

# Cotrel–Dubousset Instrumentation in Idiopathic Scoliosis

## A Preliminary Report

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This is a preliminary report on Cotrel–Dubousset (CD) instrumentation for the surgical management of idiopathic thoracic scoliosis. From September 1985 through April 1986, 37 patients were treated at the authors' hospital, by posterior spinal fusion with CD instrumentation. Twelve patients had surgical treatment of spinal deformity associated with other disorders or had revision surgery. The remaining 25 patients, with no prior surgery, were diagnosed as having juvenile or adolescent idiopathic scoliosis. After operation, this group of patients was routinely noted to have significant improvement in rib deformity. This is associated with the rotational correction achieved with CD instrumentation and contrasts with the minimal rib deformity correction with Harrington instrumentation documented by some workers. In this series, no rib resections have been necessary in conjunction with CD instrumentation. No postoperative external immobilization was used. Ambulation began on the second postoperative day, and patients were discharged five to seven days after operation. Gradual resumption of normal activities was allowed at six weeks, and full activities, other than contact sports, after three months.

Cotrel and Dubousset introduced universal instrumentation (CD) for the surgical management of spinal deformity.<sup>6</sup> This posterior instrumentation consists of knurled 7-mm rods, a series of pedicle and laminar hooks that can be secured to the rod at any

point along its length and in any transverse axis of rotation, and transverse approximators (DTT: Device for Transverse Traction, Stuart, Inc., Greensburg, Pennsylvania).<sup>14</sup> The system permits distraction, compression, or rotation between hook sites and emphasizes correcting scoliotic deformity by derotation while at the same time maintaining or restoring normal sagittal contours of the spine. In essence, a contoured rod is secured into the scoliotic deformity and rotated into the sagittal plane.

### OPERATIVE PROCEDURE

The sequence of surgical steps varies with the type of curve pattern, *i.e.*, thoracic, thoracolumbar, or lumbar. The authors' initial experience with CD instrumentation in idiopathic scoliosis was limited to thoracic or Type II double thoracic/lumbar curves, as described by King *et al.*<sup>9</sup> Therefore, only the surgical management of a thoracic curve in idiopathic scoliosis is discussed.

The levels to be instrumented are carefully determined by evaluating the standing posteroanterior (PA) and lateral films of the spine.<sup>7,9,10</sup> Supine bending films are used to determine the degree of flexibility of the scoliosis and the presence of uncorrectably wedged intervertebral discs above and below the apical vertebra. For a thoracic curve, a distractive force is applied in the concavity of the curve between the vertebrae spanning

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these wedged intervertebral discs (usually two or three) with additional hook sites at the ends of the instrumentation. In the convexity of the curve, compression is applied between an apical vertebral hook and hooks at the ends of the instrumented levels. Additional hook sites may be used to help correct local spinal deformity.

Routine posterior exposure of the spine is performed, hooks are placed, and meticulous decortication and facet excision are done at remaining interposed vertebral levels. The rods are then seated. In thoracic curves, the concave rod, contoured to the deformity, is seated first. Slight distraction is applied between the two hooks spanning the apex of the deformity. The rod is then rotated (ideally 90°) so that the contour is converted from a scoliotic deformity to a sagittal curve. The convex rod is seated next, with compression and distraction applied between the hook sites as clinically indicated. The rods are then secured to each other with the transverse approximators.

#### MATERIAL AND METHODS

From September 1985 through April 1986, 37 patients had posterior spinal fusion with CD instrumentation at the authors' hospital. Twelve patients had surgical treatment of spinal deformity associated with other disorders or had revision surgery (Table 1). The remaining 25 patients who had not had prior surgery were diagnosed as having juvenile or adolescent idiopathic scoliosis. The hospital chart, pre- and postoperative roentgenograms, anesthetic record, and clinical photographs of the 25 patients with idiopathic scoliosis were reviewed and form the basis of this report.

Idiopathic, single, thoracic curves were fused according to the criteria listed above. In the case of Type II double thoracic/lumbar curves, the extent of thoracic fusion was determined using the criteria of King *et al.*<sup>9</sup> Surgery was carried out under hypotensive general anesthesia with the patient on a Hall-Relton<sup>11</sup> frame without traction. Spinal cord monitoring was used routinely and autogeneic blood transfusion was given whenever possible.

