

Fractures of allografts used in limb preserving operations

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SUMMARY

One hundred and thirty-seven allografts used since 1986 in limb preserving operations for malignant bone tumours were reviewed. The follow up was longer than two years. There were fourteen fractures (10.2%) in twelve patients at a mean time of 22 months from the operation. Most of them were in the metaphyseal area and were related to perforations of the allograft made for stabilisation with plates, for tendon and ligament reattachment, or any other hole in the allograft. Fractures occurred always after the allograft-host junction was united. Healing was achieved in 7 cases by internal fixation with autologous bone grafting in a mean of 5 months. In cases of multiple fractures of the allograft, the graft was exchanged. We recommend using intramedullary fixation in order to reduce the incidence of allograft fracture, and the use of internal fixation, with intramedullary whenever possible, and autologous bone grafting to achieve consolidation of the fractures.

RÉSUMÉ

Nous présentons notre expérience 137 allogreffes avec un recul moyen supérieur à deux ans, utilisées depuis 1986 dans la chirurgie reconstructive des sarcomes osseux. Nous avons eu quatorze fractures chez douze patients (10.2%) après un délai moyen Post operative de 22 mois. La plupart étaient métaphysaires en relation avec les perforations nécessaires pour l'ostéosynthèse, pour attaches tendineuses ou d'autres trous sur l'allogreffe. La fracture de l'allogreffe s'est toujours produit nécessaires pour e après a consolidation avec l'os receveur. La consolidation fut obtenue chez sept patients, après ostéosynthèse avec autogreffe, en cinq mois de moyenne. En cas de fractures multiples de l'allogreffe, celle-ci fut remplacée. Les auteurs recommandent l'utilisation des clous endomédullaires afin de réduire la fréquence des fractures, ainsi que l'ostésynthese interne (endomédullaire si possible) associée a une autogreffe afin d'obtenir la consolidation des fractures.

INTRODUCTION

Fracture of an allograft is one of the significant complications in limb preserving operations for malignant bone tumours. The incidence has been reported to be between 10% and 19% [2, 5]. Fractures of allografts decrease the success rate for these procedures. Some authors have recommended exchange of a fractured allograft because of its limited intrinsic potential for healing. The purpose of this paper is to report our experience with this complication in limb preserving operations for malignant bone tumours.

PATIENTS AND METHODS

Since 1986, 184 consecutive massive bone allografts have been used in our Department for the reconstruction of defects created by resection of primary malignant bone tumours. We reviewed 137 allografts with a follow-up of more than two years. The mean age of the recipients was 19 years (range 4 to 69 years). Allografts were harvested under sterile conditions from cadaveric donors, and cryopreserved following the criteria of the American Association of Tissue Banks. Antibiotic prophylaxis was ensured with cefazoline for 3 weeks, while no immunosuppressive treatment was given. External radiation (40 to 60 Gy) was used as antitumour therapy in 37 patients who received an allograft. Radiographs of the operated limb were taken at regular intervals during follow up. The mean follow up was 66 months (24 to 114 months).

We have evaluated the number of fractures in these allografts and the factors which could have influenced the occurrence of the fractures including the type of allograft, its location, the method of internal fixation, the time after operation and anti-tumour therapy. The treatment of the fractures was also assessed.

RESULTS

There were 14 fractures in 12 allografts (10.2%). In 2 cases the patient sustained 2 fractures in the same allograft, but at different times. Eleven fractures were in the metaphyseal area. All occurred after union had occurred at the allograft-host junction. On average, the fracture occurred 22 months (range 12 to 54 months) after the limb preserving operation.

There were no statistically significant differences in procedure ratio regarding type or location of the allograft (Tables 1, 2). Of the 37 patients who were given external radiation as antitumour therapy, 4 sustained a fracture, whereas 8 of the 100 patients who did not receive radiotherapy had a fracture. Table 3 shows that there were more fractured allografts where plates were used for internal fixation.

In 11 cases the fractures began at the perforation made in the allograft for the screws, for tendon and ligament reattachment (Fig. 1), and for inserting staples and Kirschner wires. In the 2 cases of double fractures, the second fracture occurred at the site between the two internal fixation devices, one of which had been used for stabilisation at the allograft-host union and the other for management of the first fracture (Table 4). The treatment of these fractures is shown in Table 5.

DISCUSSION

The incidence of fracture and allografts in our series is similar to others [2, 4-6, 8], as was the most frequent of most the allograft fractures in the metaphysis. The type or location of the allograft seemed to have no influence on the risk of fracture in our series. This has also been reported by Thompson [8].

