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ORIGINAL PAPER

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Cortical allografts in spinal tuberculosis

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Abstract One-hundred-twenty-three patients with neurological deficit due to spinal tuberculosis underwent anterior spinal decompression and anterior column reconstruction with fresh-frozen femoral allograft. Fifty-two patients with a follow-up of more than 5 years were evaluated to assess the incorporation and the efficacy of allograft in maintaining correction. The allograft was incorporated in 49 patients at a mean follow-up of 6.5 (5.3–8.2) years. Complete neurological recovery occurred in 39 patients. The mean pre-operative kyphosis of 37° (15°–67°) was corrected to 18° (5°–45°). Fresh-frozen allografts are a suitable alternative to autologous rib and iliac crest grafts in the treatment of spinal tuberculosis.

Résumé Cent vingt trois malades avec un déficit neurologique dû à une tuberculose vertébrale ont subi une décompression antérieure et une reconstruction de la colonne rachidienne antérieure par allogreffe fémorale congelée. Cinquante deux malades avec un suivi de plus de cinq années ont été évalués pour apprécier l'incorporation et l'efficacité des allogreffes dans le maintien de la correction. Les allogreffes ont été incorporés chez 49 malades ayant un suivi moyen de 6.5 années (5.3–8.2). La récupération neurologique complète s'est produite chez 39 malades. La cyphose pré - opératoire moyenne de 37° (15–67) a été ramenée à 18° (5–45). Les allogreffes congelées sont une alternative convenable aux greffes autologues de côte et de crête iliaque dans le traitement de la tuberculose vertébrale.

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Introduction

Previous studies have reported an increase in tuberculous kyphosis of between 11° and 30° in patients treated with chemotherapy alone [16, 20, 21, 27]. The progressive kyphotic deformity following anterior spinal decompression and fusion has been linked to the status of the graft material [1, 2, 12, 22]. Hodgson and Stock [12] reported rib graft fracture and slippage in 12% of patients. Bailey et al. [1] noted an increase in kyphosis of 22° due to rib graft failure following anterior spinal decompression and fusion. In this study, we evaluated the long-term (5.3–8.2 years) results of the incorporation of fresh-frozen allografts in adults following anterior spinal decompression for tuberculosis.

Patients and methods

Between February 1994 and January 1997, 123 adults with spinal tuberculosis underwent anterior spinal decompression and reconstruction with fresh-frozen femoral allografts at our institution. A retrospective clinical and radiographic review was performed on 52 patients with a follow-up of more than 5 years. There were 19 males and 33 females, with a mean age of 38.3 (range 19–62) years. The co-morbidities in this study group included three diabetics on oral hypoglycaemic agents, a further two patients were diagnosed as diabetics during the pre-operative evaluation and a known rheumatoid who was on steroid therapy for 10 years. Sixteen patients were treated for pulmonary tuberculosis in the past and 23 patients had a family history of tuberculosis. Apart from constitutional symptoms (loss of weight and appetite and night sweats), all patients reported unremitting back pain and progressive deformity prior to the onset of neurological symptoms. The Frankel [6] grading system was used to classify the neurological status [F(A) 8, F (B) 27, F(C) 17]. The dorsal spine was affected in 46 patients and the lumbar spine in six; in 12 patients, more than two contiguous vertebral bodies were infected. The deformity, which measured 37° (range 15–67°) on supine lateral radiographs, was the angle subtended between the superior and inferior uninvolved vertebral bodies above and below the lesion respectively.

