Support of the anterior column with allografts in tuberculosis of the spine

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Fresh-frozen allografts from the humerus were used to help to stabilise the spine after anterior decompression for tuberculosis in 47 children with a mean age of 4.2 years (2 to 9). The average angle of the gibbus, before operation, was 53°; at follow-up, two years later, it was 15°. Rejection of the graft or deep sepsis was not seen. Cross trabeculation between the allograft and the vertebral body was observed at six months, with remodelling occurring at approximately 30 months.

Received 21 July 1998; Accepted after revision 22 September 1998

In 1956, Hodgson and Stock\(^1\) described a radical operation which involved resection of a tuberculous (TB) lesion in the spine with reconstruction of the defect using ribs and grafts from the iliac crest. A controlled trial of various methods of treatment was carried out by the British Medical Research Council Working Party on spinal TB.\(^2\)\(^-\)\(^5\)

Information gathered over the last ten years has shown that chemotherapy together with the modified Hong Kong operation produced the best results. Residual kyphosis and loss of correction, however, were observed with all methods of treatment. Long-term results have shown that radical anterior surgery alone limits the capacity for remodelling of the spine.\(^6\) The one-stage combined Kalfong procedure allowed for significant correction of long-standing rigid kyphosis.\(^7\) We have found that fresh frozen allografts combined with a posterior spinal fusion are suitable alternatives to autologous rib and iliac grafts for restoring and maintaining the sagittal profile of the spine.

Patients and Methods

The incorporation of fresh-frozen allografts was evaluated prospectively in 47 children who had had an anterior spinal decompression between 1991 and 1995 in the treatment of paraplegia secondary to TB. The allografts, which were obtained from the National Tissue Bank (Bone SA), were harvested according to the guidelines set by the American Association of Tissue Banks. Potential donors with malignancy, hepatitis, septicaemia, death due to an unknown cause and of known high risk (HIV-positive, AIDS, drug abuse, homosexuals, prostitutes and haemophiliacs) were excluded. The remainder were screened for hepatitis, HIV and venereal diseases. A blood culture for aerobic and anaerobic organisms was undertaken and multiple bacteriological cultures of soft tissue and bone marrow were obtained during the recovery phase of banking. Bone was harvested within 24 hours of death under sterile conditions and stored at -80°C. The soft tissues were removed and the bone sprayed under high pressure to remove fat, blood and marrow, and then rinsed in 70% alcohol. The allograft was dried, packed, frozen, sterilised by gamma irradiation (2.5 mrad) and stored at -80°C.

There were 32 boys and 15 girls with a mean age of 4.2 years (2 to 9). The mean duration of the paraplegia was nine weeks (6 to 17). In 40 patients, the lesions were confined to the lower dorsal region, the dorsolumbar junction and the lumbar spine (Figs 1a and 1b, 2a and 2b). The mean number of vertebral bodies involved was 2.5 (1 to 4) and the mean angle of the kyphosis as described by Konstam and Blesovsky,\(^8\) was 53° (15 to 94). Three consecutive vertebral bodies were involved in 28 children, and concurrent pulmonary TB was present in 34. In 23 children, the plasma albumin was <30 g% and 24 were anaemic (Hb<10 g%).

Spinal decompression was carried out once the patient had achieved adequate nutrition and lung function. A left thoracotomy was used to expose thoracic lesions and the retroperitoneal route for the lumbar spine. A left anterior approach was utilised for lesions involving the cervical spine and the cervicodorsal junction. The diseased vertebral bodies were excised and the spinal cord was decompressed from the ventral, lateral and medial aspects. Compression was due to bony sequestra, disc material and an extradural cuff of granulation tissue. Adhesions tethering the dura at
the apex of the deformity were carefully released. Simultaneously, the gibbus was exposed through a posterior incision. The interspinous ligaments and the cartilaginous caps over the tips of the spinous processes were removed and the facet joints denuded of articular cartilage. The spinous processes and ribs were used as grafts, posteriorly. Posterior fusions were not carried out for lesions involving the cervical spine. The anterior column was gently distracted by spreaders and manual pressure applied over the gibbus, taking care to avoid any tension on the spinal cord. The medullary cavity of an appropriate segment of allograft was thoroughly cleaned; the rib harvested at thoracotomy was morsellised and compacted into the medullary cavity. The mean length of the allograft was 4.2 cm (2.4 to 6.8) (Fig. 1c). The prepared graft was then introduced and the image intensifier used to verify its position. The spinal cord was assessed for any excessive tension. After the wounds had healed the children were mobilised in a plaster cast. Appropriate chemotherapy was administered for 18 months.

