COTREL-DUBOUSSET INSTRUMENTATION IN IDIOPATHIC SCOLIOSIS A 5-YEAR FOLLOW-UP

S. A. ANTUÑA, J. G. MÉNDEZ, J. C. LÓPEZ-FANJUL, J. PAZ JIMÉNEZ

The results of Cotrel-Dubousset instrumentation in 50 patients with idiopathic scoliosis were evaluated. The patients were followed for 24 to 108 months with a mean follow-up of 5 years. Their average age was 15 years and 3 months. The scoliotic curves were classified according to King *et al.* There were 4 type I, 20 type II, 10 type III, 10 type IV and 1 type V. Five curves could not be included in this classification : 2 double lumbar, 1 right lumbar and 2 left thoracic curves.

Coronal plane analysis showed an average postoperative correction of 56% for thoracic curves and 57% for lumbar curves. The loss of correction at the most recent follow-up was 14% and 15%, respectively. Higher corrections were obtained in King types III and IV than in types I and II. Mild increase of thoracic kyphosis was noted in previously hypokyphotic curves. The normal sagittal curve in the lumbar spine was maintained at the most recent follow-up.

There were no major neurological deficits. A symptomatic pseudarthrosis developed in one patient with a concomitant L5-S1 spondylolisthesis. Another patient developed a delayed deep wound infection that resolved after the instrumentation was removed.

The data from this study suggest that Cotrel-Dubousset instrumentation achieves a satisfactory correction of the curves with an acceptable loss of correction over time. The system also preserves lumbar lordosis when fusion to the lower lumbar spine is required.

Keywords : scoliosis ; Cotrel-Dubousset instrumentation ; spine.

Mots-clés : scoliose ; instrumentation de Cotrel-Dubousset ; colonne vertébrale.

INTRODUCTION

Since its introduction in 1984 (7), Cotrel-Dubousset instrumentation (CDI) has become a standard method of treatment for idiopathic scoliosis (2, 3, 5, 11, 14, 16, 22, 25). Its advantages over that of the Harrington system are a more rigid fixation and improved three-dimensional curve correction (9, 29). It was designed to permit the application of selective distraction and compression forces on the spine, to preserve lumbar lordosis and increase thoracic kyphosis.

The CDI system has been used in our institution since 1986. This report presents the results in the first 50 patients treated for idiopathic scoliosis, with a mean follow-up of 5 years.

MATERIAL AND METHODS

Between March, 1986 and January, 1993, 65 patients with idiopathic scoliosis (IS) were treated with spinal fusion and CDI. All the operative procedures were performed or supervised by one of us (J. C. L. F.). Only 50 patients met the criteria for inclusion in the study, which were : (a) the diagnosis was IS, (b) the patient had been treated with posterior fusion and CDI, (c) a minimum follow-up of 2 years and (d) a complete set of good quality radiographs to perform adequate measurements. The average age of the patients was 15 years, 3 months, range 11-26 years. There were 42 girls and 8 boys. The average follow-up was 60 months, range 24-108 months.

AP and lateral radiographs of the entire spine, with the patient standing, were made preoperatively, one week postoperatively, and at the time of the most recent follow-up. The scoliotic curves were classified according to the system of King *et al.* (15). There were 4

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type I, 20 type II, 10 type III, 10 type IV and 1 type V. Five curves could not be included in this classification : 2 double lumbar, 1 right lumbar curve and 2 left thoracic curves.

The degree of coronal and sagittal curvature was assessed using the Cobb method. The rotation of the apical vertebra was measured by the technique of Nash and Moe (21). The percentage of flexibility of the thoracic and lumbar curves on maximum lateral bending and under traction was determined preoperatively. The end, neutral and stable vertebrae were recorded, as were the most cephalic and caudal vertebrae incorporated in the CDI. Coronal balance was assessed according to the translation of the apical vertebra from the central sacral line (cm) and to the tilt of the most caudal instrumented vertebra (°).

