

RESULTS OF SURGICAL INSTRUMENTATION IN ADULT IDIOPATHIC SCOLIOSIS

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When compared with the adolescent patients surgical treatment of adult idiopathic scoliosis is a challenging problem. In adults, curves are more rigid and risk of neurologic deficit is higher. In this study, 23 patients, treated in 1st Orthopaedics and Traumatology Department of Ankara Social Security Hospital, between December 1989 and December 1993 were evaluated. 11 of the patients were instrumented with Cotrel-Dubousset (CDI) system and the remaining 12 were instrumented with Texas Scottish Rite Hospital (TSRH) system. Preoperative mean Cobb angles were 56.6 ± 10.7 in CDI group and $68.6 \pm 11.4^\circ$ in TSRH group. Postoperative correction percentages in Cobb angles were $51.5 \pm 7.7\%$ for CDI and $58.1 \pm 6.8\%$ for TSRH group. When all patients are taken in to consideration mean correction of major curves was $54.9 \pm 12.1\%$. Relief of pain was seen in 82.6% of the patients. In light of these datas, we concluded that both of these systems are efficient in the treatment of selected adult idiopathic scoliosis cases.

INTRODUCTION

A scoliotic adult patients is the one that has completed his growth and who is Risser 5. Cronologically accepted limit is 20 years of age and more. Adult scoliosis is generally the result of the progression of the curves whose has been ignored at adolescence (1, 5).

In 1981, Kostuik and Bentivogilis reported that thoracolumbar and lumbar curvature incidence was 3.9% in adults. It has been understood that, the previous opinions suggesting scoliotic deformity does not progress after maturity are wrong. Weinstein and Ponsetti demonstrated that curvature continued to progress in adulthood too (1, 7).

In adult, of course, the most important and the most encountered complaint is pain. Pain exists in 59% of the patients (3). In adult idiopathic scoliosis the other important complaint is the cosmetic one. Rib hump deformity and the deterioration of the body balance are responsible reasons for this complaint. Pain and deformity are two important indications for the treatment. Conservative treatment consists of muscle strengthening physical therapy and rehabilitation, breathing exercise and oral therapy with analgesics for pain and anesthetic injections and orthoses may also be administered (1, 3, 5, 8, 11).

The purpose of surgical treatment is to provide the stability and the spine balance while correcting the pain and deformity symptoms. Surgical treatment in adult scoliosis is more challenging than that in adoles-

cence. The reason for this is the certain medical problems in old patients, and these develop secondarily with the increase of deformity and age. Degenerative facet arthrosis and spontaneous fusion make the curvature rigid and limit the rity of. Disc degeneration increases the rigidity of the curve. In lumbar region, especially, sagittal plane deformity occurring with the decreased lordosis accompanies scoliosis.

Cotrel-Dubousset Instrumentation (CDI), which has been popular in the recent years in idiopathic scoliosis treatment has high success rate with its derotational effect, high correction potential in frontal and sagittal planes with building a rigid frame with multiple hook and DTT, is also being used in adult scoliosis. In literature there are publications regarding the successful results of the system.

In this study 23 idiopathic adult scoliosis were examined and the surgical results of CDI and "Texas Scottish Rite Hospital" (TSRH) system, about which there is no application in literature for the application of adult scoliosis treatment were evaluated. Correction rates, the effects of them on complaints, complications according to the different curvature types were investigated.

PATIENT AND METHOD

From December 1989 to December 1993, 11 adult idiopathic scoliosis were operated at the 1st Orthopaedics and Traumatology Clinic of Ankara Social Security Hospital by performing CDI and 12 adult patients by TSRH. The rate of female and male was 6/

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17. The mean age was 27.6 (22-36). The mean follow up period was 28.2 months (1-48 m). The last controls of the patients were performed in January 1993.

After the evaluation of the patients complaints and history, physical and neurological examinations were performed. In the radiological evaluation, antero-posterior and lateral standing standart graphs and right-left bending ones were taken. Respiratory function tests as well as examinations of all preoperative routine laboratory test were carried out. Patients were classified in to the groups according to the classification suggested by King (15).