No postoperative external immobilization was used. Ambulation began on the second postoperative day. Patients were discharged five to seven days after surgery. Gradual resumption of normal

TABLE 1. Diagnoses of Patients Treated with CD Instrumentation for Spinal Deformity Other than Idiopathic Scoliosis

<i>Diagnosis</i>	<i>No. of Patients</i>
Congenital scoliosis	4
Scoliosis with	
Cerebral palsy	2
Beal's syndrome <sup>12</sup>	1
Schwartz-Jampel syndrome <sup>12</sup>	1
Revision in idiopathic scoliosis	1
Kyphosis with	
Cerebral palsy	1
Marfan's syndrome	1
Lordosis with otopalatal digital syndrome <sup>12</sup>	1

activities was allowed at six weeks, and full activities, other than contact sports, were allowed after three months.

#### RESULTS

For the 25 patients with idiopathic scoliosis, the average operating time was three hours and 45 minutes (range, three to five hours). The average intraoperative blood loss was 1000 ml (range, 350–1900 ml).

The curve patterns of these patients are listed in Table 2. The average preoperative curvature was 57° (range, 40°–82°). The best-bend correction averaged 32°, with postoperative curvature averaging 23° (range, 3°–48°).

Thoracic kyphosis was measured by the Cobb angle between the uppermost discernible vertebral body and the inferior edge of

TABLE 2. Curve Pattern of 25 Patients with Idiopathic Scoliosis Who Had CD Instrumentation

<i>Curve Pattern</i>	<i>No. of Patients</i>
Double thoracic	4
Thoracic	15
Thoracic/lumbar	6

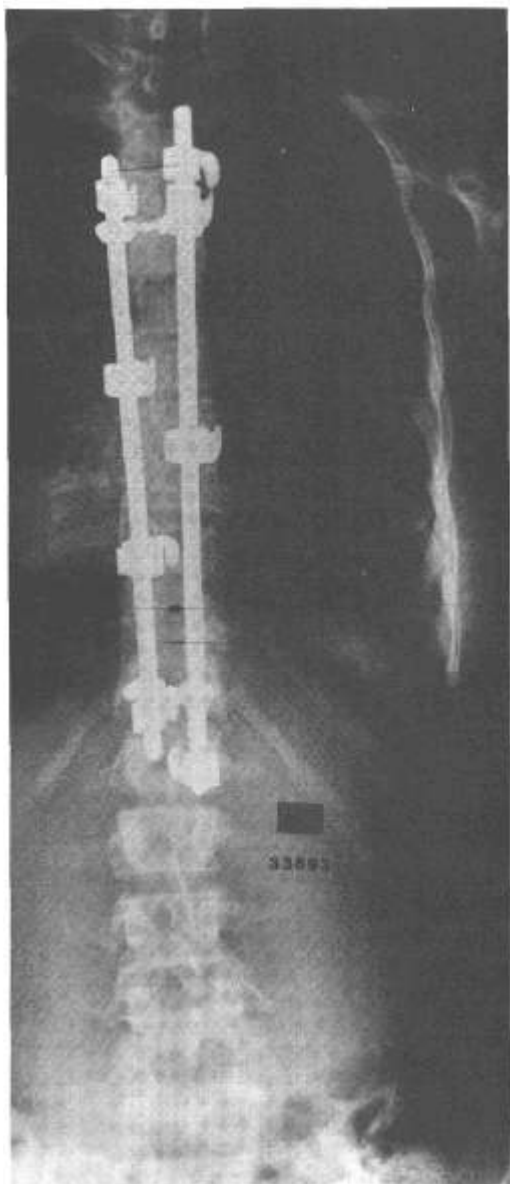


FIG. 1. Initial standing postoperative AP roentgenogram.

T12. After operation this averaged  $27^\circ$ , compared with  $30^\circ$  before operation. Specifically, 14 of the 25 patients showed no significant change in thoracic kyphosis (a measured change of  $4^\circ$  or less). Two patients had an intentional increase in kyphosis, whereas nine patients had decreased kyphosis after

operation. One of these nine patients had an intentional reduction of a preoperative kyphosis of  $54^\circ$ ; the remaining eight patients with decreased kyphosis averaged  $29^\circ$  of kyphosis before operation with an average postoperative reduction of  $7^\circ$ – $22^\circ$ .

There were no intraoperative complications, and to date there have been no wound infections or neurologic injuries. One patient lost fixation after operation. Her initial postoperative correction and implant stability appeared adequate (Fig. 1). Three weeks after surgery, she fell hard on her buttocks when the school bus in which she was riding struck a deep bump. She noted immediate pain in her back but did not consult the authors for two weeks. At that time, the inferior convex laminar hook was displaced (Fig. 2). This was revised by shortening the rod and reinserting a laminar hook two levels higher (Fig. 3). Correction did not appear to be appreciably changed, and she did not require subsequent external immobilization.

