OSTEOSYNTHESIS OF PATHOLOGIC FRACTURES AND PROPHYLACTIC INTERNAL FIXATION OF METASTASES IN LONG BONES

L. LINCLAU, G. DOKTER

Osteosynthesis was performed in 36 pathologic fractures, and in 21 metastases prophylactic internal fixation was carried out.
The principles of the operative technique consist of a rigid osteosynthesis with removal of metastatic tissue and filling up of the bone defect with allograft or methylmethacrylate. The indications and benefits of prophylactic internal fixation are discussed.

Keywords : allograft ; metastasis ; internal fixation.
Mots-clés : allogreffes ; métastases ; ostéosynthèse.

INTRODUCTION

Recent advances in chemotherapy and radiotherapy often prolong the lives of patients with carcinomatosis. However the pain and disability caused by metastatic deposits in bones or resulting from pathologic fractures require local orthopedic treatment for relief of pain or restoration of mobility.

The advances in techniques for the rigid fixation of fractures are of great value in the treatment of patients with metastatic bone lesions. This article describes our experience with osteosynthesis in patients with bone metastases and pathologic fractures of the long bones.

PATIENTS AND METHODS

From 1978 through 1982 in the Slotervaart Ziekenhuis in Amsterdam and from 1983 through 1990 in the Eeuwfeestkliniek in Antwerpen we operated on 50 patients for metastatic disease in the long bones. The patients' ages ranged from 34 to 86 years (mean 61 years).

Thirty-six patients (72%) were women.

In these 50 patients, 57 operations were performed. Four patients showed two metastatic localizations which needed operative treatment, while in three metastases a second operation was necessary before they consolidated.

Carcinoma of the breast was the most frequent primary tumor in women. In men the most frequent primaries were hypernephroma and carcinoma of the bronchus (table I).

Almost 50% of the metastases were localized in the trochanteric and subtrochanteric region. The other 50% occurred almost equally in the femoral shaft and the humerus. One metastasis was treated in the tibia (table II).

There were 36 pathologic fractures, and we performed 21 prophylactic osteosyntheses. The fractures were almost equally divided between the subtrochanteric region, the femoral shaft and the humerus. On the contrary, 62% of the prophylactic osteosyntheses were performed in the subtrochanteric region (table III).

In 90% of the cases we carried out an osteosynthesis with a plate (table IV) : straight femoral plates in the femoral shaft (fig. 1) and the middle and distal part of the humerus (fig. 2). A T-plate was used in the proximal part of the humerus (fig. 3). For the subtrochanteric region we used angular plates of 130°, or 95° condylar plates (fig. 4). In some subtrochanteric fractures we bent a 130° plate to 150° to improve stability (fig. 5).

In the vast majority of cases we removed as much metastatic tissue as possible, and the resulting bone defect was filled with allograft or allograft and bone cement in 42 cases (74%). In 11 cases (19%) only bone

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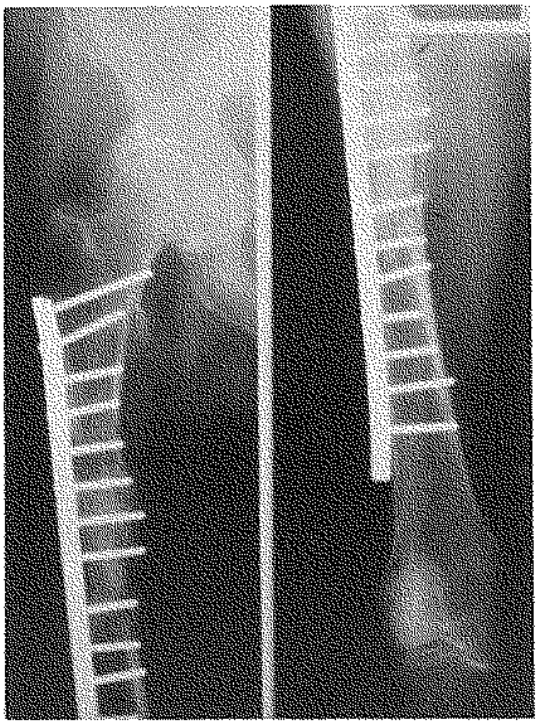

Fig. 1. — Osteosynthesis of a metastatic fracture in the femoral shaft with a straight plate and filled with allograft and methylmethacrylate.