The suggested instrumentation plans were realized. The regions suggested by King were included to the fusion area. All patients were operated in prone position with hypotensive induced general anesthesia. In light of the preoperative planning posterior instrumentation and fusion was performed with autologous iliac or banked allografts. Eight patients had two seanced procedure with TSRH with anterior discectomy and release followed by posterior instrumentation and fusion.

In the postoperative period patients were evaluated clinically and radiologically, neurological deficit and early complications were detected. In the statistical evaluation, "Difference Between Means and paired observation" test was employed for the frontal plane.

The patients were turned to the right and left on the 1st day postoperatively, on the 2nd day they were seated and the 3rd day they encouraged the. No postoperative cast and brace were used. The patients were discharged on the 13th day (11-17 d), on an average, turned to their labor on the 43rd day (35-76 d). All the patients were called back for control on the 1st, 3rd, 6th, 12th, 24th and 36th months and their radiological evaluations were performed.

RESULTS

In the preoperative period, all patients had complaints related to pain and cosmetic deformities. It was established that, blunt and sharp pain existed in the back and that spread into hips and shoulders. There existed radiculopathy findings in 2 (18.2%) patients in CDI group and in 5 (41.7%) patients in TSRH group, but in the rest of the patients there were no paraplegia, paraparesis or paresthesis. In the postoperative radiological evaluation, the distribution of the patients according to their curvatures is shown in Table 1.

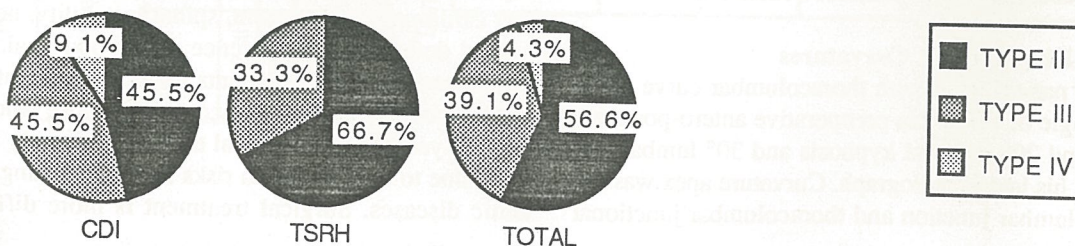
A. Type II Curvatures

There were 13 patients in this group and 5 of them had one stage posterior CDI and 8 of them had anterior release and than posterior instrumentation and fusion. TSRH instrumentation was applied to 3 of 8 pa-

Table 1. The Distrubation of the Patients According to King Classification

CURVE TYPE	COTREL-DUBOUSSET INSTRUMENTATION	TEXAS SCOTTISH RITE HOSPITAL SYSTEM	TOTAL
TYPE II	5	8	13
TYPE III	5	4	9
TYPE IV	1	0	1
TOTAL	11	12	23

KING CLASSIFICATION



tients in the same session to whom anterior was made, following halofemoral traction in other 5 patients.

The preoperative and postoperative Cobb angles of the patients and correction percentages are shown in Table II. The major thoracal curve with was $63^{\circ} \pm 12.9^{\circ}$ in the CDI group and $80.4^{\circ} \pm 22.1^{\circ}$ in the TSRH group was corrected by $42.3 \pm 9.4^{\circ}$ and $48.5 \pm 8.6\%$ respectively. In lombar region the percentages of this correction were 37.9 ± 12.9 and 28.2 ± 9.1 respectively.

When all the patients with type II curvatures were included, preoperative mean Cobb angles were $73.7^{\circ} \pm 28.3$ in thoracal region, and $62.5^{\circ} \pm 21.2^{\circ}$ in the lombar region and it was established that they were postoperatively corrected $43.9 \pm 11.1\%$ and $31.8 \pm 13.6\%$ respectively. It was determined that the correction amounts obtained were statistically significant both for all patients and for two sepearte groups ($p < 0.05$). It was stated that there was lordosis in thora-cal region in 7 patients wth type II curvatures. In six patients it was found out that there was kyphosis or hyperkyphosis in the thoracal region (Table III). While normal sagittal contours were obtained in 5 patients postoperatively, it was established that there was a deviation of 10° from normal in 8 patients.

