

## Comparison between the effects of Harrington Rod and multisegmented instrumentations in sagittal plane correction of idiopathic scoliosis

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### Abstract

**Objective:** To present the changes in projected thoracic hypokyphosis and the behavior of lumbar lordosis within and below the fusion and to compare these changes between the Harrington rod (HR) and posterior multisegmented hook instrumentation.

**Methods:** 178 patients with idiopathic scoliosis, who had undergone posterior spinal fusion with Harrington technique (106 patients) or multisegmented hook system (72 patients), were analyzed.

**Results:** The average coronal plane correction was 37% with the Harrington technique and 54% with the multihook system. In sagittal plane correction and in thoracic kyphosis in patients treated with HR technique, the preoperative thoracic hypokyphosis became normal in 20% of cases, remained unchanged in 60% and deteriorated in 20% of cases. Normal preoperative thoracic kyphosis did not increase in any of the cases. The thoracic kyphosis in patients treated with multihook technique became normal in 66%, remained unchanged in 17% and deteriorated in 17% of cases. Normal preoperative thoracic kyphosis remained the same post-operatively in 92% and changed to kyphosis in 8% of cases. Of 38 cases with decrease in total lumbar lordosis, 33 cases showed decrease, and 5 cases remained unchanged postoperatively concerning lumbar lordosis at the fusion level.

**Conclusion:** The effect of the multihook system to correct coronal plane deformities was markedly better than the HR system (53.8% vs. 37.9%).

**Keywords:** hypokyphosis, sagittal contour, lumbar lordosis, Harrington, idiopathic, multihook.

### Introduction

Scoliosis is a three dimensional deformity of the spine. The research of Donge et al shows that idiopathic cases usually exhibit a flattening of the sagittal curves, which is further deteriorated when the Harrington technique is used. The consequences include flat back, angular increase of lumbar lordosis below the fusion and low back pain [1]. Previous studies showed no

or only moderate correction of thoracic hypokyphosis when using multihook segmental instrumentation [2].

The present study compared the effects of multihook segmental instrumentation versus Harrington rod technique on the lumbar spine within and below the fusion.

### Methods

In the present study, 178 patients underwent fusion with multihook or HR posterior fusion

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for scoliosis during 1974-2000. The inclusion criteria were as follows [3]: 1- a diagnosis of idiopathic scoliosis, 2- posterior only correction and fusion with Harrington or multihook systems, 3- no post-operative hook displacement and/or no evident sign of pseudarthrosis and 4- a minimum F/U of 2 years. HDR system was used in 106 patients, CD in 52 and diapasonTM in 20 patients. In 128 cases the curves were right thoracic, in 8 cases left thoracic, in 12 cases right thoracolumbar, in 4 cases left thoracolumbar, in 4 cases right and in 4 cases left lumbar and in 18 cases double (right thoracic left lumbar). 134 patients were female and 44 patients were male. 96 patients were between 11-15 years of age, 62 patients between 16-20 and 20 patients were above 20 years. The classic rules of Cottrell and Dubousset were followed for hook positioning and insertion in the upper and lower end vertebrae as well as rod contouring.

When the thoracic spine was markedly hypokyphotic, the superior limit shifted one or two levels upper and an intermediate pedicular hook was applied to the concavity to provide more segmental distraction and to achieve kyphosis.

Sagittal and coronal angle evaluation were done using the Cobb's method as described below. Cobb's method of measurement, recommended by the terminology committee of the scoliosis research society, consists of three steps: 1) locating the superior end vertebra, 2) locating the inferior end vertebra and 3) drawing intersecting perpendicular lines from the superior surface of superior end vertebra and from the inferior surface of the inferior end vertebra. The angle of deviation of these perpendiculars from a straight line is the angle of the curve.

## Results

Statistical analyses were performed using student t-test. The Mann-Whitney U test was applied when the number of elements exceeded 100. Statistical significance was set at a P value

less than 0.05 and a U Value more than 2. Coronal plane correction results showed that in 106 patients treated with HDR technique, coronal plane curve was between 45-95 degrees with an average of 62.5 degrees preoperatively. The obtained correction at the end of follow-up was 23.5 at mean (range 12°-40°) which showed approximately 37.9% correction.

In the group of multihook system (72 pats), preoperative coronal plane curve was between 43°-78° with an average of 52 degrees. The correction obtained with this system was 12°-48° with an average of 27.3 degrees, i.e., the average percent of obtained correction was approximately 53.8%.

Sagittal plane correction results were as follows:

Thoracic kyphosis is considered normal when it's between 20°-40° from T4 to T12.

In patients treated with HDR technique, thoracic hypokyphosis (i.e. less than 20 degree) became normal in 20%, deteriorated in 20% and remained the same in 60% of patients.

In patients treated with multihook systems, thoracic hypokyphosis improved in 66%, remained unchanged in 17% and deteriorated in 17% of cases.

Normal thoracic kyphosis remained unchanged in 92% of patients treated with multihook system and lessened in the remaining 8% of cases. Thoracic kyphosis of more than 50 degrees came back to normal in 90% of cases and remained unchanged in 10%.

Of 106 patients treated with Harrington technique, total lumbar lordosis (L1-L5) decreased in 76, and increased in 30 patients. In 76 patients total lumbar lordosis decrease was from 4-30 degrees with an average of 12 degrees. In 30 patients total lumbar lordosis increase was from 5-16 degrees with an average of 9.5 °.

