PREOPERATIVE AND POSTOPERATIVE MEASUREMENT OF VERTEBRAL ROTATION WITH CT IN IDIOPATHIC SCOLIOSIS

C. SOLAKOĞLU MD. ** M. ALTINMAKAS MD. * N. AYDOĞAN MD.*
M. TAŞAR MD. *** A. ŞEHİRLİOĞLU MD. ** G. MOLLA MD.****

ABSTRACT :

Many different methods have been described at the measurement of spinal rotation in idiopathic scoliosis. Measurement of rotation with computarized tomography is a considerably new method when compared to Moe and Pedriolle method.

We performed spinal instrumentation with TSRH and ALICI systems to 26 cases with idiopathic scoliosis at the Orthopaedics and Traumatology Department of Gülhane Military Medical Academy between January 1991 and November 1995 but we measured spinal rotation with CT in 16 patients preoperative and postoperatively. Thirteen (81.25%) of the cases were female and 3 (18.75%) were male. While determining spinal rotation with CT, two different measurements; RAml and RAsag were used as described by Aaro and Dahlborn in 1981 (1, 2). Statistical analysis of the data was made and we observed that we could be able to make a rotational correction about 28% in apical vertebra.

While the lateral inclination in frontal plane is easily corrected in scoliosis surgery, the correction rate of the other important components of scoliosis namely inclination in sagittal plane and rotation in axial plane are valuable criterias in evaluation of the success of the surgical treatment. We observed that the rotation of concave rod to 90 degrees at time of correction did not completely reflect to the apical vertebrae. Sublaminar wiring or double hook (claw) application to apical vertebrae are the options for more correction in rotation at the center of scoliosis. Another option is to apply 90 degrees rotation to concave rod two times first with slight distraction, second with full distraction.

Since the pedicle shadows are obstracted by the metallic implant postoperatively, the measurement of vertebral rotation could not be possible with Nash and Moe method. In contrary, the CT establishes the remarkable areas clearly and distortion of the images are no longer problems with new technolog, so CT does measurements more accurately. In conclusion, CT is a reliable method for measuring spinal rotation.

Key words: *Adolescent Idiopathic scoliosis, surgical treatment, spinal rotation, CT scan.*

INTRODUCTION

During the last 25 years, surgical treatment of scoliosis has been able to achieve significant correction in fixed lateral curvature of the spine but less correction of vertebral rotation has been possible. Especially Harrington instrumentation achieved little in rotation deformity, so it was combined with sublaminar wiring to achieve derotation and translation manouver more. Dickson and Archer (7, 8) have emphasized the three dimensional nature of the deformity of idiopathic scoliosis and stated that the instrumentation which adresses this fact is essential for adequate correction. Cotrel-Dubousset Spinal Instrumentation (CDI) was first developed and used in 1986 to supply these demands of modern spinal surgery (5).

The importance of vertebral rotation in the etiology and management of scoliosis is well established in the last 15 years. While the displacement of the spinous process from midline was used to measure rotation initially (4), later Nash and Moe found this method to be unreliable because of the asymmetrical development of spinous process of the scoliotic spine. They introduced their own method in which the displacement of the convex side pedicle toward midline was considered in direct proportion to the degree of rotation (13).

* Assoc. Prof. Dept. of Orthopaedics and Traumatology, GMMA
** Assist. Prof. Dept. of Orthopaedics and Traumatology, GMMA
*** Assist. Prof. Dept. of Radiodiagnostic Radiology, GMMA
**** Resident, Dept. of Orthopaedics and Traumatology, GMMA

Pedriolle quantitatively measured pedicle shift using a special template in 1979 (14). CT has began to be used to measure rotation lately but it required to identify reliable landmarks and Aaro-Dahlborn identified these points in 1981 (1, 2). The landmarks were the middle of the sternum, the center of the posterior neural arch, and the axis of the vertebra.

In this article, the measurement of vertebral rotation in idiopathic scoliosis with CT scans preoperatively and postoperatively using TSRH and ALICI systems was made and the prospective study of the correction of vertebral rotation achieved by these instrumentations has been declared.

MATERIAL AND METHOD

We performed surgical treatment to 26 patients with idiopathic scoliosis who attended to Orthopaedics and Traumatology Department of Gülhane Military Medical Academy, Ankara between January 1991 and November 1995. But 13 (81.25%) female and 3 (18.75%) male, totally 16 patients were asked to have CT scans to measure vertebral rotation preoperative and postoperatively. So the other 10 cases were excluded in this study. The ages of the patients were ranged between 13 and 38 (mean: 16). Two (12.5%) of the cases had King type II, 8 (50%) had King type III, and 6 (37.5%) had King type IV curves. These cases have been studied in detail:

Preoperative assessment: Each patient gave a complete history; physical examination paid particular attention to the extend of the rib hump and the neurological status. Radiographic studies included standing anteroposterior and lateral films and also anteroposterior bending films. The height of the rib hump was also measured. All CT images were obtained in supine position preoperatively and third month postoperatively to assess vertebral rotation and rib cage deformity. Siemens Somoton DRH (third generation) was used for obtaining images. Dosage was 135 KV, 280 mAS. The spinal curvature was scanned including upper, apical and lower end vertebrae determined first with plain films and CT slices were made like mediastenal images in order to establish the whole chest thus the points required for determining the rotation like sternum and posterior neural arch.