B. Type III Curvatures

In this group there were 9 patients and to 5 of the had CDI and four of them had TSRH instrumentation. In patients to whom CDI was applied, it was determined that 51.6 ± 4.8 preoperative mean Cobb angle, was corrected to $63.6 \pm 8.5\%$ postoperatively. In the TSRH group, mean Cobb angle $45.3^{\circ} \pm 7.1^{\circ}$ was corrected to $68.6 \pm 8.1\%$. When all patients in this group were included, the mean Cobb angle of $48.8^{\circ} \pm 9.3^{\circ}$ was corrected to $66.3 \pm 11.3\%$ (Table II). When the correction rates obtained both for CDI and for TSRH group were considered there were statistically significant ($p < 0.05$) difference.

In 9 patients with type III curves in thoracal region there were hypokyphosis or lordosis, but a decrease in lumbar lordosis. It was determined that physiological sagittal countours were obtained (Table III).

C. King Type IV Curvatures

One patient (9%) with thoracolumbar curve had a cobb angle of 50° in his preoperative antero-posterior graph and 20° thorocal kyphosis and 30° lumbar lordosis in his lateral radiograph. Curvature apex was the thoracolumbar junction and thoracolumbar junctional

kyphosis angle was 20° . In bending radiograpms, curvature was corrected 15° , reached to 35° and there was correction of 30%.

In this patient, the curvature was corrected 48% and became to 26° postoperatively (Table II). Thoracal and lumbar sagittal contours of this patient were in normal limits (Table III).

D. Evaluation of All Patients

The preoperative mean major curves which was $56.6^{\circ} \pm 10.7^{\circ}$ in CDI group and $68.6^{\circ} \pm 1.4^{\circ}$ in TSRH group was corrected by $51.5 \pm 7.7\%$ and $58.1 \pm 68\%$ postoperatively. When all the patient were taken in to account, mean Cobb angle of the major curvature in frontal plane was $62.9^{\circ} \pm 18.5^{\circ}$ and this was corrected $54.9 \pm 12.1\%$. The correction rates obtained with different instrumentation systems were statistically significant ($p < 0.05$).

In 15 out of 23 patients (65.2%) normal sagittal contours were obtained and it was established that in 8 of them there was a deviation of 10° from normal.

In postoperative follow-up it was determined that there was loss of correction of $8^{\circ} \pm 7.1^{\circ}$ averagely? Early and late systemic or local complication were not encountered. Neurological deficit was not observed in any patients. During follow-up, pain decreased in all patients except 3 patients with radiculopathy and 1 patient whose pain can not be related to any other cause.

DISCUSSION

There has been a great deal of progress in the treatment of adult idiopathic scoliosis in the last few years. The indication of surgical treatment has widened because of the improvement in implant technology and searching for solutions to the complaints (1, 5).

To date, pain has been accepted as the most important indication of surgical treatment and posterior fusion has often the spinal deformity. Winter et al contended that the cause and the pattern of the pain should be definitely evaluated using technique such as CT, myelography and discography.

Therefore today, the most important indication accepted, is the progression of deformity which may effect cardiopulmoary system, spinal instability, neurological deficit and the absence of the body balance. The treatment of adult patients under 25 years of age is the same as that of adolescents. For those who are over 50 years of age, surgical treatment is rarely indicated due to the anesthesia risks and the existing systemic diseases. Surgical treatment is more difficult

Table 2. Preoperative (PRE) and postoperative (PO) mean Cobb angles and mean correction percentages (COR%) in the frontal plane according to curvature types. (A: Average, Sd: Standard deviation, T: Thoracic, L: Lumbar, TL: Thoracolumbar, CDI: Cotrel Dubousset Instrumentation, TSRH: Texas Scottish Rite Hospital System).

