External fixation in tumour pathology

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SUMMARY

An appraisal of the clinical records of patients with malignant bone tumours enabled us to identify 61 whom we have treated by external fixation. There were 38 males and 23 females with ages ranging from 4 to 58 years, the mean being 14 years. The average period of follow-up was 6 years (1-12 years). For the purpose of our analysis the patients were divided into three groups according to whether the fixator was fitted before, during or after tumour resection.

RÉSUMÉ

Dans le traitement des tumeurs malignes des os, l'objectif n'est pas seulement de sauver la vie du patient, mais aussi de conserver les membres avec leurs fonctions et leurs longueur. Le sujet de cette étude est de rapporter notre expérience de l'usage des fixateurs externes dans la chirurgie des tumeurs. Sur tous les patients de la clinique, atteints de tumeurs malignes des os, nous avons été capable d'identifier 61 patients, dans 71 procédures, utilisant une fixation externe pour différentes raisons. Sur ceux-ci, 38 étaient des hommes et 23 des femmes. Leurs ages étaient compris entre 4 et 58 ans, la moyenne étant de 14. La moyenne de la période d'étude était de 6 ans (1-12 ans). Les patients ont été divisés en trois groupes: 1. Fixateur placéavant la résection de la tumeur. 2. Fixateur placé dans le cadre de la technique de résection de la tumeur, et de la reconstruction de l'os atteint. 3. Fixateur placé après la résection de la tumeur. Dans chacun des groupes, l'utilisation de fixateurs externes s'est révelé trés utile.

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INTRODUCTION

In the treatment of malignant bone tumours, the objective is not only to save the patient's life, but also to conserve the affected limb with its former length and intact function. New chemotherapeutic agents, improved radiotherapy and better methods of diagnostic imaging, have proved useful adjuncts to modern bone-reconstruction techniques [1-10, 13]. The aim of this study is to report our experience in the use of external fixators in 61 patients with malignant bone tumours.

PATIENTS AND METHODS

Between 1985 and 1995 we were consulted by over 300 persons with a malignant primary bone tumour. A review of the clinical records enabled us to identify 61 patients who had been treated by external fixation, in 71 procedures (Table 1). A unilateral fixator (Wagner or Mono-tube) was always employed (Fig. 1), because the surgical team have considerable experience in its use. In some instances the same fixator was used to fulfil different functions such as the use of a three-part fixator to achieve compression of the focus of a pseudoarthrosis and lengthening because of asymmetry. Post-operatively the patients were recommended to wash daily with soap and water to prevent infection of the pins.

They were divided into three groups according to whether the fixator was fitted before, during or after tumour resection.

Group 1
A pathological fracture had been treated by external fixation.

Group 2
Physeal distraction had been undertaken following tumour resection or bone transport was performed in order to reconstruct a bone defect. Others in this second group were those in whom a fixator was employed to maintain the position of the autograft used to reconstruct the bone defect at a time when no bone bank was available. In the remainder, a pathology report was awaited after resection of the tumour where it was uncertain whether or not the tumour had reached the epiphysis.

Group 3
These patients had been treated by external fixation at some time after primary oncological surgery had taken place for the treatment of asymmetry (bone lengthening), pseudoarthrosis, infection, correction of angular deformity, and rescue surgery for knee prostheses which had succumbed to bone reabsorption (Table 2).

Physeal distraction for metaphyseal malignant tumours in children is performed in three phases [2-4]. The external fixator is fitted so as to begin physeal distraction in the operating room, and this is continued at a rate of one or two millimetres per day until the two centimetre mark is reached, thus separating the epiphysis from the metaphysis. During the second stage, the fixator is removed and the tumour is resected in the diaphysis, leaving the recommended safety margin; local intraoperative radiotherapy is administered to the tumour bed. The final stage consists of filling the defect with an allograft or autograft held in place by stable internal osteosynthesis.

RESULTS

In a patient with a pathological fracture of the femur caused by an Ewing's sarcoma during radiotherapy, an external fixator was worn for the 24 days prior to tumour resection (Fig. 2). Another patient aged 58 years had a pathological fracture of the femur due to myeloma; consolidation was complete after 128 days stabilisation with the external fixator.

Another three fractures, one in the femur above a knee prosthesis, and two of an allograft, were treated using external fixation. In the first of these patients, consolidation of the fracture was achieved after 116 days, and in the two with fractures of the graft, the external fixators were worn for 40 and 90 days respectively, as they were also employed for lengthening the limb (Fig. 3).

