Acta orthop. scand. 53, 913–917, 1982

SURGICAL TREATMENT OF SEVERE ANGULAR KYPHOSIS

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Five patients 10–21 years old were treated for severe angular kyphosis, ranging from 61 to 133 degrees, by a three-stage procedure: 1. distraction in a halo-pelvic apparatus, 2. anterior decompression and/or fusion and 3. posterior fusion with Harrington compression rods. An average correction of 68% and a good cosmetic result were obtained. A solid fusion was achieved in all patients. There were no neurological complications. A 12-year-old girl gained 20 cm in height and the spinal kyphosis was reduced from 133 to 27 degrees.

Key words: anterior fusion; halo-pelvic traction; kyphosis; operative treatment; posterior fusion

Accepted 6.vi.82

The most frequent causes of angular kyphosis are congenital malformations of the vertebral bodies, myelomeningocele, spinal fractures and laminectomies. Other causes are tuberculosis, neurofibromatosis and radiation treatment affecting the spine. When the deformity is established, significant progression often occurs in childhood and during the preadolescent growth spurt leading to a severe spine deformity regardless of the aetiology. The greatest threat is spinal cord compression leading to neurological dysfunction and finally paraplegia. Early fusion is the best way of preventing this natural outcome of this condition.

During the last few years, surgical procedures and techniques have improved the outlook for patients with severe kyphosis. The purpose of this paper is to draw attention to these new possibilities by presenting the result of a three-stage procedure for correction and stabilization of spinal kyphosis.

PATIENTS AND METHODS

Five patients, three females and two males, with severe angular spinal kyphosis of different aetiology were treated. The age at operation varied from 10 to 21 years (Table 1). None had previously had any treatment of the spinal deformity. Of the three cases with congenital deformity, two (A.B. and A.M.) had small dorsal hemivertebrae, Type I, and the other (A.R.) had a combination of a dorsal hemivertebrae and failure of segmentation, Type I/II. The case histories revealed gradually increasing deformity from 1 to 2 years old.

The oldest patient (R.F.) had a spinal fracture of the lower thoracic region when five years old. In this case gradual increase of the spinal deformity had been noticed even after skeletal maturity. The boy (A.A.) with a mid-thoracic kyphosis was operated on when 9 months old because of a malignant neuroblastoma in the mediastinum. He received postoperative radiation and a kyphosis developed gradually during the following years, but there were no signs of recurrence of the tumour.

The kyphosis varied from 61 to 133 degrees. All curves were rigid, with minimal passive correction, and had minor scoliosis of less importance. All patients were severely cosmetic embarrassed, but only the oldest complained of pain. Patients A.B. and A.A. had hyperreflexia in the legs, but no neurological deficits. The pulmonary function was moderate to severely re-

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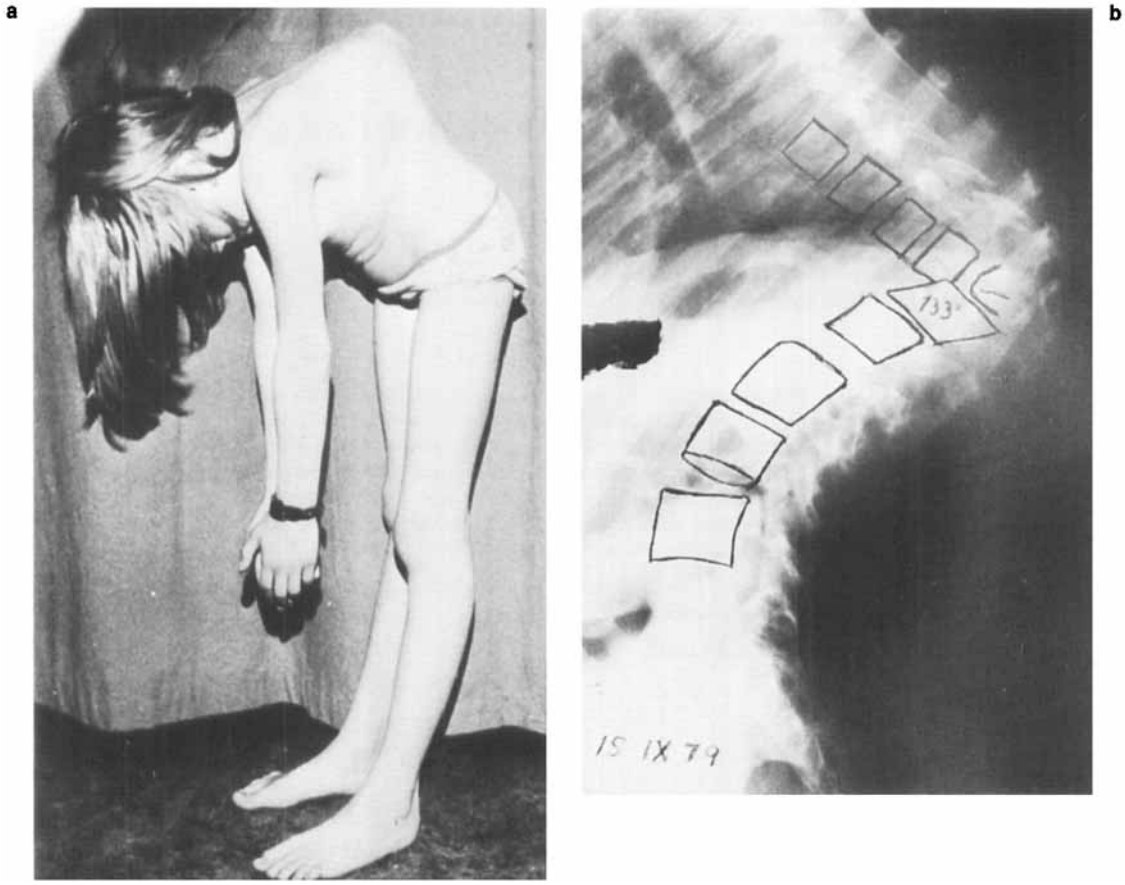