All patients were given 1 gr of cefazolin intravenously every 8 hours for 24 hours, beginning just before surgery. A Stagnara wake-up test was performed during the operation in all the patients. Autogenous bone graft was obtained from the posterior part of the ilium. Allogeneic bone graft was added in double curves when long fusions were performed. No postoperative orthosis was used. Hospital stay averaged 16 days and ranged from 12 to 23 days.

In an effort to assess the data objectively, all radiographs were reviewed retrospectively by two of the authors who had not been involved in the surgical treatment.

Statistical analysis was performed using the Student t test and the Mann-Whitney test when necessary.

RESULTS

Thoracic curves averaged 57° preoperatively, 24° one week after the operation and 32° at the most recent follow-up. Lumbar curves averaged 47° preoperatively, 20° postoperatively and 26° at the most recent follow-up. The average correction was 56% for thoracic curves and 57% for lumbar curves. The loss of correction was 14% and 13% respectively (table I). Analysis of each type of curve showed higher correction at the most recent follow-up for type III and IV (fig. 1) curves than for type I and II ($P < 0.05$) (fig. 2).

The mean preoperative translation of the apical vertebra from the central sacral line was 4.3 cm. After the operation, the average translation de-

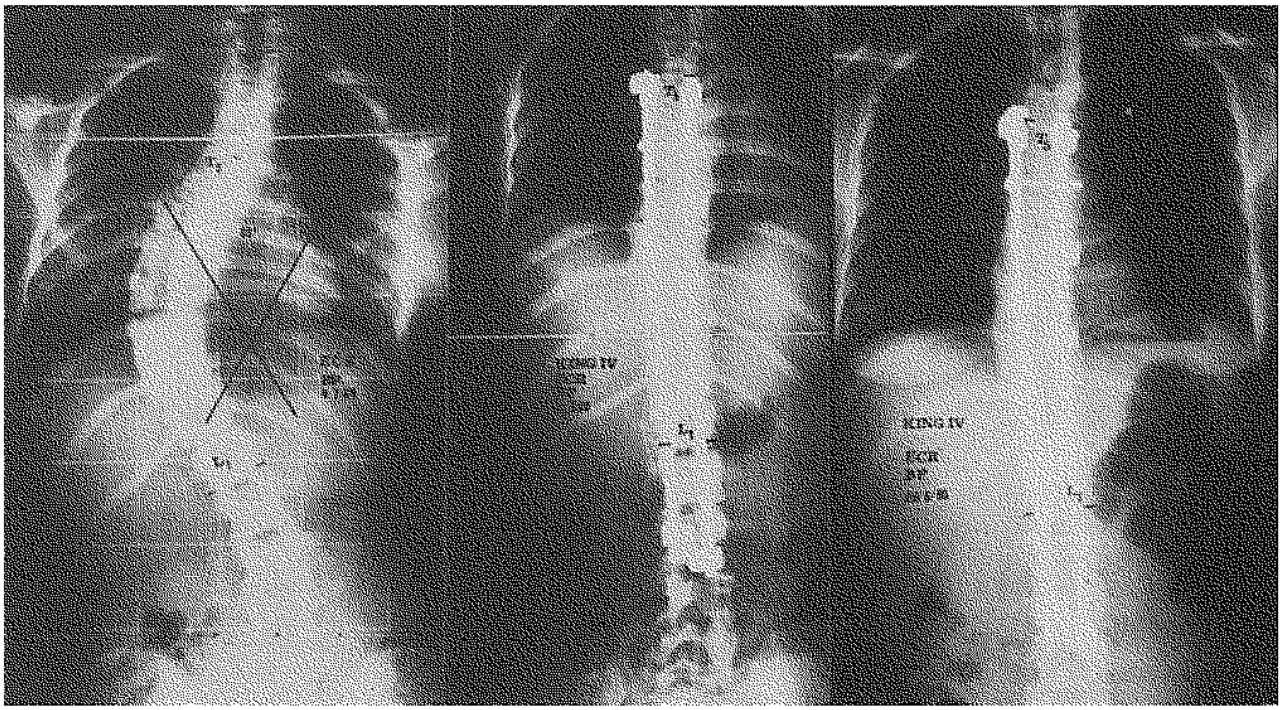

Fig. 1. — Preoperative, postoperative and follow-up standing anteroposterior radiographs of a 14-year-old girl with a King type IV curve. The postoperative correction was excellent with minimum loss after 6 years.