Operative assessment: Ten (62.5%) of the patients were operated with TSRH spinal instrumentation system and 6 (37.5%) with ALICI spinal instrumentation system. We applied the rules of CD (9) for application of hooks but with some modifications in order to increase the correction in all three planes. We instrumented the lower end of Harrington stabile zone (11) with two level transpedicular screws. Also we observed that the rotation of concave rod to 90 degrees did not completely reflect to the apical vertebra. So we performed double hook claw system to apical vertebra. Also we applied 90 degrees rotation to concave rod two times first with slight distraction, second with full distraction. Then we performed claw hook system at the upper end of convex side and applied compression. Intraoperative spinal cord monitoring recordings were made and the Stagnara wake-up test was used during the operation.

Postoperative assessment: Each patient had standing anteroposterior and lateral radiographs and CT slices through the same vertebraes. All complications were recorded and patients were assessed at regular intervals.

Rib hump evaluation: The rib hump was measured in the forward bending position with a vertical movable rod placed upon the spinous process of the apical vertebrae and a horizontal rod balanced on the apex of the rib hump.

CT scans: The CT scans were assessed using the guidelines of Aaro and Dhalborn (1, 2). We used precise bony landmarks to provide more reliable data.

The landmarks were the middle of the sternum, the center of the posterior neural arch, and the axis of the vertebra. The angle formed between the midline of the torso (a line between the center of the posterior arch and the middle of the sternum) and the axis of the vertebra was accepted as the vertebral rotation relative to the midline (RAml) (Figure 1). Also the angle between a perpendicular and axis of the vertebra was accepted as the RAsagittal (Figure 2). The angles were measured in the pre- and postoperative CT scans independently by two persons for at least two times in order to lessen the intra-observer error.

RESULTS

Cobb angle: The mean preoperative Cobb angle was 67.3 (range: 42-120) degrees. It was found 40.7 (range: 19-90) degrees in the early postoperative period ($p<0.005$). The average correction rate was 58.69% in accordance to the correction of major curve in frontal plane and it was statistically significant ($p<0.005$).

CT scans: Measurements on the CT scans showed a preoperative mean RAml of 28.6 (range: 10-

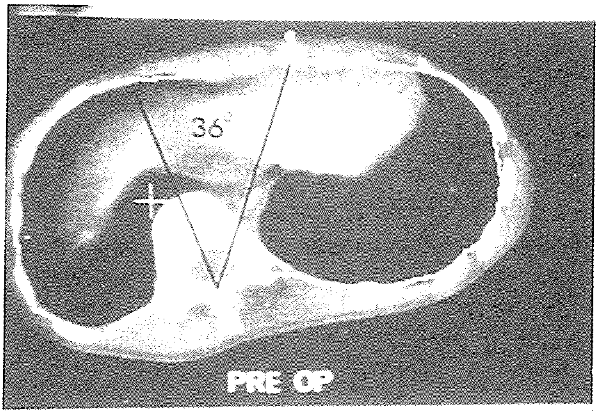

Figure 1. Rotation relative to midline (RAml)
1) Middle of sternum
2) The center of the posterior neural arch
3) Axis of vertebrae.

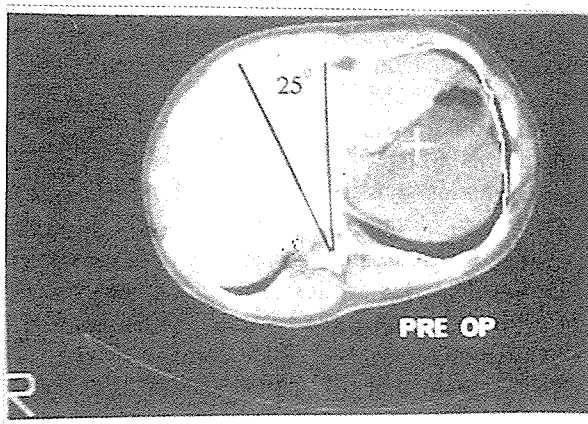

Figure 2. Rotation relative to perpendicular (RAsagittal)
1) Perpendicular to the center of posterior neural arch
2) Axis of vertebrae.