Figure 1. A 12-year-old girl with severe angular kyphosis (a), 133° (b), preoperatively (c), reduced to 27° (d) after a 3-stage procedure; halo-pelvic traction, anterior decompression and fusion, and posterior instrumentation and fusion.

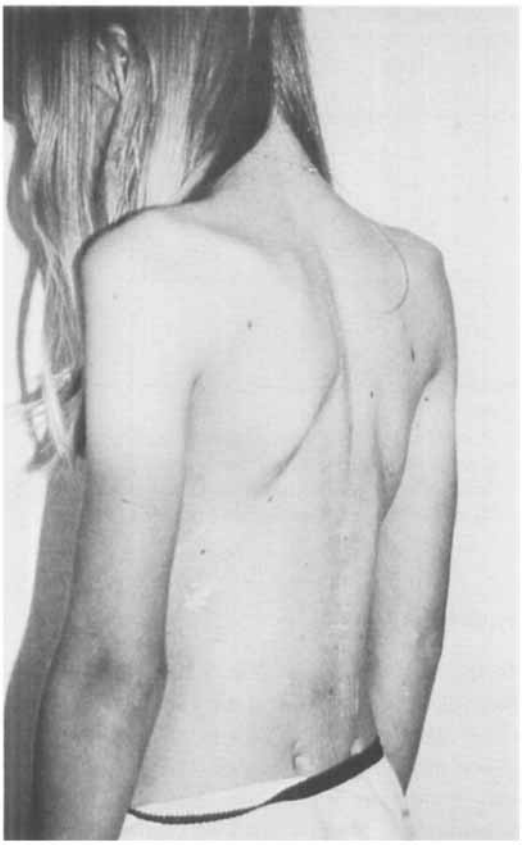
duced, the patient with post radiation deformity had extensive fibrotic changes of the left lung.

