / 38.2 ± (8.5 / 5.5)
T3-4	30.1 / 20.5 ± (13.3 / 14.4)
T4	23.1 / 24.2 ± (7.1 / 7.5)
T4-5	14.6 / 7.3 ± (6.7 / 9.7)
T5	9.9 / 8.4 ± (5.4 / 9.7)
T5-6	10.0 / 3.7 ± (10.4 / 7.8)
T6	6.8 / 5.0 ± (7.9 / 5.7)
T6-7	10.1 / 7.5 ± (10.6 / 7.4)
T7	9.3 / 6.6 ± (9.7 / 6.0)
T7-8	13.5 / 11.6 ± (11.1 / 12.2)
T8	14.5 / 13.3 ± (11.6 / 8.3)
T8-9	19.3 / 20.1 ± (12.5 / 18.0)
T9	21.9 / 21.6 ± (12.3 / 10.7)
T9-10	29.7 / 27.8 ± (13.0 / 13.2)
T10	34.1 / 33.1 ± (12.6 / 15.4)
T10-11	44.0 / 36.6 ± (12.0 / 14.3)
T11	46.5 / 39.4 ± (11.2 / 13.4)
T11-12	54.3 / 42.4 ± (11.2 / 17.3)
T12	56.3 / 55.0 ± (10.6 / 14.2)

M*: male, F†: female

Table 2. Diameter of thoracic aorta (mm).

Level	Diameter of thoracic aorta (mm) (M* / F†) ± SD (M* / F†)
T2-3	24.5 / 26.6 ± (1.7 / 2.8)
T3	22.2 / 22.8 ± (5.8 / 2.0)
T3-4	24.2 / 24.4 ± (4.1 / 5.2)
T4	23.0 / 22.3 ± (4.7 / 3.6)
T4-5	24.7 / 25.4 ± (3.7 / 3.8)
T5	24.3 / 23.7 ± (3.8 / 4.0)
T5-6	23.9 / 24.1 ± (2.6 / 3.3)
T6	23.4 / 24.1 ± (3.4 / 3.5)
T6-7	23.1 / 23.0 ± (3.5 / 3.6)
T7	22.5 / 22.1 ± (3.5 / 3.9)
T7-8	22.2 / 22.2 ± (3.3 / 3.5)
T8	22.0 / 22.2 ± (4.4 / 3.6)
T8-9	21.9 / 22.6 ± (3.3 / 3.6)
T9	22.3 / 22.4 ± (2.9 / 4.3)
T9-10	22.2 / 22.4 ± (3.4 / 3.9)
T10	22.5 / 21.2 ± (3.2 / 3.3)
T10-11	20.8 / 20.6 ± (3.8 / 4.4)
T11	20.4 / 20.3 ± (3.4 / 4.5)
T11-12	19.3 / 19.3 ± (3.6 / 4.2)

M*: male, F†: female

PiView (Version 4.0) (caliper tool) vs SPSS (Version 11.0) (descriptive statistics) (One-Way Sample T-test) (p-value) 95% (Table 1). (Fig. 2), PiView (Fig. 1). T1 (Fig. 3). PiView (Fig. 4). T1 (Table 2).

0.05 (Table 1). 28 (Fig. 4). 7, 8, 9 (Table 2).

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Table 3. The shortest distance between thoracic vertebral body and thoracic aorta (mm).

Level	The shortest distance between thoracic vertebra and thoracic aorta (mm) (M* / F†) ± SD (M* / F†)
T2-3	11.8 / 6.2 ± (1.7 / 3.8)
T3	10.0 / 5.9 ± (4.6 / 0.5)
T3-4	7.1 / 6.7 ± (3.6 / 3.5)
T4	5.3 / 6.6 ± (2.8 / 2.6)
T4-5	4.7 / 3.9 ± (2.2 / 1.6)
T5	3.6 / 3.0 ± (1.9 / 2.0)
T5-6	3.2 / 3.4 ± (1.9 / 1.3)
T6	2.7 / 3.2 ± (1.9 / 1.1)
T6-7	2.7 / 3.7 ± (2.0 / 1.5)
T7	2.9 / 3.0 ± (2.3 / 0.9)
T7-8	3.3 / 2.8 ± (2.2 / 1.3)
T8	3.3 / 2.2 ± (2.6 / 1.2)
T8-9	2.6 / 3.2 ± (1.7 / 1.2)
T9	2.6 / 2.1 ± (1.6 / 1.0)
T9-10	1.9 / 1.4 ± (1.4 / 0.7)
T10	1.3 / 1.0 ± (0.6 / 0.8)
T10-11	0.8 / 1.4 ± (0.8 / 1.0)
T11	1.1 / 0.9 ± (0.5 / 0.7)
T11-12	0.9 / 1.1 ± (0.5 / 0.6)
T12	0.7 / 0.8 ± (0.3 / 0.5)

M*: male, F†: female

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