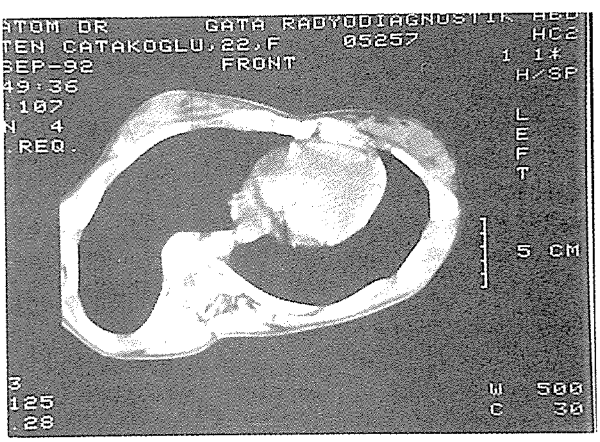

Figure 3. A.Ç. 22 Yr. female, Preop. CT

Figure 4. A.Ç. Postop. CT

70) degrees and a postoperative mean of 29.06 (range: 5-56) degrees. This indicates a 27.66% derotation of the apical vertebrae (Figure 3, 4). The mean preoperative RAsagittal angle was 25.06 (range: 8-50) degrees against a postoperative mean of 17.87 (range: 4-34) degrees, indicating a 28.4% improvement in rotation (Figure 5, 6). The RAml and RAsagittal angles were decreased in all cases except one case who had a severe King type II curve. She showed 5 and 7 degrees increase consequtively and her values were calculated as minus values in total.

Rib cage: The contour of the rib cage was seen to improve in all CT scans, with the vertebral body assuming a more central position within the thorax.

Rib hump: While the preoperative mean height of rib hump was 23.14 (range: 8-41) mm., it was found 12.39 (range: 2.5-30) mm. postoperatively. The average correction was 10.75 mm and this represented a 50.35% correction of the deformity ($p<0.005$).

Follow up: The patients were assessed for an average of 22.1 (range: 8-39) months. The mean loss of Cobb angle correction was 4.5 degrees in the late postoperative period. The instruments of 4 cases were disassambled since they completed the two year period for solid fusion and no pseudoarthrosis observed in the postoperative period.

DISCUSSION

It has been shown that Harrington instrumentation could only correct the deformity in frontal plane and its effect to axial and sagittal deformity is minimal (12). Our experience with CD derived instruments like

TSRH and ALICI has shown that the correction obtained at operation is maintained better than that obtained with Harrington rod instrumentation. We attribute this to the segmental nature of instrumentation.

Correction of the rib hump deformity is one of the main aims of surgery for idiopathic scoliosis; failure to achieve this is disappointing for both patient and surgeon. Our study have shown that a good clinical correction of the rib hump can be achieved and maintained for at least two years by derotation of the vertebral column with CD-like instrumentation. This technique can also significantly correct the lordoscoliotic deformity, and can produce a kyphotic thoracic spine (6, 7, 8).

Minor loss of correction can occur in the first months postoperatively and does not deteriorate further, indicating that a solid fusion has then been achieved. Hence, the incidence of pseudoarthrosis in the fusion also decreases markedly.

Measurement of vertebral rotation in difficult without the use of CT scans. Nash and Moe described a method of determining vertebral rotation using stardart AP radiographs and estimating the position of the pedicles across the vertebrae (13). Pedriolle developed a template using the same parameters (14). But, since the pedicles are often obscured by the metal rods; postoperative measurements may not be possible. In contrary, CT scanning allows accurate localization of the three bony landmarks both before and after operation. CT slice is performed through the apical vertebrae and the sternum, posterior neural arch are easily identifiable. The axis of the vertebrae itself is the main source of observer error especially if the vertebrae is asymmetrical secondary to deformity (3).

The RAsagittal angle which uses a perpendicular may be inaccurate because of the variable position of the patient on the CT table. Also the postoperative reduction of the rib hump will allow the supine patient to roll towards the convexity of the spinal deformity, thereby increasing the apparent RAsagittal angle and giving a false impression of an increase in rotational deformity. In our series, the RAsagittal angle gave lower mean values than the RAml angle pre- and postoperatively but both did show a similar percentage in correction of rotation.

Some authors previously reported that the rib hump deformity had no direct relationship to the degree of vertebral rotation (10, 15). But we found a positive correlation between the rib hump deformity and vertebral rotation. We suggest that the Nash and Moe method used at the previous studies failed to provide data accurate enough to reveal rotation. But our more accurate measurements with CT resulted from the better method of assessment of vertebral rotation.

CONCLUSION

Evaluation of vertebral rotation by CT scans has established that CD derived spinal instrumentations like TSRH and ALICI produced a significantly better correction at three planes of deformity in idiopathic scoliosis than previous techniques. Transpedicular screw fixation of the lower end of deformity, claw application to apical vertebrae with double hooks and giving two times rotation to concave rod are our suggestions for better correction in rotation and CT is a reliable method for measuring vertebral rotation since it establishes all remarkable areas more accurately both before and after the operation.

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ERRATUM

Figure 1 of the article entitled "Treatment of herniated lumbar disc with laser discectomy, Erbayraktar et al., which should have been placed in Vol. 6, page 67, 1995 has been erroneously appeared in Vol. 6, page 98, 1995; and figure 1 of the article entitled "Percutaneous automated nucleotomy in the diagnosis and treatment of a herniated juvenile cervical intervertebral disc calcification: Case report., Ösün et al., which should have been placed in Vol. 6, page 98, 1995 has been erroneously appeared in Vol. 6, page 67, 1995.

We hereby apologize for the inconvenience.