THE RESULTS OF SURGICAL TREATMENT USING COTREL-DUBOUSSET INSTRUMENTATION FOR LATE-ONSET IDIOPATHIC SCOLIOSIS

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From December 1988 to June 1991, 62 Cotrel-Dubousset instrumentations were performed at the 1st orthopaedics and Traumatology Clinic of Ankara Social Security Hospital for the correction of late onset idiopathic scoliosis. There were 27 female and 35 male patients. Mean age was 14.6 and mean follow-up was 26 months. When all types of curves were included, the mean Cobb angle had decreased to 23,5° from 53,2°. The best results were obtained in flexible thoracal lordoscoliosis, postural angles came within normal limits in the sagittal plane. An average of 7.2° correction loss was seen during the follow-up period. It was concluded that Cotrel-Dubousset Instrumentation can be performed successfully in the treatment of late onset idiopathic scoliosis.

Key Words: *Idiopathic scoliosis, Cotrel-Dubousset Instrumentation.*

INTRODUCTION:

The main aim in the treatment of idiopathic scoliosis is to correct deformity in three planes. Halting the progression of the curvature, prevention of pain and pulmonary dysfunction and correction of the patient's body balance are other important goals (12, 20).

Conservative treatment indications in scoliosis in the adolescent period are fairly limited. If there is progression before maturation, surgical treatment is inevitable (2).

Numerous surgical techniques are currently being used in soliosis surgery. The most frequently used Harrington rod system has disadvantages such as a significant loss of correction, high rate of pseudoarthrosis, 15% failure of instrumentation and failure of correction in sagittal and axial planes (1, 2, 14, 28).

The Luque technique and modifications of the Harrington technique can achieve a good correction and stable internal fixation (13, 23, 30). However, Leatherman et al. (19), Winter and Anderson (33) and others have observed significant loss of correction without the use of postoperative external support in their series of Luque instrumentation. In addition, with the Luque technifue, a high risk of neurologic impairment has also been reported (5, 17, 33).

Cotrel-Dubousset (CD) technique, with the use of multiple hooks and DTT system, gives the chance of a rigid internal fixation and the correction of rotational deformity that can not be obtained by other techniques. Morbidity is low and there is no need for postoperative external support. Patients can return to work or school in a short period of time (3, 7, 12).

In this study we report the results of 62 late onset idiopathic scoliotic patients treated by the CD technique.

PATIENTS ANT METHOD:

From December 1988 to June 1991, 84 CD Instrumentations were performed at the 1st Orthopedics and Traumatology Clinic of Ankara Social Security Hospital. Sixty-two of them had been performed for late onset idiopathic scoliosis and were included in this study. Average follow-up period was 26.0 months (10-42 months).

There were 27 (43.5%) female and 35 (56.5%) male patients, mean age was 14.7 and all of them were between 10 and 19 years old.

In the clinical examination, besides a systemic and detailed neurologic examination, the patients' weight and height, posture properties, direction and location of the curve, rib hump deformity and deviation of weight line from the intergluteal crease were mesaured.

In the radiological assesment, antero-posterior, lateral and bending radiograms were taken with the patient standing up and the type of the curve was determined using the King method. Cobb angle in the frontal plane, contour angles in the sagittal plane were measured, flexibilty was evaluated and type of the curve was defined and the appropriate preoperative

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CD planning was performed (8, 9, 11).

In 5 (8.7%) patients with rigid curves, preoperative halo-femoral traction was applied ant the patients were sent to surgery with a final weight of 13.7± 2,1 kg.

In all patients a one-stage posterior procedure with hypotensive general anesthesia was used. In type II curves, only thoracal curves were instrumented as it has been shown in recent studies that after instrumentation of thoracal curves, the lumbar secondary flexible curve improves by itself. Type III and IV curves were instrumented using the standard CD methods (8, 9, 18). In all of the patients, posterior fusion was performed with autologous bone grafts (18).

Postoperatively, the patients were seated in the second day, were allowed to walk in the third day, and discharged in the 10-15 days. No external support was used and patients were recalled for postoperative controls in the 1., 3., 6., 12., 18., 24. and 36th months. In the follow-up examination was done and condition of the curve, asymmetry in topograhical points, differences in the rib hump and weight line were noted. In the radiological assesment, the lateral curve in the frontal plane and differences in the sagittal postural angles were evaluated. The statical evaluation was done using the "Difference Between Means for Paired Observations" test and the "Kruskall-Wallis Analysis of Variance" test.

