THE COMPARISON BETWEEN THE RESULTS OF THE HARRINGTON INSTRUMENTATION AND LEEDS PROCEDURE PERFORMED ON SCOLIOSIS

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We reviewed the results of the Harrington distraction (plus compression sytem) and the Leeds procedure performed on 39 patients with scoliosis with a mean follow-up time of two years. The magnitude and flexibility of the curves were approximately the same in both of the groups. We achieved a mean correction of 28 per cent in the first group ond 40 per cent in the second group. In hypokyphotic curves the Harrington instrumentation couldn't normalize the sagittal contour. Leeds procedure was especially efficient in curves less than 70° in maintaining the normal sagittal alignment and correcting the deformity in the coronal plane.

Key Words: Leeds procedure, Harrington instrumentation.

In the past 30 years there has been a significant evolution in the operative treatment of patients with scoliosis. Harrington's system was the first to have gained widespread international acceptance and became a standard for the correction of spinal deformities, but one of the major negative aspects of this technique was the inability to correct the thoracic idiopathic scoliosis (4). Therefore several instrumentation techniques, like the Leeds procedure, were developed purposing to correct the lordoscoliotic curvature in combining the benefits of the distraction force and the segmental transverse correction. In this study we will compare some of the basic qualities of both of these systems and will evaluate from different aspects.

MATERIALS AND METHODS

Thirty-nine patients with available complete records are included to this study. All operations were performed in Ccrrahpa§a Faculty of Medicine, Department of Orthopaedics and Traumatology between 1985 and 1989. They were divided into two groups: group 1, twenty-three patients who had the Harrington instrumentation (in four cases the compression system was added) and group 2, sixteen patients who had the Leeds procedure. The preoperative evaluation of all patients was standard and included a careful neurological examination, routine blood evaluation, posteroantcrior and lateral standing radiographs, right and left maximum-bending radiographs, pulmonary function testing and clinical radiographs. In group 2 the surgical technique consisted of tightening of sublaminar wires (18-gauge stainless steel) on the Harrington square-ended rod which has been contoured to the normal thoracic kyphosis and lumbar lordosis. Different numbers of vertebral segment above and below the apical vertebra receved sublaminar wires (mean 3.6 vertebral segments) depending on the rigidity and the extent of the curve. All but one underwent a similar posterior fusion which included removal of facet joints, decortication and use of bone graft from the iliac crest. One patient, 6-ycars old, was operated with Harrington system subcutancously without fusion. We performed the wake-up test routinely. In the postoperative period they all wear a plaster cast for 9 months, the last two months being of bclow-the shoulder type.

RESULTS

Table 1 summarizes us the detail of the clinical and radigraphic data of the two study groups. Table 2 gives us the breakdown of the complications. One patient with rod breakage (plus pseudoarthrosis) in group 1 refused the reopcration; in another patient with rod breakage in the same group we didn't observed any sign of pseudoarthrosis at the reopcration so that we contented with the extraction of the implant. In the other three patients in both of the groups we changed the broken rod and added iliac graft. The patient with upper hook dislodgmcnt didn't showed any loss of correction in the follow-up period so that we abondonncd

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Table 1
Comparison of clinical and radiographic data of the two study groups

Factors analyzed	Group 1 (23 Cases)	Group 2 (16 Cases)
Age at surgery (yrs.)	14 (6-19)	15.8 (10-23)
Sex (male:female)	13:10	9 : 7
Distribution of diagnoses		
idiopathic scoliosis	17	16
congenital deformity	1	-
neurofibromatosis	4	-
Marfan's syndrome	1	-
Curve type		
thoracic (lower-thoracic)	18	11
thoracolumbar	2	2
double	3	3
Preoperative Cobb angle	69.1° (42, 108)	62.6° (36 - 98)
Maximum-bending curve	51.1°	44.5°
Preop. correction by max.bend.	26 %	29 %
Postoperative Cobb angle	49.6°	37.3°
Postoperative correction	28.2 %	40.4 %
Postop. corr. acc. to max. bend.	3 %	16.1 %
Pulmonary function		
FVC (preop/postop)(ml)	2521 / 2606	2524/2887
FVC1 (preop/postop)(ml)	2301 / 2386	2220/2282
MMFR (preop/postop)(1/s)	3.09 / 2.8	2.4/2.6
Loss of correction	3°	-
Follow-up time (months)	30.6	13.1

Table 2)
Complications

	Group 1	Group 2
Rod breakage	4	1
Upper hook dislodgment	-	1
Lower hook dislodgment	-	1
Pseudoarthrosis	3	2
Deep vein thrombosis	1	-

the surgical intervention. At the reopcration of the patient with lower hook dislodgment we extracted the implant because there was solid fusion despite the loss of correction. Table 3, 4 and 5 show us the amount of correction in coronal and sagittal planes and the factors acting on the level of the correction.