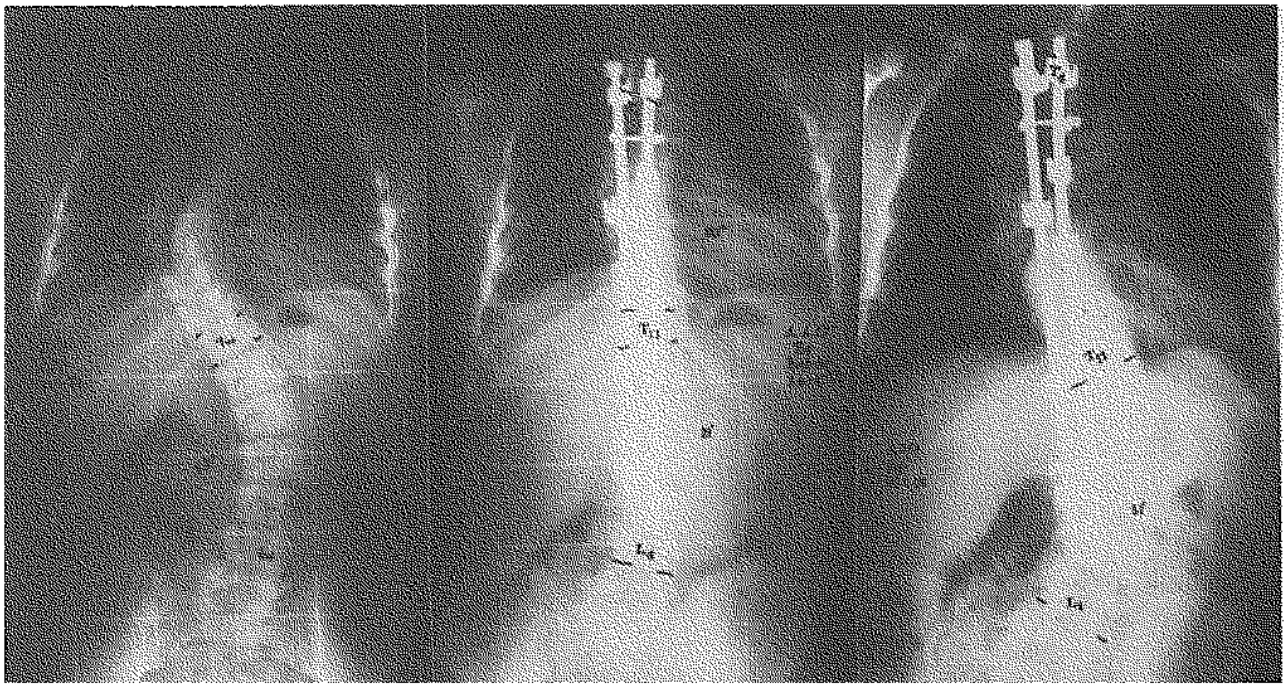

Fig. 2. — Preoperative, postoperative and follow-up standing anteroposterior radiographs of a skeletically immature 13-year-old boy with a King type II curve. Good postoperative correction was obtained but the curves had progressed significantly at the most recent follow-up.