Physeal distraction for malignant metaphyseal bone tumours was carried out in 22 patients, 14 of whom had osteosarcoma and 8 Ewing's sarcoma. In every instance the tumour was metaphyseal and proximal to the growth cartilage, which was unaffected. Physeal distraction was performed using an external fixator at a rate of 1-2 mm/day until a gap of approximately 2 cm was created. The fixator was left in position for 10 to 20 days and the result was good in all patients. In three patients there was some doubt as to whether the physis had been affected and the external fixator was used as a spacer until the pathology report arrived. When it had been established that the physis was not involved, the procedure was continued in all three patients. There was no local recurrence in any of our patients, although three died of lung metastases between one and three years after the operation (Fig. 4).

The fixator was used in a girl aged 4 years with an osteosarcoma of the distal metaphysis of the femur. Bone reconstruction by bone transport was undertaken after resection of the tumour. The fixator was adapted to perform bone transport and she wore the device for 235 days (Fig. 5).

Before a bone bank was available (1987), reconstruction of defects after tumour resection was performed using autografts of the contralateral tibia or iliac crest. As these grafts are insubstantial, they required backup osteosynthesis. On 6 occasions an external fixator was used, producing good results in terms of consolidation of the focus in 3 patients. In the other 3, the occurrence of pseudoarthrosis necessitated a further operation with a graft and internal osteosynthesis. The fixator was kept in place for between 3 and 5 months.

Twelve bone segments were lengthened in 10 patients who had previously undergone surgery for a primary malignant bone tumour with resection of the growth cartilage. Limb length discrepancy ranged from 7 to 18 cm; the femur was lengthened on 5 occasions and the tibia on 7. In one patient, the tibia and femur were lengthened simultaneously, the mean gains being 10.7 cm. In two patients, the lengthened callus fractured and had to be treated with a plaster, the fixator being worn for between 8 and 16 months (Fig. 6). Infection occurred in one patient with tibial lengthening. This abated after antibiotics were given (Amoxicillin 500 mg/8 hours) and cleansing performed every 12 h.

Five patients, who had undergone limb re-construction by means of an autograft developed a pseudoarthrosis and asymmetry. Three were treated by the technique of lengthening-compression using three pin clamps in the fixator, and consolidation of the pseudoarthrosis was achieved. The defect failed to consolidate in one patient who had been managed by compression only. Further surgery was necessary in the form of a graft and internal osteosynthesis under compression; the fixator remained in position for 30-50 days.

One hundred and seventy massive allografts were used in the reconstruction of bone defects occasioned by conservative oncological surgery. In 12 patients the graft had to be removed and the defect supported by an external fixator acting as a spacer until the infection subsided following the insertion of gentamycin balls (Fig. 7). Of these patients one had a malignant fibrous histocytoma, one a giant cell tumour, two a fibrosarcoma, one a Ewing's sarcoma and 7 osteosarcomas. They all had a further graft, and are at present asymptomatic. The fixator remained in place for 2-7 months.

In a patient aged 18 years a compression arthrodesis of the knee joint was performed after resection of an osteosarcoma. Two monolateral fixators were used, one on each side, and these were removed after 145 days.

In 2 women aged 27 and 30 years, the external fixator was used to correct flexion deformity of the knee secondary to retraction of soft tissue caused by radiotherapy for sarcoma in the thigh. The fixator remained in position for 20 and 35 days.

One patient had severe collapse of the femoral component of a knee megaprosthesis because of reabsorption at the point where the host and allograft met in the bone. During the operation, an external fixator was fitted and lengthening was performed for 37 days at a rate of 1 mm/day. After the collapse had been corrected, an osteosynthesis plate was inserted to achieve consolidation. In a girl aged 16 years with an infected knee joint prosthesis, the latter was removed, the external fixator put in position, and gentamycin balls were inserted once the area had been cleaned. After 184 days the fixator was removed and a fresh prosthesis introduced.

DISCUSSION

In the field of bone tumours, the uses of the external fixator are very varied, despite its limitations [5-6].

The external fixator is recommended in the management of pathological fractures to facilitate the handling of the patient and as a temporary measure until the result of the biopsy is known and definitive treatment can be undertaken. Using this system, it is not necessary to confine the patient to bed.

In metaphyseal or diaphyseal osteosarcoma, we observed that in 50% of patients the physis and epiphysis were free of disease [4]. In the remaining patients, the tumour had invaded the epiphysis. The growing cartilage may act as a tumour barrier. To determine the extent to which the physis had been affected, we used conventional radiology, CT and digital angiography. More recently we have included MRI, as this is the ideal method for determining the degree of invasion of the physis.