RESULTS:

Previously 7 patients (11,3%) had been treated conservatively by orthoses (5 patients by a Milwaukee brace, 2 patients by a Boston-TLSO). Three (4,8%) patients had been treated by Harrington rod system (HRSF) unsuccesfully (2 of them with HRSF, one of them with subcutancous Harrington rod system).

Preoperatively 20 (32,3%) patients had a rib hump less than 3 cm, 25 (40,3%) cases had a rib hump between 3-6 cm and 17 (27,4%) patients had a rib hump greater than 6 cm.

When the position of center of gravity in relation to the intergluteal crease was evaluated, 22 (35,5%) patients had balanced curves, 23 (37,1%) patients had less than 3 cm, 16 (25,8%) patiens had 3-6 cm and only one (1,6%) patient had more than 6 cm of deviation from normal.

Bending radiograms of the patients were taken and the flexibily of the curves were evaluated. Corrections over 50% in Cobb angles were accepted to be flexible and thus 44 (70,9%) patients had flexible curves. Preoperative radiological evaluation of the patients showed that 39 (62,9%) patients had single classical flexible thoracal curves, 17 (27,4%) patients had double curves 6 (9,7%) patients had thoracolumbar curves.

According to the King classification, 5 patients (8,1%) had Type 1, 12 patients (19,4%) had Type II, 39 patients (62,9%) had Type III and 6 (9,7%) had Type IV curves. None had a Type V curve.

In type I curves the mean preoperative Cobb angle was 62,0°± 13,0° in the lumbar region. The secondary curve in the thoracal region had a mean Cobb angle of 44,0°± 8,6. In lateral radiograms, examination of sagittal contours showed averagely 22,1°± 7,4° of hypokyposis in thoracal vertebrae and 14,2°± 4,3° of loss of lumbar lordosis (Table-1,2). In bending radiograms, averagely 20,1% correction in lumbar site and 45,3% correction in the thoracal site was measured.

Type II curves were divided into two groups according to their sagittal contour types. Of the 12 patients, 7 (11,3%) had lordosis and 5 (8,1%) had hyperkyphosis in the thoracal region. Preoperative mean Cobb angles of thoracal curves and lumbar curves in lordotic Type II curves were 61,3°± 11,5° and 28,3°± 10,2 respectively. They had averagely -4,7°± 7,7° of thoracal and 32,9°± 8,9° of lumbar curves in sagittal plane (Table-1,2). In bending radiograms a correction of 25,3% and 40% was obtained respectively in thoracal and lumbar curves.

Type II curves with a rigid thoracal kyphoscoliosis, mean Cobb angle was 65,6°± 16,7° in the thoracal curve and 31,2°± 10,3° in the lumbar curve. Thoracal kyphosis angle was averagely 69,6°± 13,5° and lumbar lordosis was slightly decreased (Table-1,2). In bending radiograms, thoracal and lumbar curves were corrected by 20,6% and 40,3 respectively.

In 39 (62,9%) patients with Type III curves, preoperative mean Cobb angle was 49,9°± 4,6° in thoracal curves and thoracal kyphosis angle was decreased averagely to 9,7°± 11,4°. Lumbar lordosis angles were within normal limits (Table-1,2). In bending radiograms 51.3% of correction was observed.

In Type IV curves, preoperative mean Cobb angle was 48,8°± 6,9, mean thoracal kyphosis angle was 35°± 6,1° and mean lumbar lordosis angle was 29,7°± 8,1 (Table-1,2). In bending radiograms 40.6% of correction was achieved.

When all of the patients were included, postoperative rib hump deformities were corrected by 62,3°± 26,9%. Postoperative rib hump deformities according to different types of the curves can be seen in the

Table 3. The highest correction rate was achieved in Type III curves in which a derotation manoeuvre had been performed ($p<0.05$). This group was followed by Type II lordotic curves. In only type I curves, there was no statistically significant difference between the preoperative and postoperative values ($p<0.05$).

In 39 (62.9%) patients the weight line came to the intergluteal crease 21 (33.9%) patients had less than 3 cm and 2 (3.2%) had between 3-6 cm of deviation from the vertical.

Postoperative differences in Cobb and sagittal contour angles are seen in Table-1 and Table-2. In Type I curves, lumbar Cobb angle was corrected by 32,5± 13,5% postoperatively. In the thoracal curve 42,2± 15,9% of correction was obtained averagely. Both of these values were higher than the correction rates in the bending preoperative x-rays but satisfactory improvement in lumbar curve couldn't be achieved, although a statistically significant improvement was seen ($p<0.05$). In the sagittal plane an average of 11,8°± 5,4° of correction was obtained in the thoracal and 12,8°± 5,7° in the lumbar curve ($p<0.05$). ın all patients physiological thoracal kyphosis was constituted and 20% of the patients were brought within physiological lumbar lordosis limits.

