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Surgical correction of Scheuermann's kyphosis

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Abstract This is a retrospective study of eight consecutive patients of mean age 19 (13–27) years with severe Scheuermann's kyphosis who underwent anterior and/or posterior fusion using the Cotrel-Dubousset (CD) instrumentation. In two an anterior release and fusion with rib grafts had been previously performed. The mean follow-up was 5 years. The preoperative hyperkyphosis averaged 86° (71° – 99°), which was postoperatively 44° (32° – 58°). The average loss of correction was 4.6° (1° – 12°). The lumbar hyperlordosis spontaneously improved from -67° to -48° . Two patients, who had chronic back pain refractory to conservative treatment, improved considerably after surgery.

Résumé C'est une étude retrospective de huit patients âgés en moyenne de 19 (13–27) ans atteints d'une cyphose majeure sur maladie de Scheuermann, traitée par arthrodèse antérieure et/ou postérieure avec instrumentation Cotrel-Dubousset (CD). Les données ont été analysées avec un recul moyen de 5 ans. Une libération et arthrodèse antérieure suivie par traction Halo a été faite dans deux cas. La cyphose préopératoire moyenne était de 86° (71° – 99°), la cyphose postopératoire était de 44° (32° – 58°). La perte de la correction était de 4.6° (1° – 12°). La lordose lombaire a diminué de -67° à -48° . Sept malade avaient une scoliose concomitante de 17.4° en moyenne, corrigées à 7° . Deux patients avaient des dorsalgies chroniques n'ayant pas répondu au traitement médical, et ont été améliorés nettement après la chirurgie.

Introduction

Scheuermann's disease is the most frequent cause of severe kyphosis in adolescence. The reported prevalence

varies between 0.4% and 8.3% [1]. Conservative treatment with hyperextension casts and bracing can be considered in skeletally immature patients. Although no prospective controlled study using the Milwaukee brace has been reported, this appliance has become the mainstay of treatment [2, 9, 14]. However, patients with a kyphosis of over 74° are poor candidates for brace treatment [14], but surgery is rarely required. The indications may include skeletally mature patients with a rigid hyperkyphosis greater than 70° – 75° associated with disabling pain refractory to conservative treatment [1, 3, 6, 7]. In exceedingly rare circumstances younger patients with milder (65° or more) and relatively flexible deformities may be treated surgically, either if they refuse to accept treatment with braces, and/or if the kyphosis progresses rapidly [1, 6, 16].

The aim of this study is to assess the results of surgical treatment using the Cotrel-Dubousset (CD) instrumentation in a group of patients with severe Scheuermann's kyphosis.

Patients and methods

Eight patients (13–27 years of age) with Scheuermann's kyphosis were operated on between 1991 and 1998. The kyphotic deformity usually involved seven vertebrae and the average preoperative kyphosis was 86° (range: 71° – 99°). A concomitant scoliosis was found in seven. All the patients had been treated by bracing, but this had failed to correct the kyphosis. Two patients had non-radiating pain at the apex of the deformity that had not responded to conservative treatment. Six underwent a single stage posterior correction and fusion using CD instrumentation, in two this followed an anterior release. The average follow-up period was 5 years (range: 2–8 years; Table 1).

Treatment started with preoperative traction. The anterior release was performed through a posterolateral thoracotomy using a transpleural approach. The interbody fusion involved impacting a long rib graft into a prepared groove made in the vertebral bodies, and this was reinforced by wedging small pieces of rib into each interspace. After 1 week in Halo-traction a posterior correction fusion with CD instrumentation was performed using autogenous iliac-bone grafting. The upper limit of instrumentation was either at the level of, or above the proximal vertebra of the kyphosis. The lower limit was determined with the aid of a hyperextension radio-

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Table 1 Patients and deformity patterns (RC right convex, LC left convex)