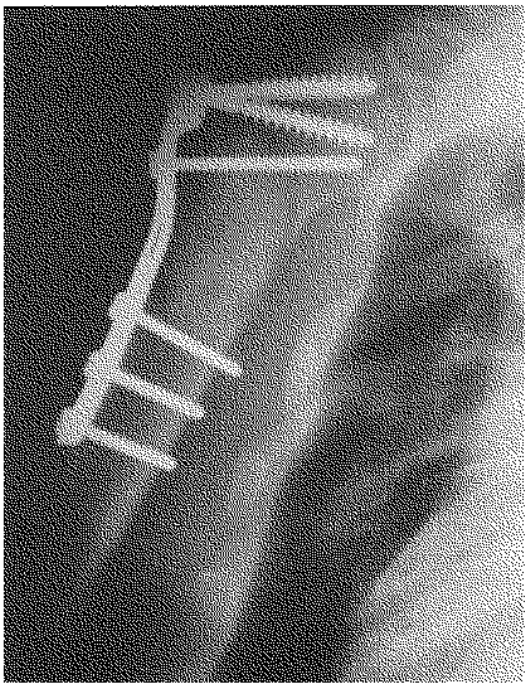

Fig. 3. — Prophylactic internal fixation of a metastatic deposit in the proximal humerus, using a T-plate and bone cement.

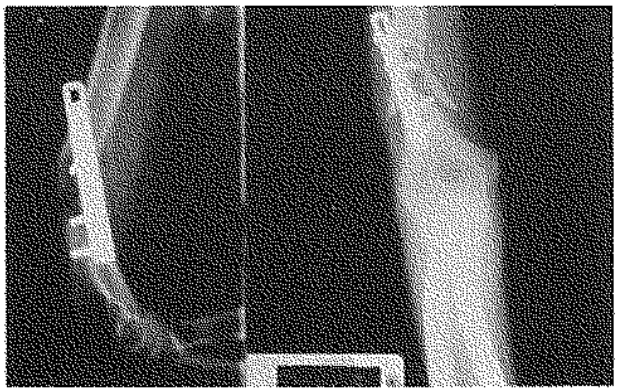

Fig. 2a. — Fracture of the distal humerus, after previous osteosynthesis without removal of the metastasis.

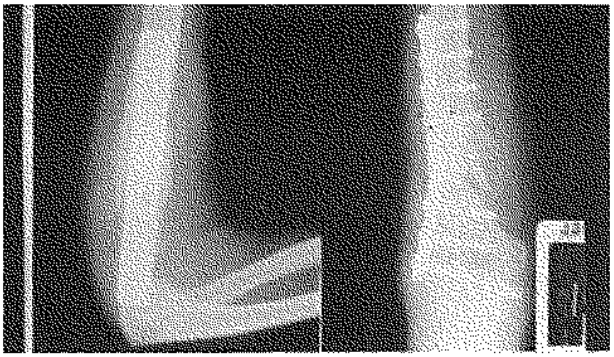

Fig. 2b. — Osteosynthesis using a femoral plate and bone cement (same patient).

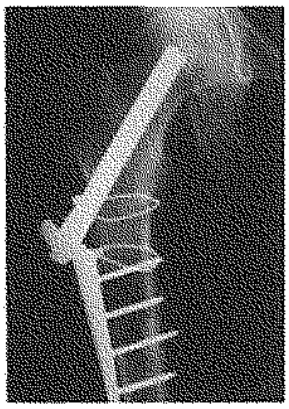

Fig. 4a

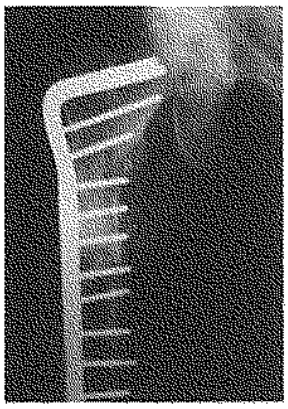

Fig. 4b

Fig. 4a. — Prophylactic internal fixation of a subtrochanteric metastatic lesion, without removal of the metastasis. The patient still has pain, weightbearing is impossible and there is nearly a fracture.

Fig. 4b. — Same patient. Prophylactic osteosynthesis by means of an extra long custom made, 95° condylar plate. The bone defect has been filled up with bone cement and allograft. The patient no longer has pain and is capable of weightbearing.