The haemoglobin was 9.1 g/cm (range 7.4–11.5 g/cm), and the serum albumin measured 27g/dl (range 19–38g/dl). The erythrocyte sedimentation rate (ESR) was elevated in 46 patients (mean 41 mm/h Westergren, range 37–54 mm/h). Pre-operative nutrition-

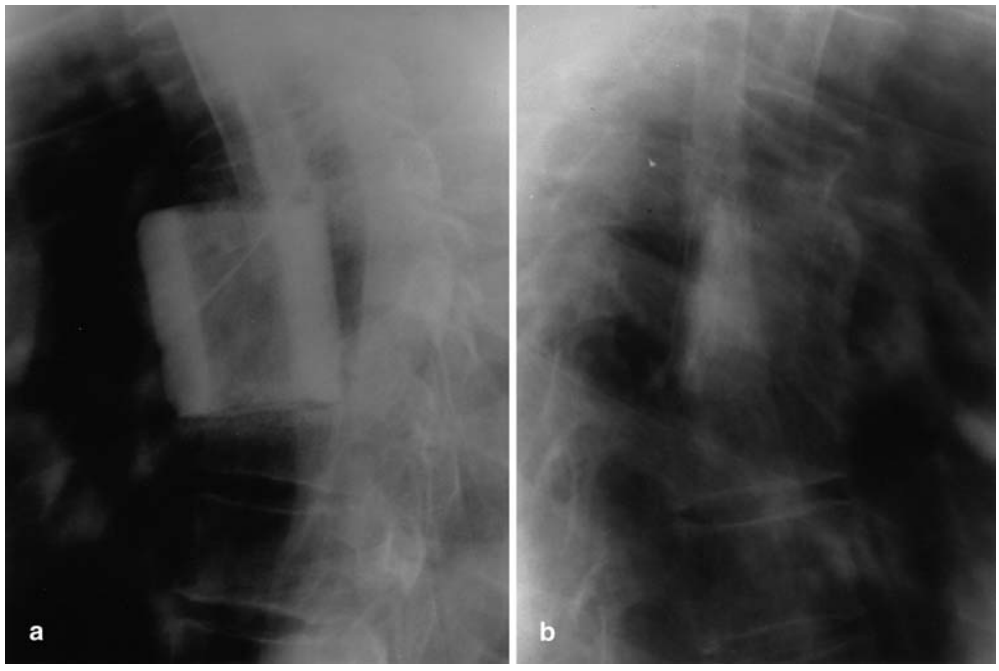

Fig. 1a–b Post-operative and follow-up lateral radiographs at 5 1/2 years. Showing incorporation, remodelling and maintenance of correction

al support was provided for all patients prior to elective anterior surgical decompression.

A left transthoracic decompression was performed for lesions involving the thoracic spine, and a retroperitoneal approach was used for the lumbar spine. Pleural adhesions from previous pulmonary tuberculosis were noted in 14 patients. A radical debridement was performed in 48 patients (total excision of the involved vertebral bodies and the pedicles) and a partial excision in four patients to create a large surface area of contact between the vertebral body and allograft. The extradural granulation tissue was excised to decompress the spinal cord, and the fibrous adhesions over the lateral and anterior aspects of the cord that tethered it to the apex of the deformity were meticulously released. Gentle pressure was applied over the gibbus to assess the degree of correction and spinal cord tension. The medullary canal of an appropriate length (range 3.7–9.4 cm) of fresh-frozen femoral allograft was thoroughly cleaned and compacted with morselised rib graft harvested during the thoracotomy. The allograft/autograft composite was positioned by interference fit after applying pressure over the gibbus, and intraoperative imaging was used to confirm the appropriate placement of the allograft.

The mean operating time was 3 h 20 min (range 2 h 42 min–4 h 15 min), and mean blood loss was 742 (range 323–1540) ml. Post-operatively, intravenous antibiotics (cephalosporins) were administered for 24 h. The granulation tissue and sequestra were subjected to histological evaluation. A caesative granuloma was noted in 38 cases, and acid-fast bacilli were observed in 14 cases. In the remaining 14 patients, the features were those of chronic non-specific inflammation, and cultures were negative for pyogenic and fungal infection. Anti tuberculosis treatment was prescribed for a year (daily schedule: Rifampicin 600 mg, Isioniazid 400 mg, Pyrizinamide 1500 mg, Ethambutol 1200 mg). Follow-up anteroposterior and lateral radiographs were done at 3-monthly intervals for 12 months and thereafter at 6-monthly intervals.

