THE SELECTION OF FUSION LEVELS AND ANALYSIS OF THE CORRECTIVE FORCES IN IDIOPATHIC SCOLIOSIS

E. ALICI * **H. BERK *** **M. ÖZKAN *** **K. YALDIZ ***

ABSTRACT

Spinal decompensation after selective thoracic fusion by using 3 dimensional corrective devices especially in type 2 curves has become a severe complication secondary to progression of the unfused curve. In this article we evaluate our patients and propose some criteria in order to prevent decompensation, lumbar kyphosis and junctional kyphosis. We concluded that the King criteria for three dimensional correction of idiopathic scoliosis are not appropriate.

Key Words : *Idiopathic scoliosis, Spinal decompensation, Corrective forces.*

In 1983, King et al. (4) developed criteria for selection of fusion levels in thoracic curves using Harrington distraction instrumentation. They classified thoracic curves in five groups, and limited thoracic fusion was done especially in Type 2 curves. Satisfactory balance was achieved. These criteria were also used for the selection of fusion levels when the instruments that correct the deformity at 3 dimensions were begun to be used. But several groups of investigators have reported progressive decompensation and progression of the unfused lumbar curve after selective fusion especially in type 2 curves. These kinds of instruments are different from the Harrington distraction system (2, 3). In 3 dimensional systems, minimal distraction coupled with derotation provides major corrective force and thus, large torsional forces are applied to the instrumented and uninstrumented portions of the spine As a result, the fixation is segmental and rigid also. The amount of correction is usually equal to or less than the correction that is gained on the preoperative sidebending films whereas postoperative correction is nearly 10 % greater than that on the sidebending films at 3 dimensional instrumentation systems. This increased curve correction and the torsional forces developed during correction is responsible for large torsional forces being placed across the uninstrumented spine, and this creates decompensation and progression especially in type 2 curves. After decompensation became a problem in selective fusion especially in Type 2 curves, many investigators suggested several methods in order to prevent decompensation but no firm guidelines have been established as to which curves may be at risk and which levels should be fused.

Richards et al. (10) reported that in Type 2 curves with a thoracic component greater than 60 and a lumbar curve smaller than 45 degree, fusion only the thoracic curve results in spinal decompensation. In such curves fusion must be done to both curves and instrumentation must be carried just beyond the apical vertebra of the lumbar curve. They recommended that in smaller type 2 curves, fusion can be carried one segment short of stable vertebra or to the stable vertebra.

Benson et al. (1) suggested type 2 curves into two subgroups. In group A, patients exhibited at least three of four criteria: 1) a lumbar curve that corrects more than 70 % on sidebending films. 2) a lumbar curve less than 35° 3) lumbar apical vertebra crossing the central sacral line 4) a lumbosacral angle less than 12°. In group B, patients have no more than two of these criteria. In group A patients, limited thoracic fusion gave excellent results whereas in group B, decompensation developed after limited thoracic fusion.

Thompson et al. (13) reported a 75% incidence of decompensation in type 2 curves fused according to King criteria and they found two factors that is responsible for this: 1) overcorrection of the thoracic curve 2) extension of the fusion to include the mobile transitional segment. They believed that shorter thoracic fusion in type 2 curves prevent or minimize decompensation.

* Dokuz Eylül University, School of Medicine, Dept. of Orthopaedics and Traumatology, İzmir.

Shuffleberger et al. (11, 12) reported that modification of the hook pattern in type 2 curves prevented decompensation. The standart thoracic hook pattern placed a distraction force at the lower concave aspect of the curve and worsened the thoracolumbar junction. Using a compression hook patterñ crossing the thoracolumbar junction prevented postoperative progression of the lumbar curve and spinal decompensation. They recommended to cross the thoracolumbar junction.

Mc Call and Bronson (9) noted that patients with a lumbar curve morethan 45 degrees preoperatively demonstrated progression of the lumbar curve after instrumentation of the thoracic curve to the stable vertebra. They also found out that a low flexibility index of the lumbar curve are at risk of decompensation after selective thoracic fusion.

Winter (6) suggested to fuse the thoracic spine shorter and possibly achieve less correction or to fuse the thoracic spine as one would like normally, but take an intraoperative radiograph to determine that the thoracic curve is not overcoorected beyond the ability of the lumbar curve to correct then fuse the curve longer into the lumbar spine or reverse the distal hook pattern at the thoracolumbar junction as suggested by Shuffleberger.

Although all of these procedures avoid us from decompensation, no factors predictive of potential decompensation were put forward. In this study we analyze our patients treated with Alıcı Spinal System (ASS) and we determined criteria in order to prevent decompensation, junctional kyphosis, lumbar kyphosis.