	Sex	Age at surgery (years)	Risser test	Follow-up period (years)	Extent of kyphosis	Apex of kyphosis	Concomitant scoliosis
1	m	16.2	4	7.4	Th6–11 (71°)	Th8	LC Th10–L2 (11°)
2	m	27.7	5	3.8	Th4–12 (90°)	Th8–9	RC Th4–12 (8°)
3	f	18.2	5	4.2	Th6–12 (80°)	Th9	LC Th10–L2 (24°)
4	f	13.1	2–3	7.9	Th3–12 (74°)	Th8	RC Th4–10 and LC Th11–L3 (20° and 21°)
5	m	18.2	5	6.9	Th7–12 (99°)	Th9	RC Th8–L1 (30°)
6	f	20.8	5	5.1	Th9–L1 (95°)	Th11	LC Th7–11 (25°)
7	m	15.9	3	2.1	Th5–12 (88°)	Th8	–
8	m	19.3	5	2.9	Th6–11 (90°)	Th8–9	LC Th7–12 and RC L1–4 (12° and 9°)

Table 2 Fusion levels and results of surgery (*n.m.* non-measurable)

	Anterior release and fusion	Posterior fusion	Preoperative kyphosis	Postoperative kyphosis	Correction (%)	Final kyphosis	Preoperative balance (mm)	Postoperative balance (mm)
1	–	Th4–L3	71°	37°	47.9	39°	–82	–8
2	–	Th4–L2	90°	58°	35.6	63°	57	–34
3	–	Th4–L2	80°	40°	50.0	52°	–60	29
4	–	Th3–L3	74°	32°	56.8	34°	–133	20
5	Th6–11	Th4–L2	99°	48°	51.5	56°	–29	2
6	Th8–12	Th4–L4	95°	47°	50.5	51°	–68	–37
7	–	Th3–L2	88°	39°	55.7	40°	0	<i>n.m.</i>
8	–	Th4–L3	90°	47°	47.8	50°	–21	60
Mean values:			85.9°	43.5°	49.4	48.1°	–48*	5*

*Calculated with the exclusion of patient #7

graph, with the fusion extending to the lumbar vertebra just proximal to the horizontal disc was the last fused level. We always used three-level bilateral pediculotransversal claws above the apex, and three-level bilateral pedicular screws linked by Chopin's interpedicular plates below the apex. The patients then remained in bed but no external support was used. Anteroposterior and lateral standing X-rays were taken before and after surgery and at the last follow-up examination.

Results

The patients' data are detailed in Tables 1 and 2. Postoperatively the kyphosis measured 44° (range: 32°–58°) and this deteriorated to 48° (range: 34°–63°) at an average follow-up of 5 (2–8) years. The average loss of correction was 5°. The lumbar preoperative hyperlordosis decreased 'spontaneously' after surgery in all the patients from –67° to –48°. Six demonstrated negative sagittal balance preoperatively. Three of these became normal and three nearly normal. One patient had a positive trunk imbalance (60 mm) postoperatively and on average the lateral gravity line of the trunk moved 53 mm anteriorly after surgery. The concomitant preoperative scoliosis measured an average of 17° in thoracic, or 9° in lumbar, or 20° in thoracolumbar deformities. After correction these averaged 8°, 2° and 6°, respectively. All the patients were satisfied with the cosmetic result, and the two patients with chronic preoperative back pain reported considerable improvement.

There were no pseudarthroses, deep infections, neurological complications nor thrombo-embolic problems during the entire follow-up period. One patient experienced a superficial wound dehiscence which was treated by excision and resuture. After 2 months another patient required operation for proximal loosening of the fixture with 32° of loss of correction, 2 months postoperatively. A 12° loss of correction was seen after one operation. At the last follow-up, one patient had developed 2° of kyphosis at the first unfused lumbar segment which had been originally slightly lordotic (–3°) after operation.

Discussion

Surgery is rarely indicated and remains controversial in the treatment of Scheuermann's disease. Murray et al. [10] assessed, after an average of 32 years, 67 conservatively treated patients with a diagnosis of Scheuermann's kyphosis of an average of 71° (Fig. 1). He found some functional limitations but that the patients had adapted well to their deformity and that this did not cause any major interference with their lives.

Operative treatment is indicated for a rigid kyphosis greater than 75° and if there is incapacitating back pain which does not respond to conservative treatment [1]. However, it is always important to exclude disc herniation, tumour or inflammation as a cause of the pain. Sur-

Fig. 1A,B Case MA: 16-year-old male patient with 71° thoracic kyphosis and Risser sign stage 4 who underwent posterior only fusion and fixation with CDI. **A** Preoperative radiogram. **B** Postoperatively the kyphosis is 37° . The instrumentation extends down to the lordotic part of the spine (to the L3, which was the cephalad adjacent vertebra to the horizontal disc on the hyperextension radiograph)

gery is indicated if a neural lesion is present but this is extremely rare [4, 5, 13]. Mobile and less significant curves respond well to bracing. If the kyphosis deteriorates rapidly or if the patient refuses brace treatment, then surgery may be required occasionally for curves greater than 65° [1, 12, 16].