Results

Mean follow-up was 6.5 (range 5.3–8.2) years. Neurological recovery, which was dramatic in 19 patients, commenced within 24 h following surgery and in 32 patients between two and 21 days. Thirty-nine patients (75%) recovered completely. Nine patients recovered partial motor function (Frankel grade C, D), four of who were community ambulators and six who remained incontinent. Three patients regained sensation without motor recovery and one patient, who developed sudden onset paraplegia (Frankel grade A) made no recovery. Two diabetics recovered completely, and the remaining three patients made a partial recovery.

Allograft incorporation was assessed with anteroposterior and lateral radiographs and at 12 months there was no evidence of fusion; however, graft slippage occurred in three patients. The criteria of Bridwell et al. [3] was used to assess allograft incorporation (grade 1 fused with remodelling and trabeculae present, grade II intact and not fully incorporated and remodelled, grade III intact with potential lucency present at the top or bottom of graft, grade IV fusion absent with collapse and resorption). At 2 years, 49 patients had a grade II fusion, and at final follow-up (mean 78 months) incorporation and remodelling (grade I fusion) was evident in 36 patients (68%) (Fig. 1). Thirteen patients (25%) including the five diabetics and the known rheumatoid had a grade II fusion (Fig. 2). Nine degrees (range 9–22°) loss of correction was recorded as a result of graft slippage in three patients who had a grade III fusion, but neurological recovery was not compromised. At the last review (mean 78 months), pre-operative kyphosis, which measured 37° (range 15–67°) was corrected to 18°(range 5°–45°). Forty-one patients (71%) were asymptomatic, nine—including three with slipped allografts—had back pain following strenuous activity, and the remaining two required intermittent medication for back pain. Twenty-one (40%) were employed as physical labourers prior to hospitalisation; 16 returned to their previous occupation, three