Table I. — Correction in the coronal plane for the different types of curves *

	Type of Curve				
	I	II	III	IV	Left Thoracic
No of patients	4	20	10	10	2
Age (*yrs.* + *mos.*)	14 + 3	15 + 6	15	14 + 4	14
Duration of follow-up (*mos.*)	42	62	60	58	84
Preop. thorac. curve (°)	43.7	62.2	52.2	59.3	60
Preop. thorac. bending test (°)	31	34.8	39.8	42.1	44
Postop. thorac. curve (°)	22.5 (48)	27.1 (52)	17 (67)	25.6 (57)	37 (38)
Thorac. curve at most recent follow-up (°)	29.2 (33)	35.3 (42)	26.9 (49)	31 (47)	45 (25)
Loss of thorac. correction (°)	– 6.3	– 8.2	– 9.8	– 5.4	– 8
Preop. lumbar curve (°)	49.2	47.7	30	44.2	35
Preop lumbar bending test (°)	22.6	17.4	14	24.3	16
Postop. lumbar curve (°)	12.5 (74)	19.8 (61)	9 (70)	24.4 (44)	25 (28)
Lumbar curve at the most recent follow-up (°)	23.7 (51)	27.7 (44)	11 (63)	23.6 (46)	32 (8)
Loss of lumbar correction (°)	– 11.2	– 7.9	– 3	+ 1,2	– 7

* King type V and lumbar curves are not included. Values are averages. The numbers in parentheses are the percentages of correction of the curves.

creased to 1.75 cm, with an increase to 3.5 cm at the most recent follow-up. The values for the tilt of the most caudal instrumented vertebra were 19°, 8° and 11°, respectively (fig. 3).

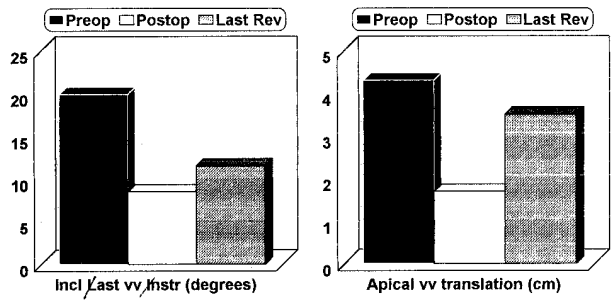

Fig. 3. — Coronal balance evolution assessed according to the inclination of the last instrumented vertebra (°) and to the deviation of the apical vertebra from the central sacral line (cm).

The sagittal curve from the fifth to the twelfth thoracic vertebra averaged 20° preoperatively, 20° one week after surgery and 23° at the most recent follow-up. The sagittal curve from the first to the fifth lumbar vertebra averaged 43° preoperatively, 37° postoperatively and 40° at the most recent follow-up (fig. 4). Analysis of each type of curve showed a significant increase in the thoracic kyphosis in type III and IV curves ($P < 0.05$). These curve patterns showed preoperative values of thoracic kyphosis lower than the rest of the curves ($P < 0.05$) (table II).

Vertebral rotation was assessed with the technique of Nash and Moe in 27 patients. The average postoperative improvement in these 27 patients was 15%. It could not be studied in the other 23 patients owing to the interposition of the instrumentation on the postoperative radiographs.

The percentage of preoperative correction on maximum lateral bending was 54% for lumbar curves and 32% for thoracic curves. The values were 41% and 35%, respectively, when the traction test was used. There was no significant difference between these two tests in predicting the evolution of the thoracic curve, but the bending test was more accurate than the traction test in predicting the evolution of the lumbar curve ($P < 0.05$). Preoperative flexibility of the thoracic curve was significantly less than the correction obtained surgically ($P < 0.05$).

There were no major neurological complications. One patient showed mild paresia of both legs with diminution of the ankle jerk postoperatively. He was treated with high doses of corticosteroids, and he made a complete neurological recovery. We believe this problem may have been caused by excessive spinal traction during the operative procedure.