Our findings enabled us to develop a surgical technique which conserves the physis and epiphysis in the treatment of distal metaphyseal tumours in the femur, tibia or fibula. The only constraint is that these structures should be confirmed to be free of tumour by means of radiological and histological investigations [4]. No instances of local recurrence of tumours in the epiphyseal region have been encountered [3].

Bone transport to fill the defect after tumour resection is a technique recommended only in very young patients and in those with small diaphyseal and distal metaphyseal tumours of the femur. It is important for the patient and the family to be informed about the procedure and the duration of treatment. Naggar et al, 1993, described an osteosarcoma in which an 18 cm postoperative defect required 16 months of treatment. In our experience we found statistical differences in consolidation time with the use of systemic chemotherapy and external radiotherapy; both delayed consolidation in diaphyseal osteotomies [12].

To maintain function, we consider that the correction of limb-length discrepancies should be given priority. Our criteria for limb lengthening in these patients are a delay of at least 3 years after completing multidisciplinary treatment, which acts as a safety margin to ensure that the patient is free of disease, and asymmetry of 4 cm or more in magnitude. Eight of our 13 lengthening procedures were performed on the bone in which the tumour had been resected, the osteotomy being carried out in the part of the bone that was the patient's own. On most occasions, even though the radiological image was not good, limb function was satisfactory and the patient's own evaluation was positive [4].

When there is a focus of pseudoarthrosis in the allograft and lengthening is desirable to correct asymmetry, we sometimes use an external fixator with three pinholders, one being used for compression and another for distraction.

The external fixator serves to support the area of the bone defect after the infected bone has been resected and, once the zone is free of infection, a fresh allograft can be put in place. We have used the external fixator for correcting deformities such as flexion contracture of the knee secondary to retraction of the soft tissues caused by radiotherapy.

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Table 1	
Patients	61
Male	38
Female	23
Nº of procedures	71
Age (yrs)	Mean: 14 min: 4 max: 58
Follow up (yrs)	Mean: 6 min: 1 max: 14
Segments	
Femur	33
Tibia	34
Fibula	2
Knee deformity	2
Tumour aetiology	
Ewing sarcoma	15
Osteosarcoma	36
Chondrosarcoma	2
Myeloma	1
Metastasis	1
Giant cell tumour	1
Malignant histiocytoma	1
Fibrosarcoma	3
Liposarcoma	1

Table 2. Indication for Operation	
Pathological fracture	3
Primary tumour	23
Autograft	6
Pathology report pending	4
Asymmetry and pseudoarthrosis	3
Asymmetry	10
Pseudoarthrosis	2
Alograft infection	12
Knee deformity	2
Prosthesis collapse	1
Fracture above the prosthesis	1
Allograft fracture	2
Prosthesis infection	1