In seven Type II curves with a lordotic pattern in the thoracal region, mean Cobb angle was corrected by 41,8 ± 7,4% in the thoracal and by 21,7 ± 4,1% in the lumbar curves. These values were higher than the correction amounts in bending radiograms in thoracal curves but lower in lumbar curves. Thoracal kphosis angle was averagely corrected by 16,7°± 2,8° in thoracal curves and 4,0°± 3,2° in lumbar curves. In the thoracal and lumbar regions, the amount of correction of deformity in both frontal and sagittal planes was statistically significant ($p<0.05$).

In 5 Type II curves with a hyperkyphosis pattern in the thoracal region, mean Cobb angle was corrected by 38,0°± 4,8% in the lumbar curves. These values were higher than the correction amounts in bending x-rays in thoracal curves but lower in the lumbar curves. Thoracal kyposis angle was averagely corrected by -19,8°± 6,9° and 80% of the patients were brought within normal limits. In all of the patients in this group physiological lumbar lordosis was reconstituted. There was statistically a significant difference between preoperative and postoperative Cobb angles in both thoracal and lumbar regions ($p<0.05$). Although there was a statistically significant difference in sagital plane angle in the thoracal region ($p<0.05$), there was no difference in the lumbar region ($p<0.05$).

In Type III curves the amount of Cobb angle correction was 67,4°± 14,3% and this value was much higher than the correction amounts in bending radiograms and was highly significant statistically ($p<0.05$). In all of these patients physiological sagittal contours were restored.

In Type IV curves, 53,8°± 23,2% correction was obtained in the frontal plane postoperatively and the difference was stastitically significant ($p<0,05$). No significant change in the sagittal contour was observed in the thoracal region in Type IV curves ($p<0.05$).

An overall correction of 57,6 ± 19,1% was obtained in the major curves of all types. The highest correction was achieved in Type III curves in which a derotation manoeuvre had been performed and this group was followed by thoracolumbar curves (Type IV) and rigid double curves ($p<0.05$).

No subjective complaints were noted during the follow-up period. In 3 (4.8%) of the patients wound dehiscence was seen and these patients were treated by secondary sutures. These were due to early removal of the sutures.

When all types of curves were included 7.2° (0-25°) of correction loss was observed. Pseudoatrhrosis was not seen in any of the patients and solid fusion was achieved in all cases. In 3 patients (4.8%) hook dislocation occured. No Neurological complications were seen and there were no deep infections.

DISCUSSION:

In the last ten years, very important developments have occurred in the evaluation of scoliotic curves in three planes. Biomechanical studies have shown that rigid fixation in all strategic levels, the use of double rods and transverse connecting devices have become an absolute must (12).

Harrington rod system was the most frequently used system till the last 10 years and many reports have been published on its use. According to various reports mean correction rate is about 55% and a significant correction loss is observed in the early postoperative period. Derotational effect of this system is very low, 15% rod breakage and 25% pseudoartrosis rate has been reported. Postoperative casting fo 6-9 months is necessary (1, 6, 12, 14, 20, 28).

In 1973, Luque developed the Segmental Sublaminar Instrumention (SSI) in which wires are passed under the laminae and secured to double "L-rods". The system has high correction rates and by bending the rod sagital contours can be provided (15, 20, 23). Although Luque does not recommend postoperative bracing, several studies have reported a high rate of loss of correction when external support is not used and suggest a postoperative cast or bracing for 4-6 months. Neurological complications such as cord contusion, root injuries and dural ruptures are seen in rates as high as 10-20%. Wire breakage as a result of bending or torsional forces during activity or trauma and neurological complications have been reported (5, 17, 19, 32, 34).

Cotrel- Dubousset system was developed between 1978-1983. Biomechanical testing of the system has shown that its resistance to ventral flexion, posterior flexion, lateral bending and rotational forces is superior to other systems. Resistance to compression is equal to the Luque system. (6, 8, 29).

CDI is a rigid system which provides various alternatives in spinal surgery. The greatest force in CDI is applied to the apex of the deformity. CDI also corrects rib hump and thorax deformity with the derotation manoeuvre, provides physiologic kyphosis and lordosis in the sagittal plane and builds a rigid frame with mutiple hooks, double rods and the DTT system (3,8-12, 15, 16, 26, 27).