Late complications occurred in two patients. One patient developed a delayed deep wound infection 24 months after the operation, with spontaneous drainage and mild pain in the back. The instrumentation was removed, and the patient had complete relief of symptoms. The other pa-

Table II. — Sagital plane analysis of different types of curves *

	Type of Curve				
	I	II	III	IV	Left Thoracic
Preop. T5T12 curve	23	17	11	17	35
Postop. T5T12 curve	20 (– 3)	22 (– 5)	17 (+ 6)	19 (+ 2)	32 (– 2)
Final T5T12 curve	22 (– 1)	26 (– 1)	22 (– 1)	20 (+ 3)	36 (+ 1)
Preop. L1L5 curve	45	44	41	47	51
Postop. L1L5 curve	36 (– 9)	33 (– 11)	38 (– 3)	45 (– 2)	44 (– 7)
Final L1L5 curve	36 (– 9)	40 (– 4)	42 (+ 1)	45 (– 2)	50 (– 1)

* Values are expressed as average degrees. The numbers in parentheses represent differences respect the initial curve ("–" : decrease ; "+" : increase).

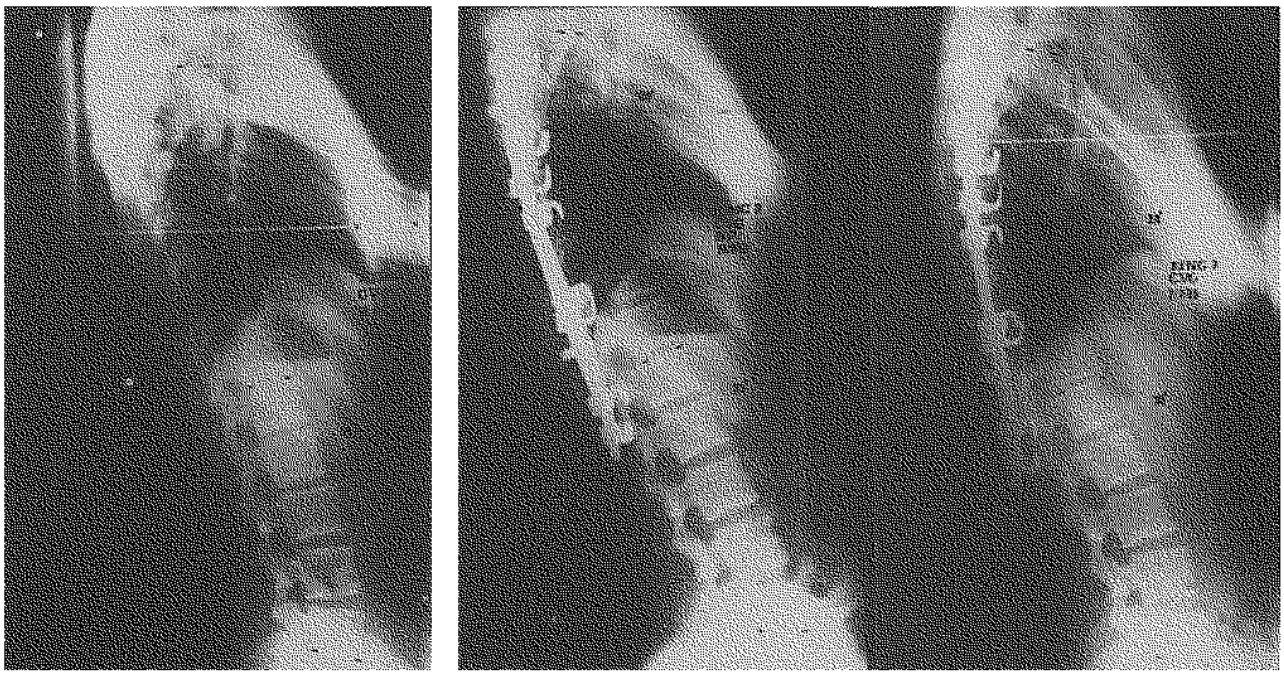

Fig. 4. — Preoperative, postoperative and follow-up lateral radiographs of a 15-year-old girl with a King type III curve. Great improvement of thoracic kyphosis can be seen with mild increase in the last revision. Lumbar lordosis has not changed significantly.

tient had been instrumented caudally to S1 because she had a concomitant L5-S1 spondylolisthesis, and she developed a pseudarthrosis at that level. The instrumentation was removed, and a new L5-S1 arthrodesis was performed resulting in bone union at 3 months.

