CT EVALUATION OF VERTEBRAL ROTATION IN SCOLIOSIS

E. Alıcı *, I. Kovanlıkaya **, N. Erel ***, Ö. Baran ****, O. Dicle *****

Departments of Orthopaedic Surgery and Radiology Dokuz Eylül University Faculty of Medicine, İzmir - TURKEY

In 34 patients with scoliosis; using CT, a new method was proposed to evaluate the change in rotation precisely. The angle of rotation of the apical vertebra was measured by taking the neutral vertebra as a reference point. In this method, the influence of the patients rotational relationship to the radiographic table was minimized. The results were compared with the Nash-Moe and Aaron-Dahlborn's methods and significant corralations were found. This study illustrates a more precise method which facilitates the three dimensional analysis of scoliosis.

Key Words : Scoliosis, Vertebral Rotation, CT

Until recently, scoliosis has been defined as a deformity in frontal and axial planes. Current literature has shown that scoliosis is a three-dimensional deformity with curvatures in the frontal and sagittal planes and rotations in the axial plane (1,2,4,5).

The use of CT in conjunction with conventional methods has provided a better information in the evaluation of scoliosis (3).

MATERIAL AND METHODS :

34 patients with scoliosis w-rc evaluated. 24 of them were idiopathic, 5 of them paralytic and the other 5 being congenital. There were 11 right dorsal, 3 left dorsal, 7 right dorsolombar, 4 left dorsolambar, 4 left dorsal right lumbar and 5 right dorsal left lumbar scoliosis.

Erect A.P. and lateral radiographs of each patient were taken. Cobb angles were measured. Apical and neutral vertcbrea were marked and the angle of rotation was estimated by the Nash and Moe method (5). The position of the vertebral column in the sagittal plane was evaluated in lateral radiographs.

Single slice CT scan was obtained through the apical vertebra. The angles between the line joining the middle of the vertebral corpus and the dorsal central aspect of the vertebral foramen and the sagittal plane were measured. This is the Aaron-Dahlborn's method (RA_{sag}) (3). The sagittal plane mentioned in this method is the plane perpendicular to the table. So, vertebral rotation is dependent to the table's plane and effected by the patient's relationship to the radiographic table, gibbosity and these change the angle of rotation. Especially gibbosity causes values lower than the real vertebral rotation.

In our study, we established a new approach in order to avoid the variations caused by the radiographic table and gibbosity. We made measurements using the same method on a neutral vertebra. This neutral vertebra mentioned is a high thoracal vertebra which is not included in the curvature in erect A-P radiographs and accepted as being neutral vertebra according to the Nash-Moe method. We figured that neutral vertebra is effected as much as the apical vertebra from the problems arising from the radiographic table or gibbosity. We subtracted the neutral vertebra's value from the apical vertebra's measurement and found the real rotational value of the apex.

DISCUSSION :

Evaluation of vertebral rotation is not precise even when done on a normal spine under ideal conditions. The problem becomes more complicated when applied to the scoliotic spine because of the well known anatomical variations that occur in the vertebrae secondary to the deformity forces of scoliosis (5). In the scoliotic spine it is difficult to differentiate the deformity and the amount of change due to rotation.

Previously, vertebral rotation had been evaluated by the position of the spinous processes (5,6). But the distortional forces of scoliosis can also change the normal configuration of the spinous processes. So, the pedicle method of Nash has been used instead of this method. The latter is preferable over the first but it should be remembered that in the pedicle method the vertebral body is assumed to be in normal configura-

* Professor in the Department of Orthopaedic Surgery
** Assistant Professor in the Department of Radiology
*** Specialist in the Department of Orthopaedic Surgery
**** Resident in the Department of Orthopaedic Surgery
***** Resident in the Department of Radiology.