A correction rate of 68% has been reported by Chopin and others with minimal loss of correction (7). Anterior discectomy and release is recommended in curves greater than 75° (8).

The maximal amount of correction with the CDI is achieved in thoracal curves. The intrumentation provides less correction in the lumbar area and postoperative loss of correction is higher than Zielke and SSI systems. Problems due to hooks in the lumbar area have been eliminated with the use of pedicular screws and Chopin plate systems (12,22).

In this study 62 patients treated with the CDI system at 1st Orthopaedics and Traumatology Clinic of Ankara Social Security Hospital between December 1988 and June 1988 were evaluated. Rib hump deformity was corrected significantly in all of the curves except Type I ($p<0.05$). The highest correction rate was achieved in Type III curves (76,0%), in which a derotation manoevre had been performed. The weight line was carried to the intergluteal crease and the body balance was restored in a significant amount of the cases (62,9). Postoperatively only 2 cases had a deviation of more had 3 cm from the vertical while preoperatively 17 had more than 3 cm.

In this study, the superior corrective effect of the CDI system in the frontal and sagittal planes, especially in single flexible thoracal lordosicoliosis (Type III) and in thoracolombar curves (Type IV) was demonstrated. In rigid lumbar curves of the Type I curves and rigid thoracal kyphoscoliotic and rigid thoracal lordoscoliotic Type II curves, the CD system achieved less correction in the secondary curves in the lumbar region. Correction rates that are obtained in this study are higher than HRSF and Harri-Luque systems, but lower than anterior systems such as Zielke and posterior systems such as SSI-Luque and Galveston (19, 25, 32). It was concluded that, to improve the correction rates in rigid curves, anterior release procedures are necessarry.

The highest correction rate in the sagittal plane was achieved in Type III curves with single thoracal flexible curves. In all patients of this group, physiological thoracal kyposis was reconstituted. In Type IV curves no significant change in the sagittal contour was observed. In Type I curves with rigid lumbar scoliosis, physiological thoracal kyphosis was restored in all, but normal lumbar lordosis was restored in only 20% of the patients. Many of the patients who had a thoracal lordosis pattern in Type II curves were brought within 20° of normal but none of them could be completely corrected. In 80% of the kyphotic Type II patients, normal thoracal kyphosis was restored.

Derotational effects of systems such as HRSF and Luque are fairly limited (1, 26, 27). There are many reports suggesting Cotrel-Dubousset system has high correction rates in the transverse plane (3, 26, 27). In contrast, there are reports suggesting that by CDI system's derotational effect, derotation is reflected to normal vertebral levels or to secondary curves, thus causing decompensation and increase in secondary curves (41, 34). Mason and Carango, in their studies showed that decompensation occurred at a higher rate in CDI than HRSF or its variants (24). However, in this study it was determined that with derotation, the rib hump deformity was corrected significantly and an increase in secondary curves or formation of secondary curves did not occur. Furthermore, body balance was restored in 62.9% of the patients in the early postoperative period.

Correction loss between 0°-10° has been reported with CDI applications, however, this is lower than results of other rigid systems such as SSI-Luque (7-11, 16, 21, 25, 27). In this study averagely 7.2° of correction loss was found after averagely 26 months follow-up Pseudoarthrosis wasn't seen in any of the patients and a solid fusion mass was observed in the follw-up period.

As CDI is a very rigid system, there is no need to use a postoperative cast or brace. Thus, complications such as emotional intolerance, cast syndrome and pressure sores aren't seen (3,8). In this study, no external support was used postoperatively.

Although CDI system has a neurologic deficit potentiol, with the exception of a few cases, important neurologic complications haven't been reported. Its neurologic deficit potential is more than HRSF and lower than Luque SSI. Heine, et al, reported reversible paralysis in 2 patients in 1990 (8, 12, 16). In this study, no neurological complications were seen.

Except for a few hook problems such as dislocation, complications of CDI haven't been reported (3, 4, 10, 21). In this study, wound dehisence in 3 (4.8%) cases and hook dilocation in 3 patients (4.8%) was observed. In one patient the displaced end of hook and rod perforated the skin of the patient and there was 25° loss of correction. During revision surgery a solid fusion mass was encountered and no additional surgery was performed.

Almost all of the operated patients were encouraged to walk on the postoperative 3rd day. They were discharged between 10-15 days and returned to work or school by the end of 3 months.