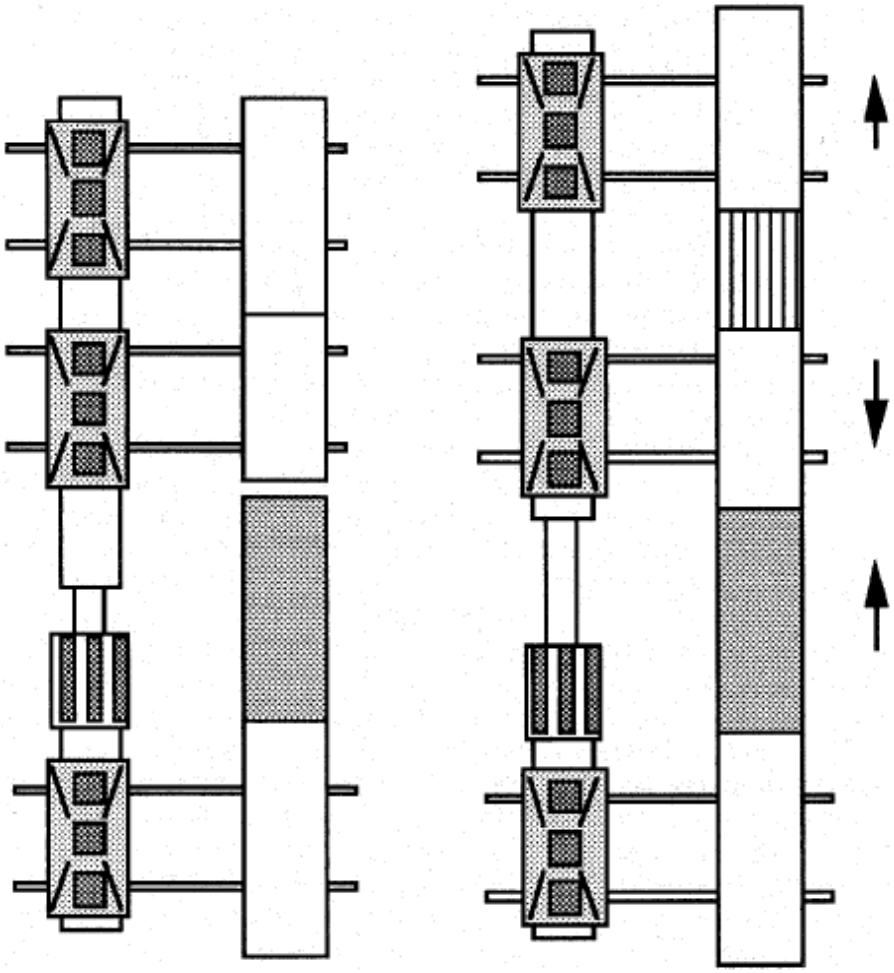

Figure 1. Lengthening-compression technique with the Monotube

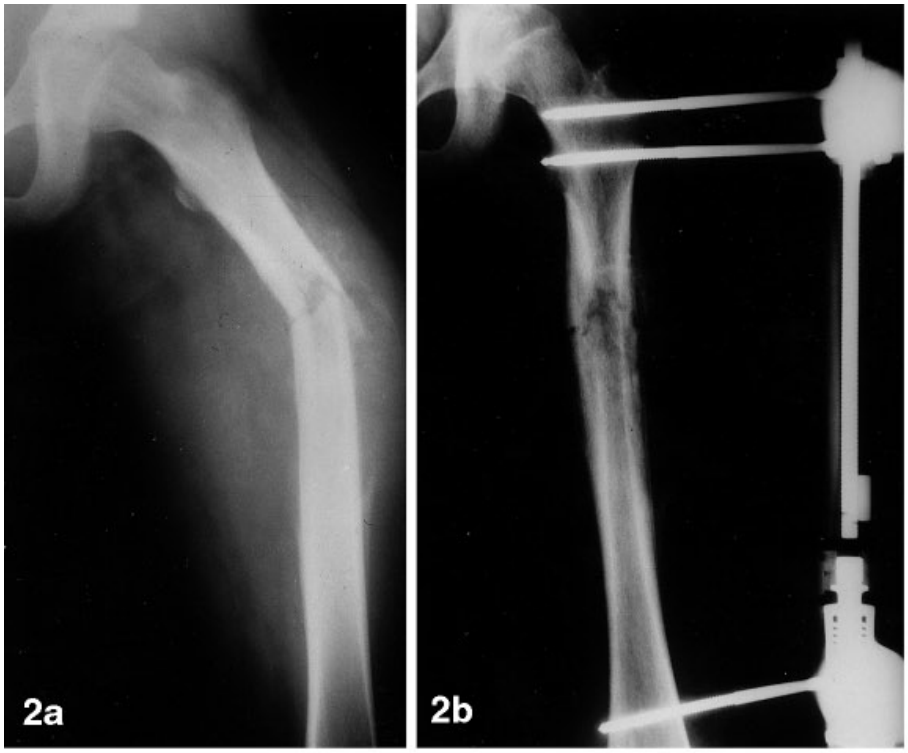

Figure 2 a. Pathological fracture of the femur secondary to a metastasis of unknown origin, **b.** The external fixator has been applied