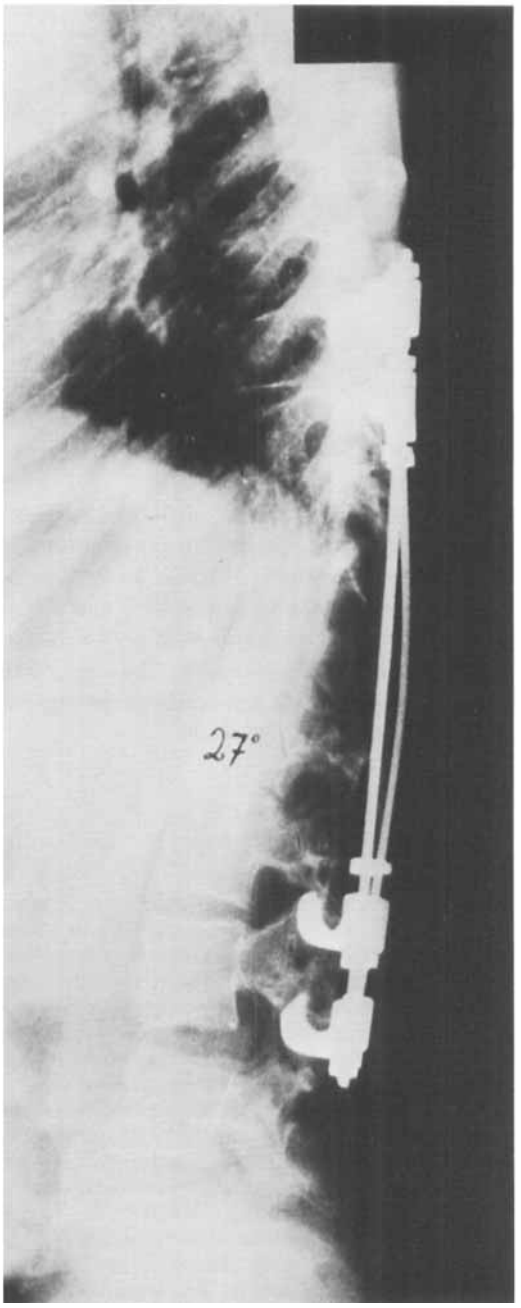
Metrizamid myelography and tomography were performed to determine the space available for the spinal cord and to rule out intraspinal anomalies.

Halo-pelvic traction. The halo-pelvic apparatus described by O'Brien (1975) was used for gradual correction of the spinal deformity. Daily assessment of the neurological function and force measurements were done to avoid too high a distraction force. Traction was continued as long as the kyphosis stretched out, which was up to 2½ months.

Anterior spinal decompression and fusion. When maximal correction was obtained, an anterior operation was performed with the patient in the halo-pelvic apparatus. One of the extension bars was temporarily removed during the surgical procedure. Depending on the level of the apex of the kyphosis, a transthoracic or transthoracic-retroperitoneal approach was used. In the latter case, the tenth rib was removed and the diaphragm divided about 1½ cm from its costal attachment (Riseborough 1973). Spinal cord dysfunction or a myelographic block were regarded as indications for anterior decompression before the fusion (Chou 1977). This was carried out in patient A.B. who had a spinal block and hyperreflexia.

The spine was exposed by subperiosteal dissection in the area to be fused. The discs were completely removed and osteotomies performed if necessary. The resected rib was used as an inlay graft placed in a trough cut in the vertebral bodies in well-corrected curves (Bradford et al. 1977). If vertebral bodies were absent or poorly developed, a solid corticocancellous block of homologous bone was inserted anteriorly between the vertebral bodies. The disc spaces were packed with cancellous autogenous or homologous bone, or both. If significant angulation persisted, anterior strut grafts were used.





The usual post-thoracotomy routine was followed, and the patients were out of bed and ambulatory on the first or second day.

Posterior spinal fusion. Two to four weeks after the anterior fusion, a posterior arthrodesis was performed extending from one vertebra above to one vertebra below the anterior fusion. Harrington compression rods and homologous bone grafting were used.

Body jacket. Six to eight weeks following the posterior fusion, the halo-pelvic apparatus was replaced by a well-fitted body jacket in the patients with thoracolumbar fusions or a body brace with Milwaukee superstructures in the patient with high thoracic fusion. The spine was immobilized for a total period of 12–15 months.

RESULTS

The kyphosis was considerably reduced in all patients. The average total correction after all three procedures was 68 per cent, ranging from 43 to 82 per cent. The degree of correction ranged from 26 to 106 degrees (Table 1).

A good cosmetic result was obtained in all patients. Patient R.J. was relieved of her dorsal pain

Table 1. Severe kyphosis treated by halo-pelvic traction, anterior and posterior fusion

	Sex	Age (years)	Aetiology	Apex	Size of kyphosis Before	After
A.B.	F	12	Congenital	T_{11}–T_{12}	133°	27°
A.M.	F	14	Congenital	T_{12}–L_2	94°	17°
A.R.	M	10	Congenital	L_1	61°	35°
R.J.	F	21	Sequel of fracture	T_{11}–T_{12}	112°	33°
A.A.	M	16	Post radiation	T_6–T_7	115°	50°

and hyperreflexia normalized in patient A.B. Shortest follow-up was more than 12 months, and radiographs have shown solid fusion and no dislocation of grafts.