In was concluded that the high success rate of the Cotrel Dubousset Instrumentation in the three plane correction of scoliosis makes it a safe, effective and reliable technique in the treatment of late onset idiopathic scoliosis.

Table 1: Preoperative and postoperative average Cobb angles and the percentage of correction in the frontal plane according to different curve types. (T: Thoracal curve, L: Lumbar curve, TL: Thoacolumbar curve, m: major curves, n: number of the patients, A: Average, Sd: Standard deviation).

Type of the curve		Preoperative A± Sd	Postoperative A± Sd	Percentage of Correction A± Sd	t	p
King Type I n=5	T	44,0°± 8,6°	26,4°± 12,7°	42,2°± 15,9°	7,67	< 0.05
	L	62,0°± 13,0°	42,0°± 12,6°	32,5°± 13,5°	5,65	< 0.05
King Type II (Lordotic) n= 7	T	61,3°± 11,5°	35,4°± 6,2°	41,8°± 7,4°	8,70	< 0.05
	L	28,3°± 10,2°	22,3°± 8,5°	21,7°± 4,1°	7,34	< 0.05
King Type II (Kyphotic) n=5	T	65,6°± 16,7°	41,2°± 13,4°	38,0°± 4,8°	14,96	<0.05
	L	31,2°± 10,3°	24,0°± 9,2°	22,8°± 12,2°	4,81	< 0.05
King Type III n=39	T L	49,6°± 4,6°	17,0°± 8,5°	67,4°± 14,3°	33,71	<0.05
King Type IV n=6	TL	48,8°± 6,9°	25,2°± 12,3°	53,8°± 23,2°	6,42	< 0.05
Total n= 62	M	53,2°± 9,7°	23,5°± 13,4°	57,6°± 19,1°	29,13	<0.05

Table 2: Distribution of mean correction values of thoracal sagittal plane angles in various curve patterns. (T: Thoracal, L: Lomber, A: Average, Sd: Standad Deviation, n: Number of the patients).

Curve type		Preoperative A± Sd	Postoperative A± Sd	Amount of correction A± Sd	t p
King Type I n=5	T	22,1°± 7,4°	34,0°± 4,2°	11,8°± 5,4°	4,93 < 0.05
	L	14,2°± 4,3°	27,0°± 7,4°	12,8°± 5,7°	5,00 < 0.05
King Type II (Lordotic) n= 7	T	(,4,7)°± 7,7°	12,8°± 7,5°	16,7°± 2,8°	15,7 < 0.05
	L	32,9°± 8,9°	36,9°± 7,4°	4,0°± 3,2°	3,34 < 0.05
King Type II (Kyphotic) n=5	T	69,6°± 13,5°	49,8°± 11,8°	(-19,8°)± 6,9°	6,41 < 0.05
	L	38,2°± 11,1°	38,4°± 4,7°	0,4°± 4,5°	0,19 < 0.05
King Type III n=39	T	9,7°± 11,4°	35,8°± 4,7°	26,1°± 9,4°	17,40 < 0.05
	L	36,1°± 6,3°	39,6°± 4,8°	3,6°± 3,9°	5,59 < 0.05
King Type IV n=6	T	35,0°± 6,1°	38,5°± 4,9°	3,5°± 2,6°	3,31 < 0.05
	L	29,7°± 8,1°	34,5°± 7,2	4,8°± 1,9°	6,10 < 0.05

Table 3: Preoperative and postoperative values, amount of the correction values and percentages of correction, hight of rib hump deformites of the patients according to various curves
(PR: Preoperative, PO: Postoperative, PC: Pertentage of correction, n: number of cases, A: Average, Sd: Standart deviation) (Numbers are cm at tha column of PR, PO and AC)

Curve type	PR A± Sd	Postoperative A± Sd	Percentage of Correction A± Sd	t p
Type I n=5	2,5°± 1,6°	1,5°± 1,1°	33,6°± 21,4°	3,65 <0,05
Type II Lordotic n= 7	7,9°± 1,4°	4,7°± 1,3°	41,5°± 8,9°	17,42 <0,05
Type II Kyphotic n=5	7,8°± 1,4°	5,9°± 1,9°	25,8°± 10,2°	7,75 <0,05
Type III n=39	3,9°± 1,9°	1,2°± 1,1°	76,0°± 20,6°	13,56 <0,05
Type IV n=6	3,3°± 1,2°	1,8°± 1,8°	51,3°± 25,6°	8,22 <0,05
Total n= 62	4,5°± 3,4°	2,0°± 1,9°	62,3°± 26,9°	15,8 <0,05

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