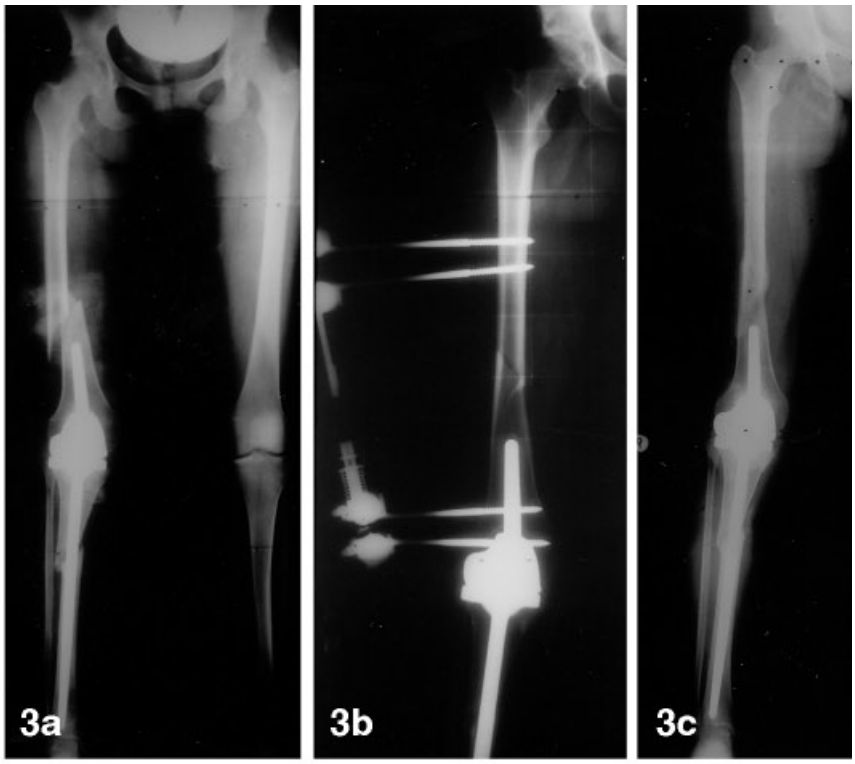

Figure 3 a. Femoral fracture after a knee prostheses, **b.** and **c.** treated with an unilateral external fixator

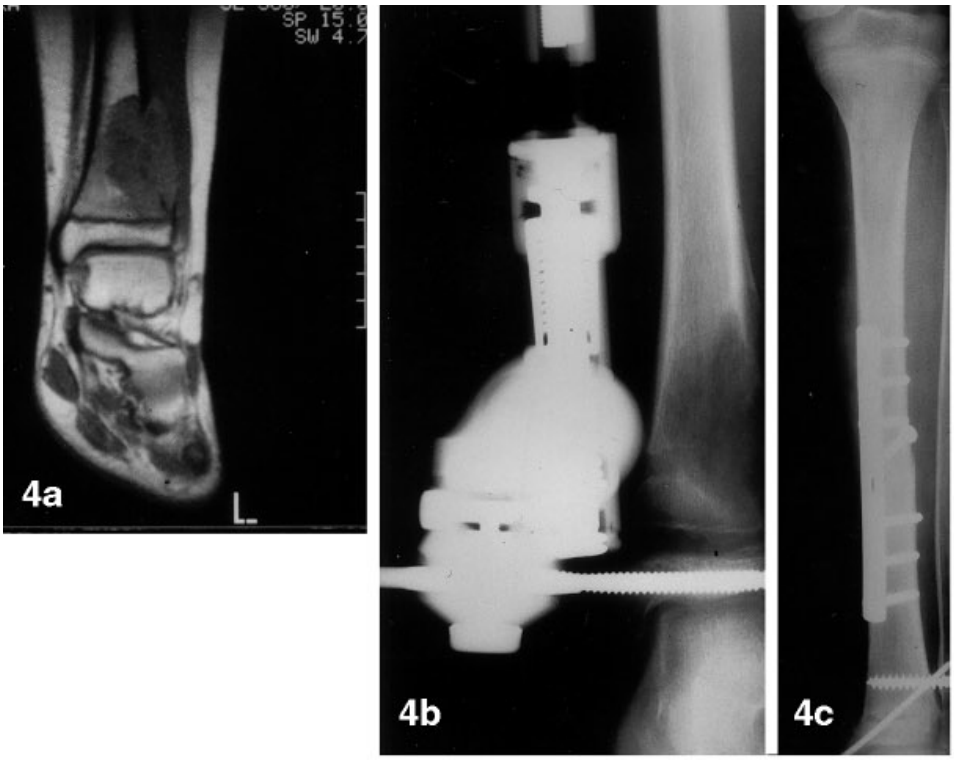

Figure 4 a-c. Physeal distraction technique, **a.** MRI of distal tibial osteosarcoma, **b.** distal tibial epiphysis distraction, **c.** allograft replacement