There were no neurological complications. Three patients had minor drainage from one or two pelvic pin openings. In two patients post-operative pneumothorax lasted for 3 and 5 days respectively. In the patient with post-radiation deformity the skin was atrophic. The upper ends of the rods perforated and 8 months postoperatively, the rods were removed.

CASE REPORT

The greatest reduction of the kyphosis, 106 degrees, was obtained in a 12-year-old girl (A.B.) with a huge congenital kyphosis due to small dorsal hemivertebrae of T11 and T12 (Figure 1a–d). She had increased tendon reflexes of the legs and a myelographic block at T11–12. The spinal block pressure, pressure on the spinal cord (Magnaes 1982), was increased to 600 mmH_2O and Queckenstedt's test was positive.

Halo-pelvic traction for 2½ months increased the girl's height 20 cm and reduced the kyphosis from 133 to 30 degrees. No neurological complications occurred. Control myelography showed a subtotal block, and the block pressure was reduced to 300 mm H_2O.

Through a left transthoracic-retroperitoneal approach with splitting of the diaphragm, the vertebral column was exposed. Anterior decompression of the spinal cord was accomplished by removing the T11–T12 microvertebrae. The resected rib was placed as two inley grafts side by side in front of the spinal cord from T9 to L2, and a solid, corticocancellous graft of homologous bone was wedged into the gap between T10 and L1. Three weeks later, a posterior fusion from T8 to L3 was done using two Harrington compression rods. The halo-pelvic apparatus was replaced by a polypropylene body jacket 2 months after the posterior procedure, and the total immobilization time was 15 months.

A stable fusion with the curve reduced to 27 degrees and a good cosmetic result was obtained. The tendon reflexes normalized, and control myelography showed a wide subarachnoid space around the spinal cord.

DISCUSSION

In five patients severe angular kyphosis was effectively reduced and securely stabilized by a three-stage procedure. Distraction with the halo-pelvic apparatus can be performed safely when the distraction forces are measured and the neurological status controlled daily. The total time in the apparatus should preferably not exceed 4 months because complications from the cervical spine may occur in prolonged traction and immobilization (O'Brien 1975). The halo-pelvic apparatus gives a more efficient distraction than the halo-femoral traction, gives excellent post-operative support, and allows immediate ambulation after anterior as well as posterior fusion.

This is a great advantage as compared to the 6 months of recumbency advocated by Winter et al. (1973) and Bradford et al. (1977).

Although progressive kyphosis narrows the spinal canal and may lead to compression of the spinal cord, one cannot expect correction by distraction to relieve the pressure on the spinal cord shown in patient A.B. It is therefore important to repeat the myelography before the anterior operation to decide whether anterior decompression should be done. Posterior decompression by laminectomy is no alternative to anterior decompression in this group of patients. The an-

terior approach provided an excellent exposure of the spine for both decompression and fusion. A close cooperation of an orthopaedic, neurosurgical, and thoracic team is, however, essential. A posterior fusion using the Harrington compression instruments adds further correction and stabilization, and prevents recurrence of the kyphosis in children owing to posterior growth.

We have used a combination of autogenous and homologous bone and have not observed any adverse effects in the ossification process.

Minor complications have been relatively frequent, but have not influenced the end result. Infection around the pelvic pins was efficiently treated by appropriate antibiotics. In particular, there was no damage to the spinal cord from traction and the division of several segmental vessels.

REFERENCES

Bradford, D. S., Winter, R. B., Lonstein, J. E. & Moe, J. H. (1977) Techniques of anterior spinal surgery for the management of kyphosis. *Clin. Orthop.* **128**, 129–139.

Chou, S. N. (1977) The treatment of paralysis associated with kyphosis. *Clin. Orthop.* **128**, 149–159.

Magnaes, B. Clinical recording of pressure on the spinal cord and cauda equina. Part 1. The spinal block infusion test, method and clinical studies. In manuscript.

O'Brien, J. P. (1975) The halo-pelvic apparatus. *Acta Orthop. Scand.*, Suppl. 163.

Riseborough, E. J. (1973) The anterior approach to the spine for the correction of deformities of the axial skeleton. *Clin. Orthop.* **93**, 207–214.

Winter, R. B., Moe, J. H. & Wang, J. F. (1973) Congenital kyphosis. *J. Bone Joint Surg.* **55**-A, 223–256.

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