DISCUSSION

Since its introduction in 1984, CDI has gained much popularity, and many reports have emphasized its advantages over the Harrington system in the surgical treatment of IS (2, 6, 14, 17, 28). Many authors have found the CD system to achieve good frontal and sagittal plane corrections with no need for postoperative immobilization (1, 3, 4, 7, 8, 11, 16, 23, 24).

We obtained a postoperative frontal correction of 56% for thoracic and 57% for lumbar curves, comparable to previously reported series. Cotrel *et al.* (8) found a 4% loss of correction at 24 months, whereas Puno *et al.* (22) reported an 11.6% loss at 33 months. We found a loss of correction under 15% for thoracic and lumbar curves. Although most of the curve progression occurred during the first two years, we also found continuous progression of the curve after this time, especially in skeletally immature patients. However, this curve progression was not clinically significant, and all the patients were satisfied with their cosmetic appearance.

Preoperative flexibility tests are essential in the analysis of the curves. Their utility in the planning of surgery was well established by King *et al.* (15), Cotrel *et al.* (7) and Shufflebarger and Clark (26). However, their real value in predicting the postoperative evolution of the curve remains controversial. We did not find differences between the traction test and the lateral inclination test in predicting the correction obtained after surgery in thoracic curves. An interesting finding is that these curves tend to correct more with surgery than would be expected from preoperative flexibility tests. This fact has also been mentioned by other

authors (11, 23) and it is important to bear it in mind in order to avoid overcorrection of the curves that could lead to postoperative frontal decompensation.

Sagittal plane correction is one of the basic principles of CD instrumentation. This system was designed to improve thoracic kyphosis and preserve lumbar lordosis when the derotation manœuvre was performed. We have not found significant changes in thoracic kyphosis when preoperative values were within normal limits. However, for those patients who were significantly hypokyphotic before surgery, there was a moderate improvement postoperatively. This occurred specifically in Type III and IV curves. This finding has also been noted by Bridwell *et al.* (4), Richards *et al.* (23) and Lenke *et al.* (16). Preservation or enhacement of lumbar lordosis is essential when fusion is extended lower than L3. The flatback syndrome that was caused when Harrington instrumentation was used lower than L3 became one of its main disadvantages (10, 13, 18, 20, 27). Most of the authors agree that lumbar lordosis is well preserved with the CD system. Our results support this view and show that lumbar lordosis is maintained within normal limits over time.

The rate of complications associated with CDI seems to be lower than with previous systems. Neurological deficits have been reported by some authors, but the overall incidence of this complication appears to be low when compared to Harrington or Luque systems (5, 19, 28). The application of segmental forces and the minimally invasive placement of the hooks in the spinal canal must contribute to this decrease in neurological complications. Apart from the patient who had a concomitant L5-S1 spondylolisthesis and developed a nonunion at that level after instrumentation was carried out to S1, we did not have any other pseudarthroses. This compares favorably with the estimated 5% rate of nonunion with the Harrington system (20, 27). There have been very few reports of pseudarthroses and rod breakage with the CD system (12). The use of multiple hooks, two rods and the DTT device confers great strength and rigidity on the system and avoids segmental vertebral movement, allowing the bone to fuse.