When considering the biomechanics of a kyphosis it is only posterior fusions that are under the continuous tensile forces which can lead to implant failure and pseudarthrosis. Additional anterior surgery comprising partial resection of the shortened anterior longitudinal ligament with excision of the discs decreases the rigidity of the deformity and thus decreases the tensile forces acting on the posterior implants. Furthermore, anterior surgery results in a fusion mass under compression and this also enhances stability. The early papers on isolated posterior fusion record high rates of pseudarthrosis with loss of correction [2, 3, 6]. In 1990 Kostuik [6] reported 36 patients operated on using anterior distraction instrumentation. The correction obtained was moderate (26.8%) but the loss of correction remained under 5° . Speck and Chopin [15] proposed posterior fusion alone for patients with a Risser sign stage 3 or 4. However, for skeletally mature patients combined anterior and posterior surgery appears to offer the best results. Sturm et al. [16] state that no anterior surgery is needed even in fixed adult deformities so long as no anterior bone bridging has occurred. Otsuka et al.

[11] like Sturm et al. [16] applied Harrington compression rods. Both of these surgeons only performed posterior surgery and they reported similar results: 55% correction and 6° – 7° loss of correction. Lowe [7] used posterior L-rods fixed with sublaminar wires after a preceding anterior release and fusion. He achieved 47% correction with 5° loss of correction 32 months after the surgery. But because of the high risk of neural injury other authors did not like this method and Lowe himself also turned to multilevel hook systems. In a later study [8] Lowe and Kasten reported 32 patients treated with a staged anterior release and posterior fusion using CD instrumentation. The average preoperative kyphosis of 85° was corrected to 41° . He noted an average loss of 4° after 42 months. The lateral spinal balance which had been negative in all patients shifted posteriorly after fusion. All the authors [3, 7, 11, 15, 16] reported good cosmetic results and full patient satisfaction.

The most frequently reported complications are instrument problems, pseudarthrosis, loss of correction and neural problems. The highest rates of neural complications (16%) and instrument problems (25%) were reported by Lowe [7] after the use of double L-rod and sublaminar fixation. In general, loss of correction is the most frequent problem but this can be reduced by using stronger posterior instrumentation and a combined anterior-posterior fusion [8, 11, 15, 16].

Concerning the levels to be fused many authors agree that this should include all the kyphotic segments [1, 8, 11, 15, 16, 18]. Too short a fusion may lead to upper and/or lower junctional kyphosis [3, 7, 8, 16]. An upper junctional kyphosis may also appear when the correction is more than 50% of the initial kyphosis [8]. In our practice we start the fusion at the proximal vertebra of the kyphotic area (or one level above) and we descend to the lordotic part of the lumbar spine. The lower limit should be the lumbar vertebra just above the horizontal disc on the hyperextension roentgenogram as recommended by Dubousset and Guillaumat in 1987 (personal communication) and described later by Zakine and Carlouz [18].

As far as anterior release and fusion are concerned, we agree with the criteria of Speck and Chopin [15], i.e. skeletally mature patients with a Risser sign stage 5. The curve flexibility test is useful in assessing the outcome of surgical correction but is not an indication for abandoning the anterior procedure and our results support the use of these indications. Two patients refused thoracotomy. In one there was only a 35.6% correction and his back remained kyphotic. Despite initial good correction isolated posterior fusion in one patient was followed by a loss of correction of 9° in the first postoperative year. We believe in both these patients that an anterior release and fusion would have resulted in better correction or better postoperative stability.

Our results suggest that satisfactory correction can be obtained when treating Scheuermann's kyphosis with a long posterior fusion and CD instrumentation. Anterior release and fusion allow better correction and prevent a greater loss of correction especially in adults, in whom this additional procedure is mandatory. However, in view of the fact that these operations are not free from complication risks, surgery should only be considered as a last resort after full conservative treatment.

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