Lumbar lordosis in the fusion area remained unchanged in 12 out of the 30 patients (who had increase in their total lumbar lordosis) and also in 4 out of 76 patients (who had decrease in their total lumbar lordosis).

Lumbar lordosis in the fusion area decreased in 18 out of 30 patients with increase in total lumbar lordosis and in 72 out of 76 patients with decrease in total lumbar lordosis.

Of 76 patients with decrease in total lumbar lordosis, lordosis below the fusion level increased in 40 and remained unchanged in 36 patients. In 30 patients with increase in total lumbar lordosis, lordosis in the fusion area increased in all cases.

Of 72 patients treated with multihook systems, total lumbar lordosis (L1-L5) decreased in 38 and increased in 34 patients. Of these 34 patients with increase in total lumbar lordosis, 22 cases showed increase and 6 cases showed decrease in their lumbar lordosis in the fusion area and in the remaining 6 patients this area remained unchanged pre- and postoperatively. Of 38 patients with decrease in total lumbar lordosis, lumbar lordosis in the fusion area decreased in 33 and remained unchanged in 5 patients.

Lumbar lordosis below the fusion level was as follows: Of 34 patients with increase in total lumbar lordosis, lumbar lordosis below the fusion level increased in 15 and decreased in 19 cases. Of 38 patients with decrease in total lumbar lordosis, lumbar lordosis below the fusion level increased in 31 and decreased in 7 patients.

### Discussion

There are a few studies over post-operative sagittal and coronal balance. In a retrospective study on 28 patients directed by Raed M. Ali, et al using third generation instrumentation in adult scoliosis, an average coronal curve measurement of 64% was found.

The surgical correction was significantly greater than the correction achieved on bending radiographs but the correction of the sagittal curves was equivalent to the correction achieved before surgery on bending radiographs [4].

Ernest et al [5] evaluated maintenance of postoperative sagittal alignment in cerebral palsy. In a sagittal plane analysis of the spine and

pelvis Jean-Marc Mac-Thiong, et al. concluded that thoracic kyphosis depends mostly on the spinal deformity, whereas lumbar lordosis is influenced mainly by the pelvic configuration [6].

In this study 178 patients with idiopathic scoliosis underwent posterior spinal instrumentation and fusion. HR system was used in 106 and multihook system in 72 patients. In 10 out of 106 patients who were preoperatively kyphotic, 20% became normal, 20% deteriorated and 60% remained unchanged in the evaluation of the sagittal plane at follow-up.

Normal preoperative thoracic kyphosis [7] remained unchanged in 74% and decreased to hypokyphosis in 26% of cases and kyphosis over 50 degrees in 28 patients became normal postoperatively.

In 72 patients treated with multihook systems, 12 patients had thoracic hypokyphosis which changed to normal in 66% (8 patients), remained unchanged in 17% (2 patients) and deteriorated in 17% (2 patients).

Normal preoperative thoracic kyphosis in patients treated with multihook systems remained unchanged in 92% and became hypokyphotic in 8% of cases post-operatively. Preoperative kyphosis of over 50 degrees in 12 patients normalized in 90% and decreased in 10% of patients post-operatively.

Lumbar lordosis in patients treated with HR system decreased in more than 70% of cases, in comparison to the lumbar lordosis of in and below the fusion level, the decrease was mostly in the fusion area. In the remaining 30% of patients, with increase in total lumbar lordosis, lumbar lordosis in the fusion level remained unchanged in 50% and in the remaining 50% lumbar lordosis in the fusion level decreased, showing that most of this increase in total lumbar lordosis is in the area below the fusion level (compensatory increase in lumbar lordosis below the fusion level).

Considering lumbar lordosis in patients treated with multihook systems (72 patients), of

34 patients with increase in total lumbar lordosis, lumbar lordosis in the fused level increased in 22, decreased in 6 and remained unchanged in 6 patients. In 38 patients with decrease in total lumbar lordosis, in 33 the decrease was in the fusion level and in 5 cases it was below the fusion level.

There were several limitations in this study, one of which was its retrospectiveness and its inability to appropriately match two groups with each other according to their sex, age and curve patterns. The next and the most important limitation was the low quality of X-rays which made the measurements very difficult and sometimes impossible. For evaluation of lumbar lordosis by Cobb's measurement, there was a need to see and mark the upper border of L1 and the lower border of L5 which was not included in most of the X-rays taken preoperatively from our patients.

Although contribution of the lower border of L5 for evaluating lumbar lordosis changed its result significantly, lumbar lordosis had to be measured from the upper border of L1 and upper border of L5 instead of its lower border because of unavailability of a proper sagittal X-ray.

The effect of the multihook system to correct coronal plane deformities was markedly better than HR system (53.8% vs. 37.9%). The effect of multihook systems in sagittal plane deformities was also obviously better than the HR technique (improvement in thoracic hypokyphosis in 66% of patients treated with multihook systems and in 20% of patients treated with HR). Multihook systems also preserved or re-obtained the normal lumbar lordosis in 90% of patients.

In some patients with change in total lumbar lordosis, this change was in the fused area. In most of the patients treated with HR technique, total lumbar lordosis decreased (flat back), and in the remaining patients with no change in their post-operative total lumbar lordosis, this was due to a decrease in lumbar lordosis in the

fusion level and compensatory increase in lumbar lordosis below the fusion level.

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