In conclusion, our 5-year follow-up results are encouraging. There is a good frontal and sagittal correction of the curves, with minimal loss of correction over time. The CD instrumentation provides a more physiological reorientation of the scoliotic curves than previous systems, with obvious preservation of lumbar lordosis and enhancement of thoracic kyphosis when necessary. There is acceptable operative morbidity and patient compliance, with the great advantage of avoiding postoperative inmobilization. Although more time is necessary to evaluate the long term results of this instrumentation, it is becoming clear that the CD system will be the standard method of treatment of IS to which other systems will be compared in the future.

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SAMENVATTING

S. A. ANTUÑA, J. G. MÉNDEZ, J. C. LÓPEZ-FANJUL, J. PAZ JIMÉNEZ. Cotrel-Dubousset instrumentatie voor idiopathische scoliosen : een follow-up van 50 gevallen.

De auteurs beschrijven 50 idiopathische scoliosen behandeld met Cotrel-Dubousset (CD) instrumentatie. De patiënten werden gemiddeld gedurende 5 jaar gevolgd : tussen de 24 en 108 maanden. De gemiddelde leeftijd bedroeg 15 jaar en 3 maand. De kurven werden ingedeeld volgens King *et al.* : er waren 4 type I, 20 type II, 10 type III, 10 type IV en één type V. Vijf konden niet worden geklasseerd : 2 dubbele lumbale kurven, 1 rechts lumbaal en 2 links thoracaal.
Een postoperatoire correctie van 56% voor de thoracale en 57% voor de lumbale kurven kon worden bekomen. Een verlies van resp. 14 en 15% werd gezien bij de laatste controle. De grootste correcties werden gezien voor de types III en IV. Een matige toename van de thoracale kyphose wanneer deze preoperatoir miniem was werd vastgesteld ; de normale sagitale lumbale curvatuur werd behouden tot de laatste controle.
Er waren geen neurologische complicaties. Een diepe infectie genas na verwijderen van het materiaal. Bij een patient met spondylolisthesis L5-S1 ontwikkelde er zich een pseudarthrose.

Deze studie toont aan dat met het CD materiaal een goede correctie kan bekomen worden, met een aanvaardbaar verlies in de loop van de tijd. Het systeem laat ook toe om de lumbale lordose te behouden wanneer de arthrodese dient te worden uitgebreid naar lumbaal.

RÉSUMÉ

S. A. ANTUÑA, J. G. MÉNDEZ, J. C. LÓPEZ-FANJUL, J. PAZ JIMÉNEZ. Instrumentation de Cotrel-Dubousset dans le traitement des scolioses idiopathiques. Un suivi de 5 ans.

Les auteurs rapportent les résultats obtenus dans 50 cas de scoliose idiopathique traités par instrumentation Cotrel-Dubousset (CD). Les patients ont été suivis entre 24 et 108 mois avec un recul moyen de 5 ans. L'âge moyen était de 15 ans et 3 mois. Les courbures scoliotiques ont été classifiées d'après King *et al.* : il y avait 4 courbures de type I, 20 de type II, 10 de type III, 10 de type IV et 1 de type V. Cinq courbures n'ont pas pu être classées : 2 doubles lombaires, 1 lombaire droite, 2 thoraciques gauches.

L'analyse dans le plan frontal a montré une correction post-opératoire moyenne de 56% pour les courbures thoraciques et de 57% pour les lombaires. La perte de correction au dernier examen fut respectivement 14% et 15%. Les plus grandes corrections ont été obtenues dans les courbures type III et IV. Nous avons noté une augmentation modérée de la cyphose thoracique quand son importance pré-opératoire etait très faible. La courbure sagittale normale du rachis lombaire s'était maintenue au dernier examen.

Nous n'avons pas noté de complications neurologiques. Un patient présentant un spondylolisthésis L5-S1 développa une pseudarthrose. Un autre développa une infection profonde qui guérit après ablation du matériel.

Cette étude nous montre que l'instrumentation CD permet une correction satisfaisante des courbures, avec une perte de correction acceptable. C'est un système qui permet de conserver la lordose lombaire quand l'arthrodèse doit être étendue au rachis lombaire.