CURVE TYPE (n : 23)	PRE				PO				PO			
	CDI A ± Sd	TSRH A ± Sd	TOPLAM A ± Sd	CDI A ± Sd	TSRH A ± Sd	TOPLAM A ± Sd	CDI A ± Sd	TSRH A ± Sd	TOPLAM A ± Sd	CDI A ± Sd	TSRH A ± Sd	TOPLAM A ± Sd
TYPE II	T	63°±12.9°	80.4°±22.1°	73.7°±28.3°	34.1°±9.1°	41.4°±21.9°	43.1°±23.9°	42.3°±9.4°	48.5°±8.6°	43.9°±11.1°		
	L	41.9°±5.5°	75.3°±15.1°	62.5°±21.2°	26.1°±11.1°	55.6°±16.7°	34.2°±21.1°	28.2°±9.1°	28.2°±9.1°	31.8°±13.6°		
TYPE III	T	51.6°±4.8°	45.3°±7.1°	48.8°±8.3°	19.8°±8.3°	14.6°±9.1°	17.5°±13.1°	68.6°±8.1°	68.6°±8.1°	66.3°±11.3°		
TYPE IV	TL	50°	-	50°	26°	-	26°	-	-	48		
Total	M	56.6°±10.7°	68.6±11.4°	62.9±18.9°	28.3°±9.9°	32.5±17.1°	30.5±16.1°	51.5°±7.7°	58.1±6.8°	54.9±12.1°		

Table 3. Pre and postoperative mean angles of sagittal contours. (TK: Thoracic Kyphosis, LL: Lumbar lordosis, A: Average, Sd: Standard deviation).

CURVE TYPE (No. OF THE PATIENTS:n)	Preoperative		Postoperative	
	A ± Sd	A ± Sd	A ± Sd	A ± Sd
Type II-L (n = 5)	TK	8°±5.8°	16.2°±4.2°	
	LL	19.4°±1.9°	25.4°±3.6°	
Type II-K (n = 8)	TK	51.2°±22.1°	39.1°±1.1°	
	LL	36.6°±18.1°	34.3°±13.1°	
Type III (n = 9)	TK	7.2°±10.9°	33.8°±4.2°	
	LL	23°±8.4°	32°±10.9°	
Type IV (n = 1)	TK	20°	40°	
	LL	30°	40°	
Total (n = 23)	TK	8.7±10.5°	26.4±11.3°	
	LL	14.5±5.5°	29.7±9.3°	

than that in adolescence and there are more risks in terms of systemic complications as well as pseudoarthrosis, metal insufficiency and some other complications (3, 4).

Thoracal curves over 50°, lumbar or thoracolumbar curves over 40° and double major curves over 50° are generally treated surgically (3). However surgical treatment is indicated in progressive, especially, painful curves over 40° and in the presence of abnormal physiological sagittal contour angles, especially if there is a certain decrease in lumbar lordosis (4).

For this purpose, it must be considered that there would be a high risk of pseudoarthrosis other complications while choosing any surgical technique and thus a rigid system should be chosen and fusion must be aided with autologous grafts (3). In the recent years, the systems which could provide three planed correction are preferred. These systems corrects the curves in frontal and sagittal planes as well as rotational deformities. Biomechanical studies show that the techniques employing double rod and cross links fixing multiple vertebrae level or strategic vertebra are more rigid (1, 5).

Harrington rod system which is one of the cornerstones of scoliosis surgery is the first widely used system in the adult scoliosis treatment. It has been established that in most series, on average, there exist 40% pseudoarthrosis, and 50% frontal "flat-back" formation, 15-20% rod breakage and 25-90% of correction loss. In cases to whom Harrington Rod applied, postoperative cast is required over 6-9 months. Adult patient tolerates postoperative cast rather badly and complications like "cast-syndrom" often occurs (1, 3). Although Luque sublaminar wiring is rather rigid system, there are no publications, regarding the use of it in adult scoliosis treatment.

Anterior instrumentations in adult scoliosis, especially in lumbar region, have been applied more often. Their application to the thoracal region is limited. Ogiela and Chan reported 61% correction through Zielke and Kaneda et al 59% correction (16, 17). Furthermore, anterior systems decrease kyphosis but they cannot restore physiological lordosis.