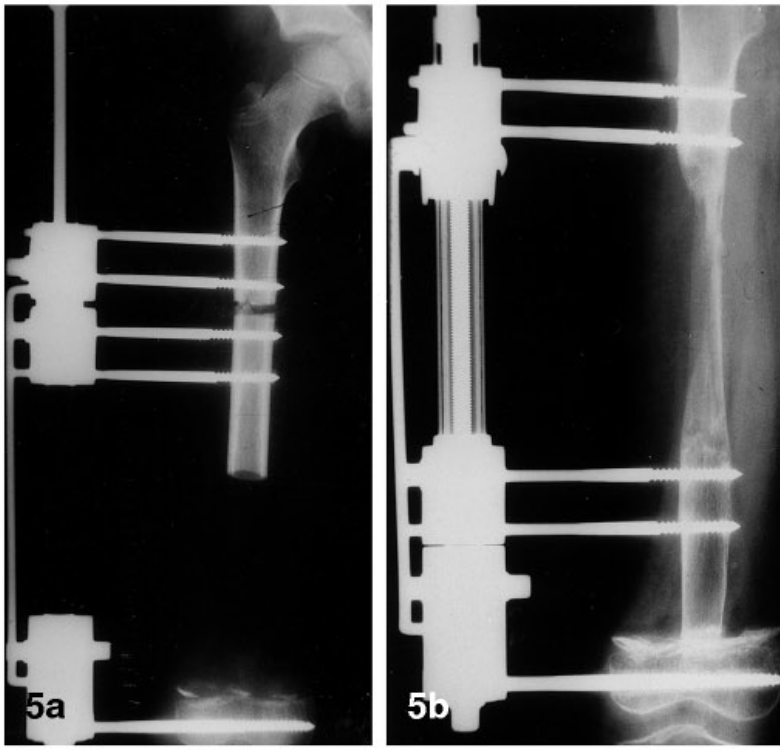

Figure 5 a, b. Bone transport

Figure 6. Correction of asymmetry by physeal distraction in a boy treated with an hip prosthesis for a malignant bone tumour of the femoral neck

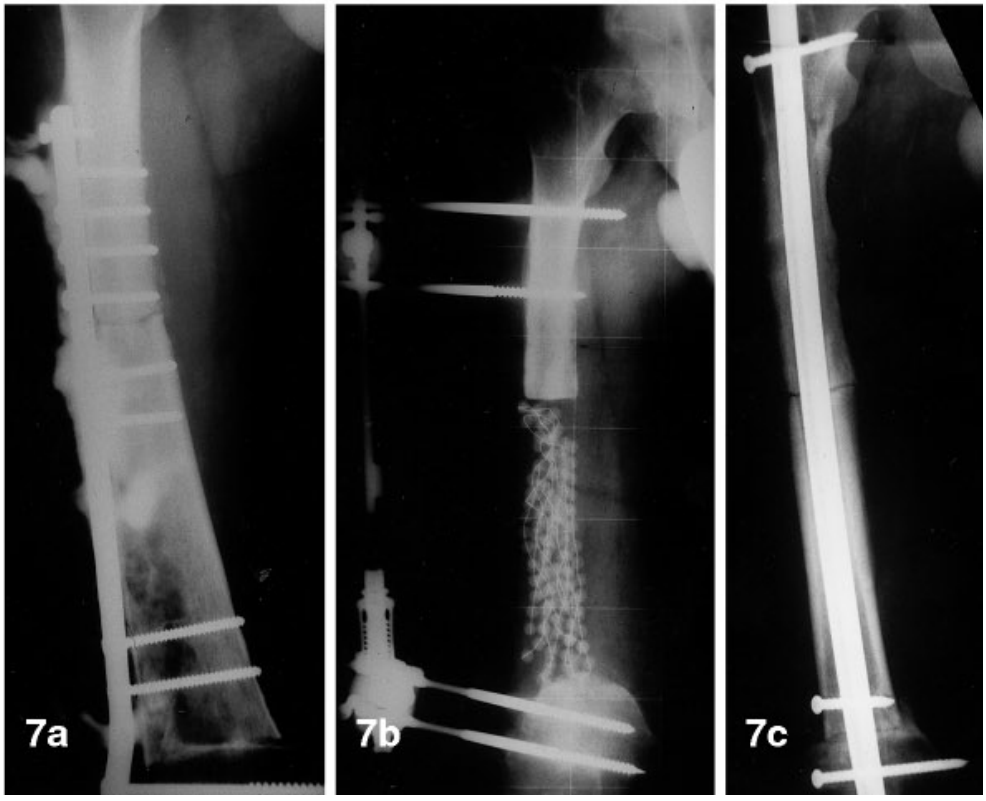

Figure 7 a. Allograft infection, **b.** an external fixator has been employed as a spacer for two months. Gentamycin balls have been used to treat the infection, **c.** new allograft stabilised with an interlocking nail