Technical note

Rib bone graft for posterior spinal fusion in children

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ABSTRACT – Treatment of columnar instability in children with conventional fusion procedures may preclude normal growth and cause dysfunction and pain due to malalignment or reduced mobility. To achieve normal growth, we have treated spinal instability in 7 children with posterior fusion, using bilateral rib transplants secured by horizontal laminar cerclages. Solid fusion was obtained and no serious complications occurred.

The goals of treatment for columnar instability in children are reduction, stabilization, and maintenance of alignment without compromising normal growth. Most procedures using rods, screws, autologous bone or a combination of these have one or several segments rigidly fixated that may interfere with bone growth and cause malalignment or dysfunction. To obtain good long-term functional results, we used autologous rib transplants with laminar cerclage fixation.

Technique (Figure 1)

Children with cervical instability were stabilized by a traction tong before intubation and positioning. The laminas of the involved vertebrae were exposed by subperiosteal dissection via a posterior approach. The correct level could be verified by fluoroscopy, if necessary. String wires were inserted below each lamina on both sides above

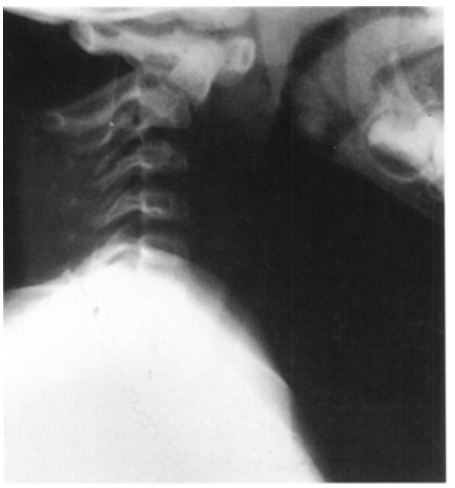
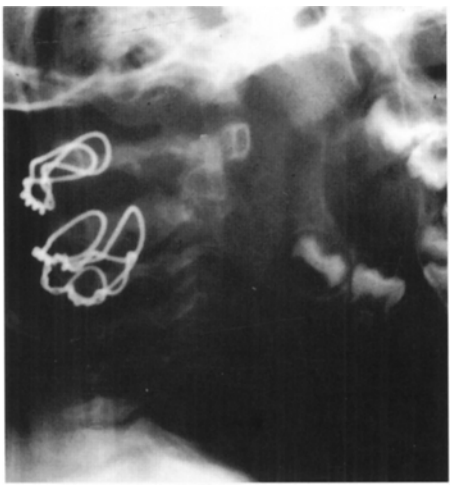


Figure 1. A dens fracture with C1-2 dislocation was sustained by a 9-year-old boy after a fall from a height.



Normal alignment after fixation of C1-3 with a rib bone graft and cerclages.

Patients operated on with rib fusion

Case	Sex	Age	Mechanism	Symptoms	Injury	Level	Follow-up (year)
1	M	2	Traffic accident	Pain	Subluxation	C2-4	19
2	F	2	Traffic accident	Pain	Dens fracture	C1-2	1
3	M	9	Fall from height	Pain	Dens fracture	C1-2	0.5
4	M	5	Violent game	Torticollis	Subluxation	C1-2	0.5
5	M	4	Traffic accident	Paraparesis	Fracture-dislocation	Th2-3	0.3
6	M	1	Congenital	Kyphosis	Larsen's syndrome	C1-3	1.5
7	M	6	Traffic accident	Paraparesis	Fracture-dislocation	Th12-L1	0.5

and below the segment(s) of instability. The 9th or 10th right rib was exposed and excised from close to the costotransversal joint to the axilla. Bilateral full-thickness rib struts were joined together with sublaminar wiring. In some cases, the rib was modulated by fracturing the corticalis on one side for optimal alignment. A postoperative chest radiograph was taken to exclude a pneumothorax.

Figure 2. A 21-year-old male who had been operated on at the age of 2 years with fixation of C2-4, showing normal alignment and fusion of the upper cervical spine.

Patients with cervical instability were mobilized early with a collar which was retained until the follow-up radiograph showed fusion and satisfactory alignment after 3–5 months.

Patients and results

We have operated on 7 children with laminar cerclages and rib transplants for spinal instability (Table), and achieved solid fusion in all. The 5 patients with cervical instability had no neurological deficits before or after the operation. Extension of the fusion mass was seen in 1 child. The mobility was normal in the cervical cases. No serious morbidity or complications at the graft site occurred.

We have one long-term follow-up. At the age of 2 years, the child was hit by a car, sustained a subluxation at C2-3 and C3-4 and instability with kyphosis. He was operated on using sublaminar wires below C2, C3 and C4 on both sides and rib transplants. He was neurologically intact after the operation, and lateral cervical radiographs showed restoration of anatomical alignment. 19 years later, he still has no complaints, a normal total range of mobility, and has started a military career. Radiographs show normal alignment and solid fusion of the upper cervical spine (Figure 2).

Discussion

Most posterior cervical fusion techniques still require bone grafts for ultimate stability. The iliac crest is the commonest source of autologous graft material. A major limitation of iliac crest harvest is donor-site morbidity (Summers and Eisenstein

1989, Sawin et al. 1998). As compared to the iliac crest, a rib autograft is rarely used in cervical spinal fusion constructs. However, the rib is an expendable and readily accessible source of corticocancellous bone graft material, which has a curvature that conforms well to the configuration of the recipient bed in normal cervical lordosis. A theoretical disadvantage of this graft source is the possibility of complications, including pneumothorax and chronic donor-site pain.

In a recent retrospective analysis of 600 consecutive cervical fusions, 300 patients underwent rib harvest and 300 had an iliac crest harvest (Sawin et al. 1998). Rib autografts yielded a lower donor-site morbidity (4% versus 25%), and neither pneumothorax nor intercostal neuralgia was seen. The healing rate (~ 95%) was the same for both types of graft.

In a series of upper cervical spine fusion using an autologous iliac crest bone graft in children (Lowry et al. 1997), fusion occurred in all 25 patients. The success rate in most published series concerning cervical spinal arthrodesis with autogeneic bone grafts mainly deals with the fusion rate and neurological outcome. Less attention has been paid to function and long-term disability that may be associated with growth disturbances and malalignment. However, in a study arthrodesis of the cervical spine in children and adolescents (McGrory and Klassen 1994), who were followed for a minimum of 7 years, mobility decreased with time after surgery. It was associated with an increase in osteoarthrotic changes on radiographs. Spontaneous extension of the fusion mass was seen in one third of the patients.

Posterior spinal fusion of the upper cervical spine is a reliable, safe, and predictable procedure, but extra caution should be used when considering arthrodesis in patients with ongoing spinal cord compression, fixed dislocations, and inherited laxity of the ligaments (Smith et al. 1991). Although we have only one long-term follow-up, the use of rib transplants secured by horizontal cerclages probably allows normal growth, and the donor-site morbidity is low.

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