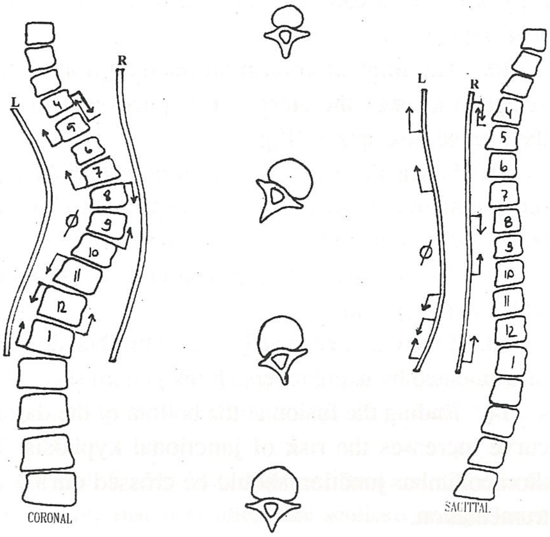
MATERIALS AND METHODS :

72 patients of (48 female, 24 male) idiopathic scoliosis treated with ASS between 1989 and 1993 were analyzed. Different fusion levels and hook patterns were used in these patients. Mean follow-up was 32 months and mean age was 15.5 (11-29) years. 19 patients had thoracic curves, 8 patients had thoracolumbar curve, 35 patients had thoracic curve. On preoperative X rays frontal cobb angles were 50.7° (22° - 98°) in thoracic curves and 35.8° (20° - 45°) in lumbar curves. Sagittal plane analysis showed mean 25.4° of thoracic kyphosis and 36.2° of lumbar lordosis. Flexibility indexes were 35.7 % and 62.3 % in thoracic and lumbar curves respectively. Mean postoperative Cobb angle was 15.3° (71% correction rate) for thoracic curves and 11.2° (68.7% correction rate) for lumbar curves.

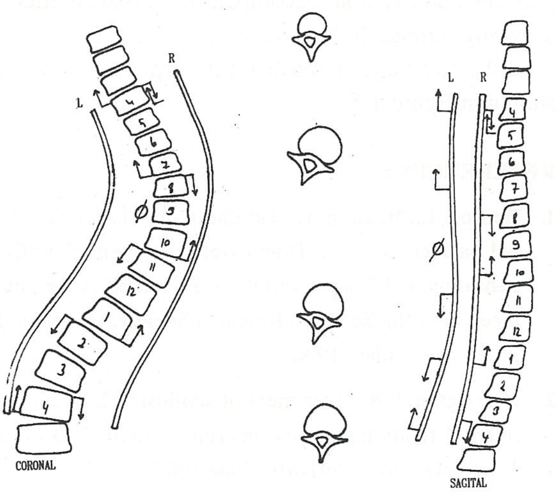
ASS was used in all patients and distraction, derotation maneuvers were done. Deformity were analyzed and corrected at three dimensions. Special importance was given to the correction of the sagittal plane deformity. Preoperative standing, traction, bending, lateral standing, lateral flexion and extension, selected plane radiograms were taken and the end vertebrae were determined on standing lateral films, vertebrae were instrumented bilaterally. Claw was done at the convex side of the end vertebra (Fig. 1-5). Apex was instrumented at the concave side because correction of the rotation and the sagittal profile could be achieved better. THis instrumentation allowed us to control the deformity at the apex easily (Fig. 1-5). Distractive forces create kyphosis and compressive forces create lordosis. At the thoracolumbar junction, modified hook pattern was used in order to establish lumbar lordosis. Evaluation of the postoperative films showed that 8 patients had spinal imbalance. The degree of the thoracic and lumbar curve, flexibility indexes and postoperative correction rates were investigated. The postoperative correction rates were much greater than the preoperative correction obtained by sidebending in these patients. Clinical and roentgenographic evidence of decompensation defined as: 1) Postoperative shift to the left of the instrumented right thoracic curve, 2) Progression of the unfused lumbar curve greater than 10 degree. 3) Thoracolumbar kyphosis. 4) Loss of lumbar lordosis.

DISCUSSION :

The first criteria for selection of fusion levels at idiopathic scoliosis were established by Moe (7, 8). Then King et al. developed preoperative criteria for selection of fusion levels in thoracic curves using Harrington distraction instrumentation (4). These criterias were also used as a guide for the selection of fusion levels when 3 dimensional systems were used. When these criterias were used with 3 dimensional systems, many investigators reported decompensation to the left of the instrumented right thoracic curve, junctional kyphosis, progression of the uninstrumented lumbar curve, loss of lumbar lordosis especially at type 2 thoracic scoliosis (5, 9). Many ideas were put forward in order to prevent decompensation but none of them