The fracture usually occurred when the allograft was healed. The mean time for union at the diaphyseal junction was 16 months in our series [7] and was influenced by chemotherapy, external radiation treatment and the age of the patient. If a fracture at the allograft junction did not unite, the internal fixation device was more likely to break. Furthermore, the allograft seemed to be more susceptible to fracture once it had become revascularised [1].

Some authors report a higher incidence of fractures in patients who were given chemotherapy [6, 8]. In our series, 132 out of 137 patients had this type of treatment; in the 5 who did not, there were no fractures. In comparison, the healing of an allograft fracture occurred faster in our series than healing at the allograft-host junction, which may be because the patients were not longer on chemotherapy when the allograft fracture healed [7]. The mean time when a fracture occurred was 22 months, while the chemotherapy usually lasted one year.

Our study shows that perforation of the allograft correlates with an increased risk of fracture. Most fractures occurred when plates and screws were used or when perforations were made for tendon and ligament attachment. We are, therefore, in favour of using intramedullary fixation whenever possible and others have reported similar results [6, 8, 10]. A nail protects the metaphysis and perforations of the allograft are avoided. In composite allograft-prostheses used for the knee, we have preferred a long prosthetic stem in order to stabilise the allograft-host junction and, in such cases, fracture of the allograft was rarely seen. The time for union at the junction was the same in our series whether plates or intramedullary devices were used [7].

Several methods have been proposed for the treatment of allograft fractures. Some have recommended exchanging the allograft in cases of fracture through it because of the limited intrinsic potential for healing [9, 10]. Amputation of the limb has also been advised [10]. Our study shows that union of these fractures can be achieved by using internal fixation and autologous bone grafting (Fig. 2). Mnaymneh [6] used autografting in 2 out of 12 fractures, and union was achieved in one case. In our series, all the cases that were autografted united. We only advise a new allograft when internal fixation and autografting is not possible. We used this technique in one case of infection associated with the fracture and in five cases of comminuted fracture. In one of these, we removed only the fractured part of the allograft and implanted another allograft. Healing of the second allograft to the remaining part of the first allograft occurred (Fig. 3), which confirmed that it was possible to achieve not only the union of a fractured allograft, but also union between the 2 allografts.

In summary, fracture of an allograft is a complication of these limb sparing procedures which can be satisfactorily treated. Our series suggest that the complications of allograft fracture can be reduced to a minimum by using intramedullary fixation of the allograft-host junction. An allograft fracture can be treated successfully with internal fixation and autologous bone grafting.

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Table 1. Fractures according the type of allograft	
Type of allograft (n°)	Allograft fracture (%)
Intercalary (46)	7 ^a (15.2%)
Osteoarticular (26)	4 (15.4%)
Composite allograft-prosthesis (48)	2 (4.1%)
Others (arthrodesis, pelvis ...) (17)	1 (5.8%)
^a Two of these were in the same allograft at different times.	

Table 2. Fractures according the location of allograft	
Location of allograft (n°)	Allograft fracture (%)
Femur (70)	6 ^a (8.5%)
Tibia (42)	6 ^a (14.8%)
Humero (12)	2 (16.6%)
Others (elbow, pelvis, ...) (13)	0 (0%)
^a One allograft sustained two fractures at different times	

Table 3. Number of fractures according the internal fixation device	
Internal fixation device	Allograft fracture
Notintra-medullary	11/59
Only Intra-medullary	0/59
Intra-medullary + plate	3/9
Others (pelvis, spine . . .)	0/10

Table 4. Details of the fourteen fractures

Number	Type of allograft	Location	Osteosynthesis	Causative feature	Treatment
1	Osteoarticular	Distal tibia	Plate	Hole for screw	Nothing
2	Knee arthrodesis	Distal femur	Intramedullary and plate	Hole for screw	OABG
3	Composite allograft-prosthesis	Distal femur	Intramedullary and plate	Hole for screw	Exchange of allograft
4	Intercalary	Femur	Plate	Hole for screw	Exchange of allograft
5	Intercalary	Proximal tibia	Plates	Hole for screw	Exchange of allograft
6	Osteoarticular	Proximal humerus	Plate	Hole for screw ^a	Exchange of allograft
7	Composite allograft-prosthesis	Proximal femur	Plates	Hole for screw	Exchange of allograft
8	Osteoarticular	Distal humerus	Plate	Hole for tendinous attach	OABG
9	Osteoarticular	Distal tibia	Plate	Hole for screw ^a	OABG
10	Intercalary	Proximal tibia	Plate and kirschners	Hole for kirschners ^a	OABG
11	Intercalary	Proximal tibia	Plate and staples	Hole for staples ^a	OABG
12	Intercalary	Proximal tibia	Plates	Fracture between two plates	Exchange of allograft
13	Intercalary	Femur	Intramedullary and plate	?	OABG
14	Intercalary	Femur	Plates	Fracture between two plates	OABG
^a The allograft was left unprotected in the metaphyseal area by the plate OABG = Osteosynthesis plus autologous bone grafting					