In recent years, Cotrel-Dubousset Instrumentation, which provides a high correction in three planes and which constructs a rigid frame with double rod and DTT system with strategical vertebrae fixation by using multiple hooks found a scope in adult idiopathic scoliosis as in adolescence (4, 5, 12, 14).

In 1987 Guillaumat et al, applied Cotrel-Dubousset (CD) technique in 18 patient over 50 years

of age due to neurologic disturbance and severely painful deformity. They established 48% correction in frontal plane in lumbar region and 57% increase in lordosis (20).

In 1989, Skubic and Kostuik reported that they provided on an average of 50% correction with Cotrel-Dubousset technique in 76 adult patients with idiopathic scoliosis and that they provided 133%-173% correction in sagittal contours and the pain disappeared 86% of the patients. They contended that the technique was effective and safe in adult scoliosis treatment (7).

In this study, when 11 adult patients operated on by CD technique were all included, it was determined that 51.5% correction was provided in frontal plane. The highest correction was obtained in King Type III curves with single thoracic flexible curvature (63.6% on average). Thoracolumbar curves (King Type IV) and double curves with rigid thoracal curve (King Type II) followed this group with an correction rate of 48%. The least correction was obtained in lumbar curve of King Type II curves (37.9%).

TSRH system is a rigid system that has been in use in last few years, and that basically resembles CDI and provides three planed correction. There is no report on the world literature regarding its application in adult scoliosis (18).

In this study, TSRH was applied to 12 adult idiopathic scoliosis patients. There was a mean 58.1% correction in the frontal plane. The highest correction rate was 68.8% in Type III patients physiological sagittal contours were provided in all patients.

In our study, there was 54.9% of correction in the frontal plane in all patients and in 65.2% of these patients the normal physiological sagittal contours were provided. The highest correction was obtained with 66.3% in Type III patients. The rates obtained were in harmony with those reported in literature. In addition there was a successful correction in sagittal contour. Body balance was provided in all patients and a massive fusion mass was observed during the follow-up period. When compared with literature our correction rates were considered to be a little higher as the mean age of the patients of our series was 27.6 and the highest age was 36 and there did not exist any secondary changes increasing with the age. Moreover the rates obtained through TSRH were higher than those of CDI, particularly in Type II patients, which depends on the application of anterior release and discectomy in the first session.

It is reported that arthrodesis is not generally necessary but if there is lumbosacral degenerative changes and pain, this should be performed (1). Kostuik reported that lumbar rigid curves between 50°-70° with certain hypokyphosis, should be included in the fusion area (19). Most studies report that unnecessary sacral arthrodesis increase the pain. L₅-S₁ mobile segment, therefore, is required to be protected (3). In this study we avoided lumbosacral fusion especially in King Type II and Type IV curves thus protecting the mobile segment.

In adult scoliosis an average of 22% pseudarthrosis, 30% residual pain, 5% mortality, 40% physiological dysfunction were reported. In some series, the total complication rate related up to 80% (1). The rates are getting higher in such systems as HRSF and SSI (1, 5).

Balderson reported that in one patient out of 90 adult scoliosis treated with CD, there was rod breakage and pseudoarthrosis and another patient had decompensation (20). Scoliosis Research Association reported that there was 3% neurological deficit risk in CD technique. This rate, undoubtedly, is quite lower than in sublaminar wiring procedures (5).

In this study, any hook removal, rod breakage and pseudoarthrosis was not encountered. There was no neurological deficits in all patients. Over the mean 28.2 month (1-48 m) follow-up, period, average, 8° (0-14°) of correction loss was observed. In no patients postoperative cast was used. Patients were encouraged to walk within 3 days and they were able to return to their labor within 43 days on the average. In 82, 6% of the patients pain totally was relieved.

In the light of this results, we concluded that CDI and TSRH systems might be applied in adult idiopathic scoliosis successfully due to the provision of high correction and low complication rates and to the relief of pain in most of the patients.

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