Six patients had Type II double thoracic/lumbar curves and were treated with fusion in the thoracic region, according to the criteria of King *et al.*<sup>9</sup> Two of these six patients failed to show expected spontaneous correction of the lumbar portion of the curve. One patient has been returned to a Boston orthosis<sup>16</sup> to control the lumbar curve and the other patient is currently being observed.

In 19 of 25 patients, postoperative roentgenograms showed at least one pedicle hook to be malpositioned either medial, lateral, or distal to the intended pedicle itself. This did not affect stability of the instrumentation, and in no case did it necessitate the use of postoperative external support.

## DISCUSSION

This article presents the authors' brief experience with CD instrumentation in the surgical management of idiopathic thoracic scoliosis. The larger number of hook sites and greater complexity of the system have extended the operating time for routine sco-

liosis surgery. This complexity, however, also renders the system versatile and allows correction or maintenance of sagittal curves. The procedure is accomplished without the

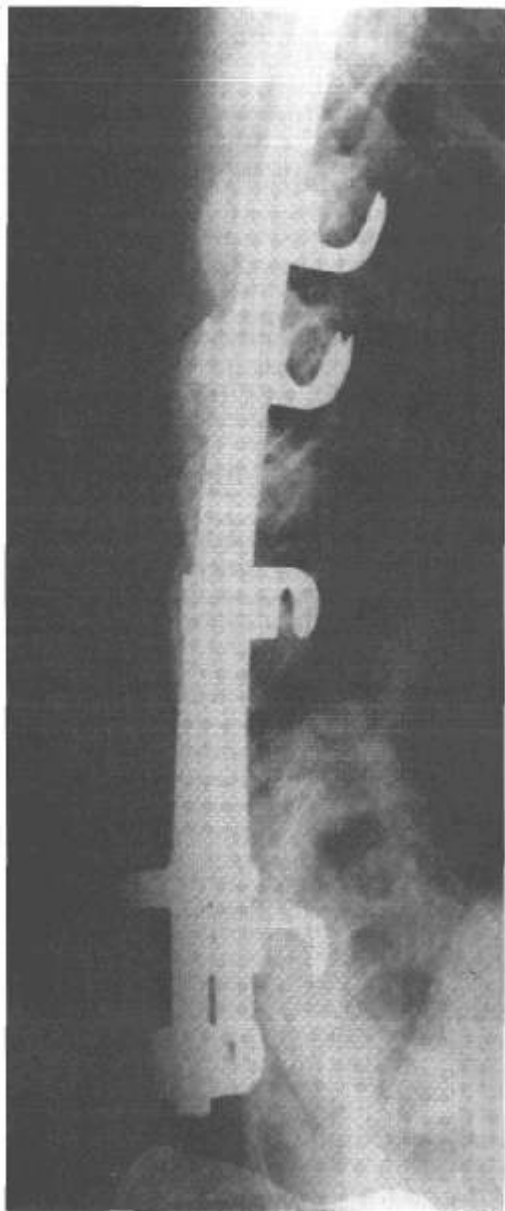


FIG. 2. Same patient as in Figure 1, five weeks after operation and two weeks after injury. She had back pain and prominence over the distal end of the rods. The inferior convex laminar hook was displaced posteriorly.