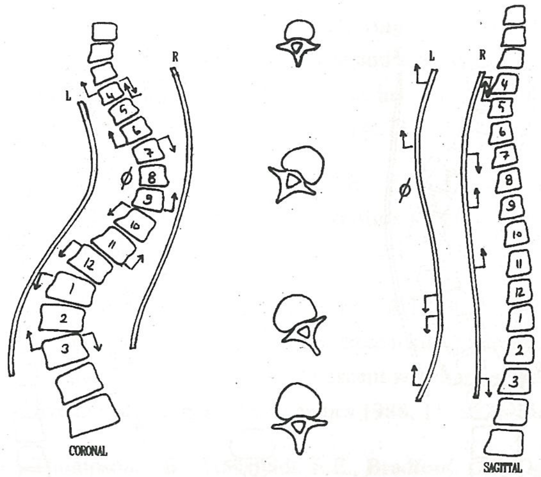


Ø : Neutral hook
Figure 1

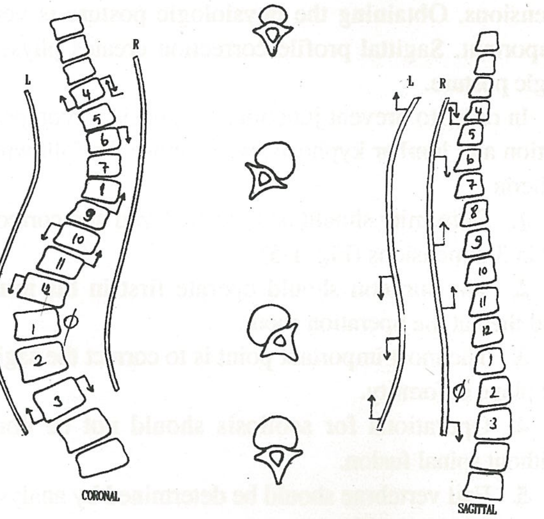


Ø : Neutral hook
Figure 2

solved the problem properly (5, 6, 9, 10, 11, 13). Many surgeons are still using King criteria that evaluate the deformity only at the frontal plane. On the other hand, 3 dimensional systems correct the deformity in axial, frontal and sagittal planes. The surgeon thinks in one plane but corrects the deformity in three planes. With 3 dimensional systems; the amount of correction is nearly 10% greater than that evident on preoperative side-

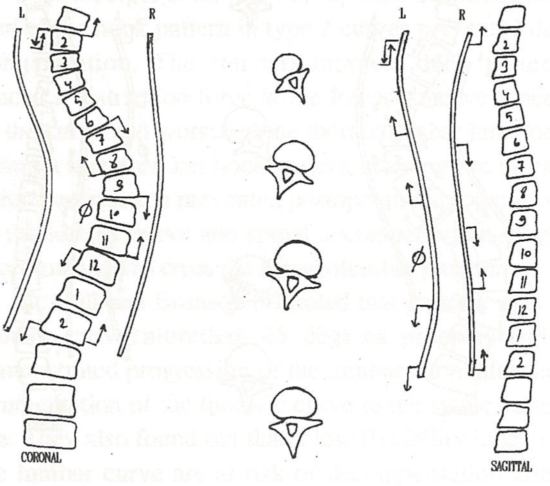


Ø : Neutral hook
Figure 3



Ø : Neutral hook
Figure 4

bending films (9). Overcorrection of the thoracic curve exceeds the ability of the lumbar curve to compensate and decompensation of the lumbar curve to compansate and decompensation of the lumbar curve will occur (9, 13). Structural changes are seen both in soft tissues and bone in idiopathic scoliosis. After selective fusion of the idiopathic scoliosis especially in type 2 curves, the structural changes in soft tissues are corrected whereas the bony changes are not. For this rea-



Ø : Neutral hook
Figure 5

son fusion must cover all structural changes in three dimensions. Obtaining the physiologic posture is very important. Sagittal profile correction creates physiologic posture.

In order to prevent junctional kyphosis, decompensation and lumbar kyphosis, we propose the following criteria :

1. Deformity should be both analyzed and corrected in 3 dimensions (Fig. 1-5).

2. The surgeon should operate first in his mind and then at the operation room.

3. The most important point is to correct the sagittal plane deformity.

4. Operations for scoliosis should not be done without spinal fusion.

5. End vertebrae should be determined by analysis of standing lateral films.

6. End vertebrae are always instrumented bilaterally (Fig. 1-5).

7. Claw should be placed on the upper end vertebra at the convex side (Fig. 1-5). It can be done at the concave side also.

8. Upper and lower vertebrae near apex at the convex side should be instrumented in order to make compression to close the opened disc spaces properly (Fig. 1-5).

9. Neutral hook should be placed at the **concave** side of the apex because correction of the rotation and the sagittal profile can be achieved better. The deformity at the apex can be controlled easily by this way (Fig. 1-5).

10. The implant configuration should always be designed to open the closed disc spaces and to close the opened disc spaces (Fig. 1-5).

11. When the sagittal profile is established, the junctional zone (transition from Kyphosis to lordosis) should be between T12-L1 (Fig. 1-5).

12. Two or three transverse connectors should be added to the system.

13. If the curve ends at T12, L1 vertebra should be instrumented by using reverse hook pattern (Fig. 1-5).

14. Ending the fusion at the bottom of the thoracic curve increases the risk of junctional kyphosis. The thoracolumbar junction should be crossed during instrumentation.

15. Both curves should be instrumented in double thoracic curves (Fig. 1-5).

16. Lumbar curves more than 45° with a flexibility index less 25° are at high risk of developing progression and eventual decompensation is seen after undergoing limited thoracic fusion.

All hook patterns in different types of curves are shown in figure 1-5.

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