DISCUSSION

An ideal system of spinal fixation would provide rigid fixation and adequate correction of the triplanc asymmetry in scoliotic deformity. In the Leeds procedure correction is more uniform than the Harrington instrumentation so that the load is distributed over multiple vertebral levels, decreasing the possibility that it would exceed the maximum force tolerated at the bone-implant interface. With the ability of acting corrective force at various vertebral segments whether in vertical or in transverse directions. One can achieve greater amounts of correction not only in the frontal plane, but also in sagittal and transverse planes. Using the frontal Cobb angle measurement to evaluate the results of the standard Harrington instrumentation, corrections at surgery up to 70 per cent were reported, but later it has become obvious that Harrington instrumentation does not correct the thoracic hypokyphosis; even it sometimes worsens the normal sagittal alignment. Furthermore, it docs not correct the rib hump deformity because it doesn't affect the vertebral rotation (1,3). In our cases we observed that the mean amount of correction in the coronal plane in group 2 was greater than the first one (28 per cent to 40 per cent) in spite of the same flexibility and magnitude of the curves (Table 1). The difference between the results relies upon the surgical correction exceeding the preoperative maximum-bending curve in group 2 (Table 1). Excessive distraction with the standard Harrington instrumentation in order to exceed the measured amount of flexibility and to achieve more correction in the coronal plane will stretch the posterior soft tissues, especially the posterior longitudinal ligament, so that the overstretched hypokyholic curve doesn't allow the correction in sagittal and transverse planes. To continue with the distraction may result in excessive stretching of the spinal cord, leading to direct injury or vascular compromise (6). Luquc has stated that the safety limit for operative correction with spinal segmental instrumentation in which neurological complications should not be encountered is the number of degrees of maximum preoperative bending correction plus 10 degrees, but excessive correction is accomplished by

Table 3
Sagittal maintainance

	Group 1		Group 2	
	preop	postop	preop	postop
Curves < 15° in the sagittal plane	9.4°	9.3°	9.6°	20.8°
Curves > 15° in the sagittal plane	40.2°	26.4°	27.3°	22.1°

Table 4
Coronal correction and the sagittal contour

	Coronal correction(%) Group 1	Group 2
Curves < 15° in the sagittal plane	27	37.1°
Curves > 15° in the sagittal plane	24.6	42

Table 5
Magnitude of the curve and the coronal correction

	Coronal correction (%) Group 1	Group 2
Curves < 70° in the coronal plane	29.7	45.5
Curves > 70° in the coronal plane	26.8	26.5

this technique due to high corrective forces to be produced with minimum risk of bone or metal failure (7). The lack of high forces in the Leeds procedure doesn't allow to pose such a risk at the lime of surgery; furthermore, affecting the vertebral rotation and maintaining the normal sagittal alignment it creates a greater safe zone within more surgical correction can be achieved. In group 1 the surgical correction was equal to the preoperative maximum-bending correction; on the other hand the sagittal countering and the vertebral derotation obtained by sublaminar wires enabled 16 per cent correction beyond the maximum-bending correction (Table 1). To minimize the risk of excessive intraoperative correction we perform the wake-up test routinely.

All curves more than 15° in the sagittal plane maintained their normal sagittal aligment in both of the groups (Table 3). The curves less than 15° in the sagittal plane in group 2 improved from hypokyphosis to the normal range, but there wasn't any change in group 1 (Table 3). This shows us again that the Harrington rod system is unable to normalize the sagittal alignment as compared with the Leeds procedure. On the other hand the amount of the correction in the coronal plane in group 2 was more than group 1 whether the curves were hypokyphotic or not which shows us the importance of the rod countering and the benefits of the transverse corrective force (Table 4).

We didn't found any big difference between the result of both of the techniques when the curve was more than 70° in the coronal plane, but the compression system must be added to the standard Harrington system to realize the same amount of correction as the Leeds procedure (Table 5). We believe that a preliminary anterior stage will be necessary for severe curves, especially for more than 90°, to provide flexibility. When the curve was less than 70° in the coronal plane we obtained the best results with the Leeds procedure in this study (Table 5). The results in this group didn't correlate with the preoperative sagittal contour of the patient, but we found that the curves more than 15° in the sagittal plane seemed to respond better to the correction by the Leeds procedure. But this was statistically not significant because of the insufficient number of the cases.

Beside the corrective force of the technique the ideal sytem for correction of scoliosis should provide stable fixation, the quality of which is determined by the maintainance of correction obtained at surgery and ability to reduce the postoperative immobilization. Because of the high incidence of instrumentation failures and the lower rate of loss of correction in the immobilized patients all of our patients wore a plaster cast for 9 months despite the fact that the patients with the Leeds procedure require shorter time in postoperative immobilization than those with a single distraction rod (2). The difference in the loss of correction in the postoperative period is statistically not significant in our cases, since the follow-up time is different, but it supports the importance of the external support (Table 1).

Broken rods or hook dislodgments should be viewed not as a failure of the instrumentation but rather as a

failure of the fusion. Therefore we observed the same high rate of failures of the instrumentation and subsequent pseudoarthrosis in both of the groups (Table 2). These cases were evaluated from different aspects but we didn't found any reason which would explain the failure. The instrumentation systems we compare are intented to be only temporary struts for maintaining correction until a solid fusion occurs. To improve the results of a technique we must improve the quality of the spinal fusion procedure. The presence of sublaminar wires doesn't reduce the area of bone available for fusion. In addition, only the apical vertebra and two vertebral segments above and below it receive sublaminar wires. On the other hand it was advocated that decortication would weaken the laminae, but we didn't observed any fracture of the laminae during the tightening of wires.

The average operating time is longer in group 2, beacuse the major disadvantage of the Leeds procedure is the hazard of passing sublaminar wires (5). The advantages of the Leeds procedure should be weighed against the possible increased risk of neurologic deficit.

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