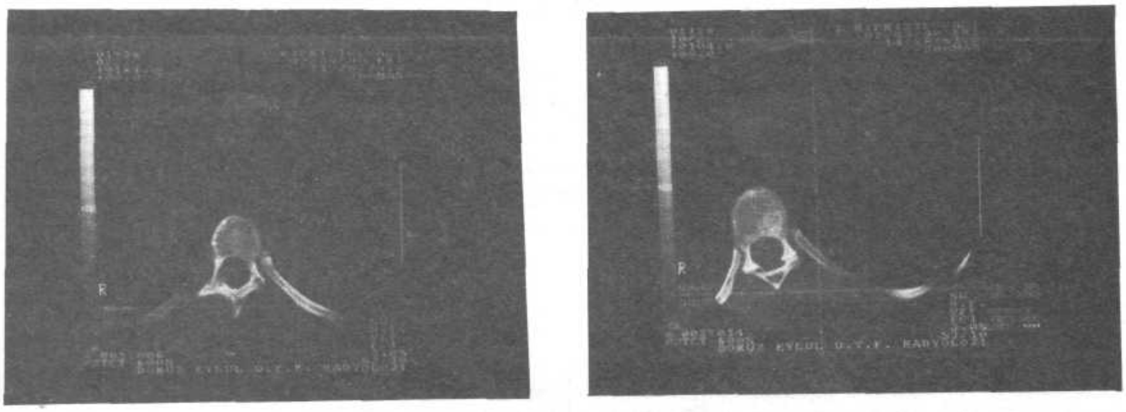
A  B

Fig. 1 A: Single slice CT scan is obtained through the neutral vertebra.
B: Single slice CT scan is obtained through the apical vertebra.

tion even though we all know that it is more or less affected by the deforming forces of scoliosis. Therefore, in order to make more precise measurements of the angle of rotation, we proposed a method similiar to Aaron-Dahlborn's method using computed tomography. Changes in rib configuration, which can occur independent of vertebral rotation can effect the patient's rotational relationship to the radiographic table (5). In our new method in order to minimize the errors arising from the patient's position in relation to the table, we used a neutral vertebra as a reference point.

When Nash-Moe method and our CT values were compared they were found to be congruent (Table 1). We concluded that CT is a useful examination to show the axial rotation of the vertebrae in three dimensional evaluation of scoliosis.

We also designed another method of measurement in our study. The angle between the frontal plane and the line joining the pedicles of the apical vertebra was measured. Frontal plane was the plane parallel to the radiographic table. In this method, measurements are effected by the patient's position in relation to the table. Therefore, rotational angle of the neutral vertebra was measured with the same method and subtracted from apical vertebra's value in order to get the real rotational angle of the apical vertebra (RAAN2).

Table 1: Angle of rotations in idiopathic, congenital and paralytic scoliosis according to the Cobb, RA_{AN1}, RA_{AN2}, RA_{sag} methods.

	Idiopathic	Congenital	Paralytic	Total
Cobb	52°.4 (30-98)	57°.8 (38-80)	83° (50-135)	61°.7 (50-135)
RA_{AN1}	19° (6.9-37.8)	25.5° (16.6-35.5)	66°.7 (37.1-78.3)	32°.8 (6.9-78.3)
RA_{AN2}	18°.9 (6.3-40.7)	28°.1 (23.7-37)	61°.2 (32.1-83.7)	32°.6 (6.3-83.7)
RA_{sag}	19° (10.1-28.8)	26°.3 (19.5-33)	57°.5 (23.7-80.9)	31°.3 (8.7-80.9)

RESULTS :

The average Cobb angle according to erect A-P radiographs was found to be 61°.7 (30-135°); being 83° (50-135°) in paralytic scoliosis, 57°.8 (38-80°) in congenital scoliosis and 52°.4 (30-98°) in idiopathic scoliosis.

Using the Nash-Moe method, out of 24 patients with idiopathic scoliosis 18 were found to be (++) while 6 were (+). All patients with congenital scoliosis were found to be (++). Out of the 5 patients with paralytic scoliosis 2 of them were (+++) and the rest were (++++).

Angles of rotation were found to be 32.8° (6.9-78.3°) using the RA_{AN1} 32.6° (6.3-83.7°) using the RA_{AN2} and 31.3° (8.7-80.9°) using the RA_{sag} method. The difference between the RA_{AN1} and RA_{AN2} method is 0.6-19° (% 4.5-6.4). The difference between the RA_{AN1} method and RA_{sag} method is found to be 2-28° (% 2.5-57.8).

The angle of rotation in paralytic scoliosis is found to be 66.7 (37.1-78.3) according to the RAANI method, 61.2° (32.1-83.2) according to the RA_{AN2} method and 57°.5 (23.7-80.9°) according to RA_{sag} method.

In congenital scoliosis, the angle of rotation is 25.5° (16.6-35.5°) using the R_{AAN1} method, 28.1° (23.7-37°) using the RA_{AN2} and 26°.3 (19.5-33°) using the RA_{sag} method.

In idiopathic scoliosis, the angle of rotation is found to be 19° (6.9-37.8°) with the RA_{AN1} method, 18.9° (6.3-40.7°) with the RA_{AN2} method and 19° (10.1-28.8°) with RA_{sag} method (Table 1).

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