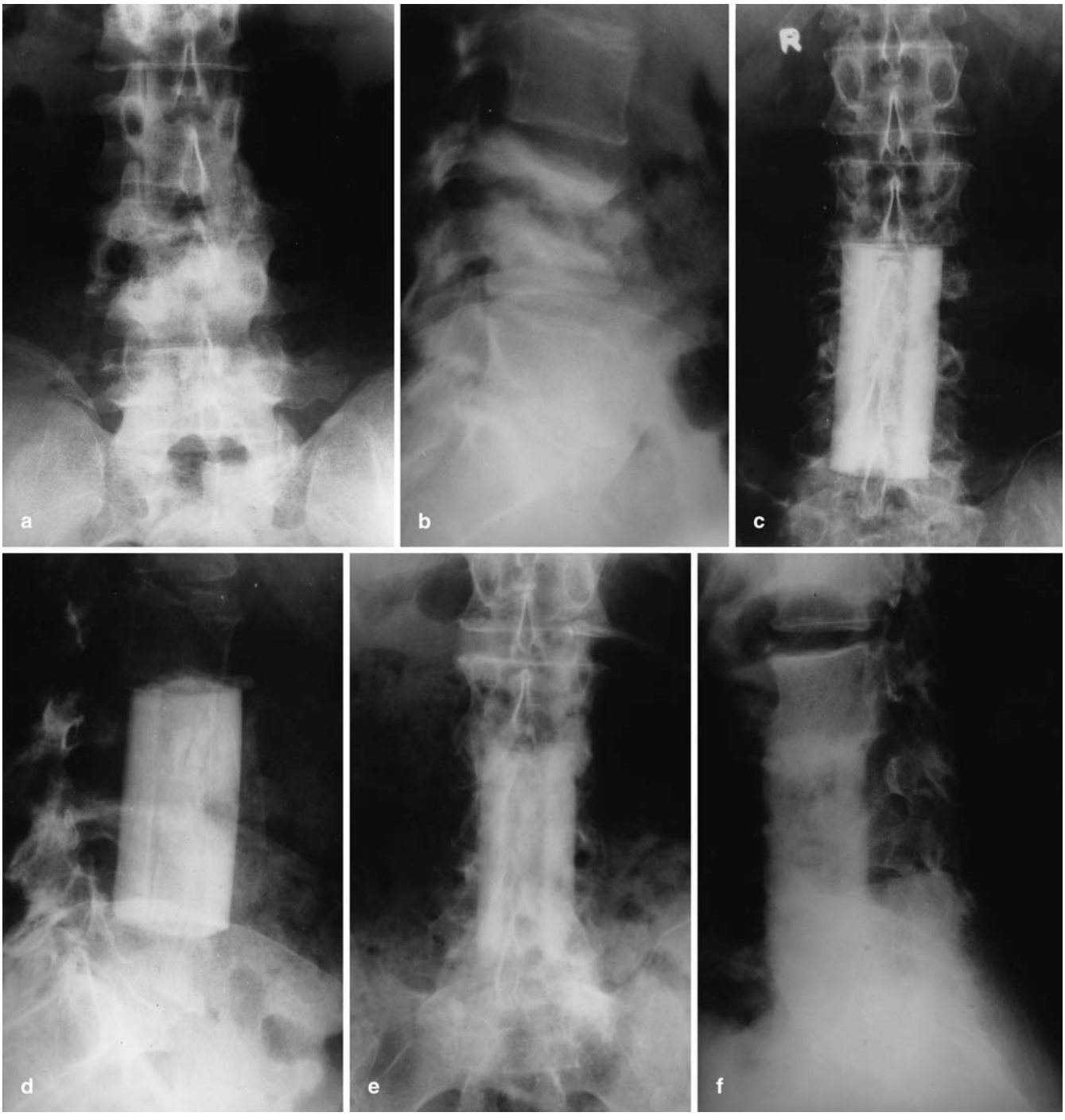

Fig. 2 a, b Infective lesion at L3/4; **c, d** post-operative views demonstrating correction; **e, f** incorporation and partial remodelling at 7-year follow-up

were doing light work and the remaining two were retrenched.

Complications

Seventeen patients (28%) who underwent a transthoracic decompression developed post-operative pulmonary complications, with atelectasis in five patients. Bronchoscopy was performed in three patients who had a poor cough reflex to clear secretions and mucous plugs. Six patients (10%) had wound dehiscence with superficial infection, and pus swabs yielded *S. aureus* in two, *S. epidermidis* in one, and no growth in three. Pulmonary complications and wound infections resolved without any sequelae. There were no wound complications in the five diabetic patients and the one on steroid therapy for rheumatoid arthritis.

Discussion

The World Health Organisation (WHO) reported that mortality following tuberculous infection was nearly three million per annum [28]. In sub-Saharan Africa, the incidence of tuberculosis has dramatically increased, and one of the main reasons for the resurgence is the spread of human immunodeficiency virus (HIV). The spine is affected in 40–60% of cases of osteoarticular tuberculosis [24].

Kemp et al. [15] reported a 32% incidence of autogenous rib-graft failure in adults, resulting in an average increase in kyphosis of 20° following anterior spinal decompression for tuberculosis. Rajasekaran and Soundapandian [26] obtained a stable rib graft construct in only 41% of patients at a minimum of 8 years follow-up. Graft slippage was observed in 24%, resorption in 20% and graft fracture in 12%. We reported an increase in kyphosis of between 5 and 20° 1–4 years following anterior spinal decompression and rib grafting in 117 patients with tuberculosis [8]. Graft failure was encountered when the small and tenuous lower ribs (10–12) were harvested for lesions of the lower thoracic spine. The graft may be resorbed even if there is no active disease, or it may subside further into cancellous bone resulting in an increase in kyphosis [14, 15, 17]. The advantages of autogenous cortico-cancellous bone grafts are their immuno-compatibility, no risk of disease transfer and their osteoinductive capability. The disadvantages in their use include limited quantity of bone available, inadequate structural support and donor site morbidity [4, 23]. The rib graft is subjected to excess loads, with enormous forces transmitted across the graft. If it spans more than two levels, graft fractures may occur [24, 26]. Despite an intact cortical shell, their weakness can be attributed to the unfavourable length/width ratio, the curvature and the small surface area of contact with the adjacent vertebral endplates [31].