Table 5. Treatment of fractured allografts	
Treatment of the fracture	Allografts
Internal fixation + autografting	7
Removal of allograft and new allograft	6
None	1



Figure 1. Fracture in an osteoarticular allograft of the elbow at the site of a hole made for tendon reattachment

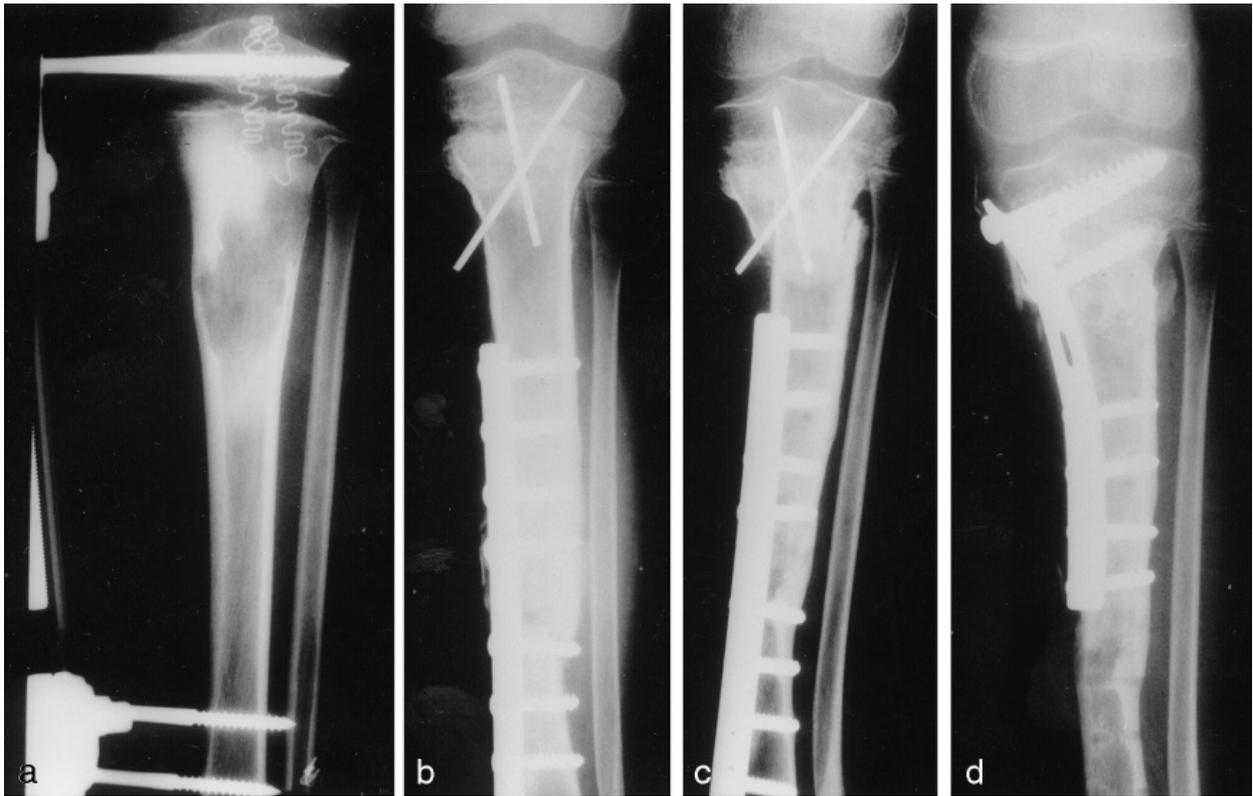


Figure 2. Osteosarcoma in the proximal metaphysis of the tibia in a 5 year old child. Physal distraction according to Cañadell's technique was used in order to preserve the joint. Intercalary allograft established with a plate at the diaphyseal junction and with two Kirschner wires at the metaphyseal junction. Fracture of the allograft through the holes of the Kirschner wires. Internal fixation and autologous bone graft were used and the fracture healed.



Figure 3. Composite allograft-prosthesis of the hip. The alignment between the allograft and the host bone is not perfect with a slight lateral displacement. Fracture of the allograft beginning at the hole for the second screw of the lateral plate. Union of the allograft-host bone junction occurred in spite of the lateral displacement. Operative radiograph showing the removal of the fractured part of the allograft preserving the non-fractured part which is healed to the host bone. Note the lateral displacement at the healed allograft-host bone junction. A second osteoarticular allograft was implanted together with an intramedullary nail, supplemented by an autologous graft. Healing was obtained between the first and the second allograft.