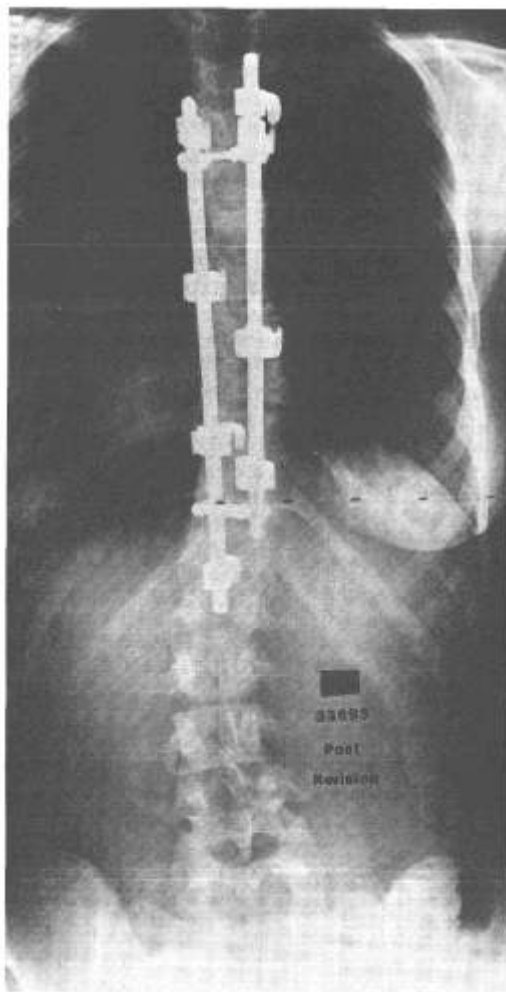


FIG. 3. Postoperative standing AP film after revision. The convex rod has been shortened and a new laminar hook placed two levels higher.

use of sublaminar wires and thus presumably has less risk of neurologic injury. The implant is sufficiently stable to obviate the need for postoperative external support. Furthermore, in the correction of idiopathic scoliosis, minimal use of distraction appears to make the instrumentation at least as safe as Harrington instrumentation.

The average case in this series demonstrated 60% correction of the scoliosis, with no loss of thoracic kyphosis. This compares

favorably with other published reports of scoliotic correction by Harrington distraction instrumentation with or without compression.<sup>5,8</sup> Harrington instrumentation has been documented deleteriously to obliterate lumbar lordosis.<sup>2,15</sup> Although it appears that Harrington distraction, particularly with compression, would reduce kyphosis similarly in the thoracic spine, this has been poorly documented in the literature. The deleterious effect of lordosis in the thoracic spine on pulmonary function, however, is well documented.<sup>3,4,5,18</sup> Although Luque instrumentation is better able to maintain sagittal contours than Harrington instrumentation, it does so at an increased risk of neurologic injury.<sup>17</sup>

After operation, this group of patients was routinely noted to have significant improvement in rib deformity, presumably related to the rotational correction achieved with CD instrumentation. This contrasts with the minimal rib deformity correction with Harrington instrumentation documented by Aaro and Dahlborn.<sup>1</sup> In fact, no rib resection in conjunction with CD instrumentation has been performed to date because it has apparently not been necessary. Before the introduction of CD instrumentation, the authors routinely combined rib resection, as described by Steel,<sup>13</sup> with Harrington instrumentation to improve the cosmesis of rotational deformity.

Two of six patients in this series with Type II double curves and fusion of their thoracic curves only failed to show spontaneous correction of the lumbar curve. The authors are uncertain at this point whether this related to the manner in which CD instrumentation effects correction of spinal deformity or if this relates more directly to spontaneous lumbar curve correction in Type II curves. At present the authors fuse the thoracic curve only, with careful observation of the lumbar curve.

Most of these patients were noted on postoperative roentgenograms to have at least one malpositioned pedicle hook. Several factors may play a role in this. The distance

between the tines of the pedicle hook is smaller than the transverse diameter of the typical thoracic pedicle. Thus when the pedicle is contacted by the tines, it is often difficult to determine whether the hood is situated directly around, medial to, or lateral to the pedicle. Furthermore, the manipulation necessary to thread the rod through the hooks frequently leads to unrecognized minor displacement of some pedicle hooks. Despite the less than ideal position of many pedicle hooks, however, the stability of the instrumentation has not been compromised. Whether or not it has reduced the effectiveness of derotational correction of the deformity by CD instrumentation is less certain. The implant material, in particular the rod, is malleable. This facilitates rod contouring. On the other hand, the knurls on the rod are easily worn away, leaving the surgeon constantly in search of new areas to grasp the rod, particularly in more rigid curves requiring firmer manipulation.

The production process for the implant is expensive. Beyond the initial capital outlay for the instruments, implants for a typical thoracic scoliosis may cost \$1300–1500. In the authors' hospital, this represents a nine-fold increase in implant cost over either Harrington or Luque instrumentations.

The follow-up periods of these 25 patients ranged from one to seven months, thus it is too early to discuss pseudarthrosis rates or loss of correction over time. Nevertheless, the authors are satisfied with the use of CD instrumentation in the correction of idiopathic thoracic scoliosis. The instrumentation appears to be safe and effectively corrects the scoliotic deformity. Rotational correction and rib deformity reduction have been satisfying. Furthermore, the instrumentation is sufficiently stable to preclude the need for postoperative external immobilization.

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