Early concerns about the quality of donor bone have centred on establishing criteria to ensure disease-free sterile allografts for transplantation. It is estimated that the chance of transmitting HIV from allograft bone is less than 1:1,000.000 [13]. In this study, the fresh-frozen allografts were obtained from the National Tissue Bank, and the harvesting and preparation of allografts have been previously reported [9]. There are two primary indications for the use of allograft bone viz. insufficient autograft and the need to provide immediate structural support [4]. In adults, femoral ring and fibular allografts have been successfully used as interbody grafts in degenerative disorders, congenital deformities, post traumatic kyphosis and following the resection of vertebral body tumours [3, 4, 5, 10]. The use of allografts affords considerable time saving during surgery and obviates potential donor-site morbidity.

The duration of biological incorporation of fresh-frozen cortical allografts is of clinical importance because it is frequently slow and unpredictable, resulting in non-union and fatigue fracture [29, 30]. Several investigators have hypothesised that at least some of these complications are mediated immunologically because measurable humoral responses to donor tissue antigens have been noted in 5–14% of patients [29, 30]. The incidence of infection related to the use of large allografts was approximately 5% in patients who had treatment for bone tumours, and 4% in patients who had revision hip arthroplasty [7, 9, 31] An infected graft bed may deter an early successful fusion, and it is possible that the chronic low-grade infection of tuberculosis may delay incorporation and remodelling.

Although it has been recommended that allografts not be used in the presence of infection, we observed no late sepsis of allografts in this study. Oga et al. [25] have shown that the adhesion of bacteria occurred along inert surfaces, with a polysaccharide film protecting the bacteria. The adhesive properties of mycobacterium tuberculosis produced less biofilm on foreign material when compared to other bacteria. Several studies [11, 18, 24, 32] have demonstrated that the use of instrumentation either anteriorly or posteriorly in the treatment of spinal tuberculosis did not aggravate the infection. Although posterior instrumentation was used to correct the kyphotic deformity in tuberculosis, instrument failure and recurrent deformity were reported as a result of inadequate anterior structural support with autografts [24]. Additional posterior stabilisation with instrumentation prolongs the operating time and increases blood loss, resulting in a higher complication rate—especially in this group of patients who are immunocompromised and nutritionally depleted.

All three cases of graft slippage occurred in the thoracic spine between 3 and 6 months, despite post-operative orthotic treatment. Radical debridement involving multiple vertebral bodies results in a potentially unstable spine. Although the interference fit of the allograft created a relatively stable construct, additional stabilisation with instrumentation is warranted when multiple vertebral bodies are resected—especially in junctional areas—to minimise graft slippage and promote union. Intra-operative imaging is essential to prevent oblique placement of the allograft, which may predispose to slippage, loss of correction and delayed union.

Yilmaz et al. [32] reported on 38 cases of spinal tuberculosis. In ten patients (26%), the anterior column was reconstructed with a fibula allograft/autograft composite and stabilised with an anterior plate screw device. Clinical and radiological union, which was achieved in all patients between 3 and 6 months, occurred much earlier than those reported in other studies [3, 4, 5, 9]. The early fusion may be attributed to the increased stability of the construct with instrumentation. In addition, the fibula allograft, which has a thinner cortex and smaller surface area, may incorporate and remodel earlier when compared to a femoral allograft.

Bridwell et al. [3] believed that anterior column support with allografts was effective only if combined with rigid posterior instrumentation. At a minimum follow-up of 2 years, of six patients who had reconstruction of

the anterior column for spinal trauma, solid fusion (grade 1) was achieved in five and a grade II fusion in one. The earlier incorporation of the allograft/autograft composite reported by Bridwell et al. [3] may be due to a healthy host bed, shorter segment allograft as a result of single-body resection and stabilisation with instrumentation.

The increased compressive strength and large surface area of contact of femoral allografts provided a stable construct to promote neurological recovery. Stabilisation with instrumentation is recommended in patients with extensive disease to enhance stability, prevent slippage and promote early fusion.

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