Results
The mean follow-up was 39 months (27 to 79) but eight patients were lost to follow-up after one year. Complete
neurological recovery was observed in 45 patients within six months, with partial recovery in the remaining two. All achieved significant correction of the gibbus with an average kyphosis of 15° at two years (3 to 32) (Fig. 2c). The correction was maintained at the final follow-up. Cross trabeculation between the allograft and vertebral bodies was seen at six months. Between 18 and 30 months the cortex and medulla were indistinguishable due to remodelling (Figs 1d, 1e and 1f). Incorporation of the allograft was not affected by the level of the lesion, the age of the patient or the length of the allograft (Fig. 3).

**Complications.** Superficial wound sepsis was seen in five children, but resolved uneventfully. There were no instances of deep sepsis or of rejection. Six patients developed bronchopneumonia during the immediate postoperative period. This resolved with appropriate antibiotics and physiotherapy.

**THE JOURNAL OF BONE AND JOINT SURGERY**
Discussion

Femoral ring and fibular allografts have been used successfully as interbody grafts in degenerative disorders, congenital and post-traumatic kyphosis and as a spacer after resection of a tumour involving the vertebral body. The risk of transmitting disease by using fresh-frozen allografts is of concern. This problem can be minimised if allografts are harvested from selected donors under sterile conditions and subjected to standard forms of processing with adequate microbiological monitoring. It is important to keep accurate medical histories of donors and the results of tests used to confirm sterility and the absence of transmissible disease. Cortical allografts usually evoke an intense immune response which enhances bone resorption and delays revascularisation. When fresh cortical allografts are stabilised under compression, however, osteo-induction and osteoconduction can occur, even in the presence of an immune response. After one year such allografts may be structurally and mechanically similar to autografts.

We have found rib autografts to be inadequate to support the anterior column in children if more than two vertebrae are resected. The ribs in children are very tenuous, particularly the lower ones. They do not provide adequate stability to the anterior column due to plastic deformation and to the small surface area of contact with the adjacent normal vertebral bodies. Using the cortical allograft, the kyphosis was noted to progress due to slippage or fracture of the graft after anterior surgery only in severe kyphosis. Rajasekaran and Soundarapandian showed an increase in the gibbus after radical surgery when only one rib graft was used or when the grafts fractured, slipped or were resorbed. Fractures occurred more often when the two most caudal ribs were used and when the graft had to span more than two vertebrae. Jenkins et al suggested that the strength of rib strut grafts in children was insufficient to support the anterior column. They noted a progressive increase in kyphosis at five years, but with no further significant change after ten. In severe thoracic deformity radical anterior surgery alone limits the capacity for remodelling of the spine. Our experience and that of Schultitz et al suggest that a simultaneous posterior fusion should be carried out to prevent an increase in kyphosis. Louw using the Kalafong operation consisting of a vascularised rib pedicle graft, posterior osteotomy and instrumentation, found a sound bony fusion within six months. The procedure gave a significant correction of the deformity with restoration of the normal sagittal profile, but required additional time and expertise to harvest meticulously a viable vascularised rib as a pedicle graft.

Failure of structural allografts is usually due to infection or fracture. We have not seen either in our patients. This may be due to the increased osteogenic potential in children and diminished adherence of the acid-fast bacillus to foreign bodies. Successful incorporation of the allografts was helped by a significant increase in the area of contact between the adjacent normal vertebral bodies and the placement of grafts under compression which improved stability and allowed early axial loading. The intramedullary rib graft may have enhanced the osteogenic potential of the allograft.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References