Table I. — Primary tumor in 50 patients

	women	men
breast	29	0
kidney	2	5
bronchus	1	3
epithelioma	0	2
gastrointestinal	1	1
nonhodgkin lymphoma	1	1
multiple myeloma	1	1
prostate	0	1
unknown	1	0
	36	14

Table II. — Localization of 57 metastases

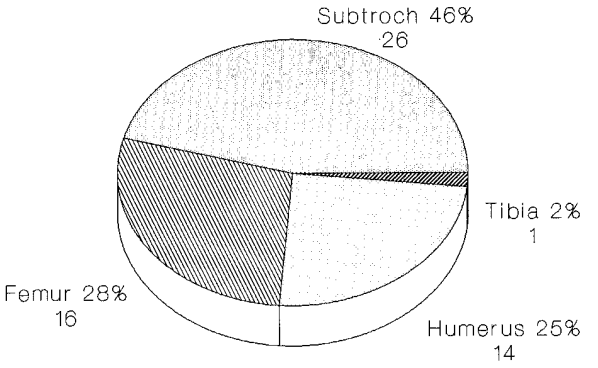

Table III. — Localization of osteosyntheses (n = 57) in prophylactic fixation and fractures

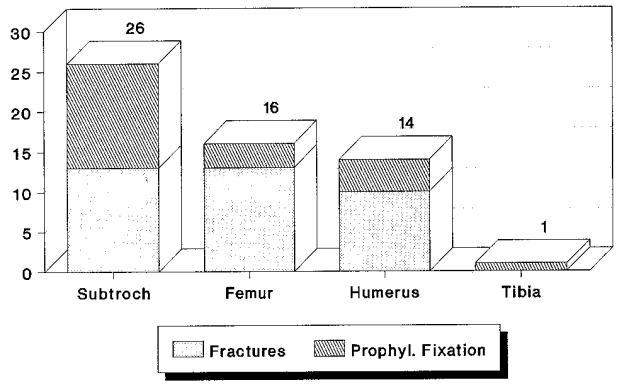

Table IV. — Material used for fixation ; localization of the operations (n = 57)

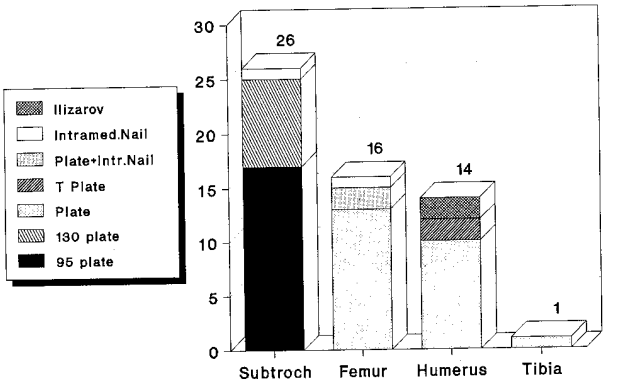

Table V. — Filling the bone defect (n = 57) in fractures and prophylactic fixation

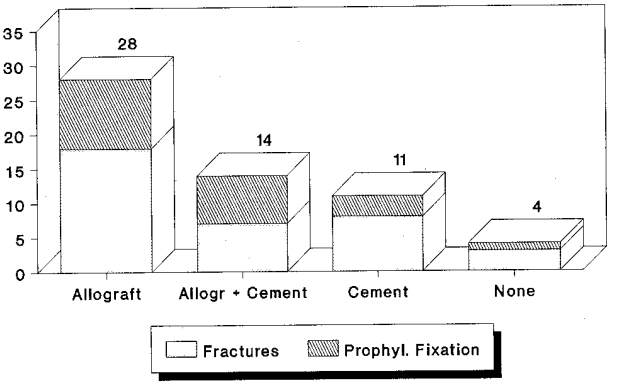

Table VI. — Filling the bone defect (n = 57) and localization of metastases

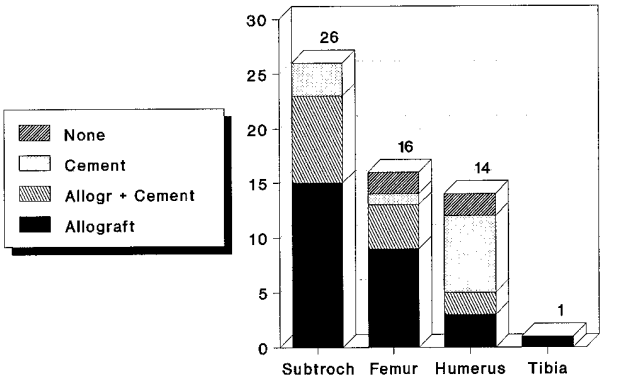

Table VII. — Causes of postoperative deaths

Cause of death	Time after operation
– pulmonary embolus ?	1 week
– carcinomatosis	2 weeks
– brain metastases	7 weeks
– perforated gastric ulcer	8 weeks
– multiple myeloma	16 weeks

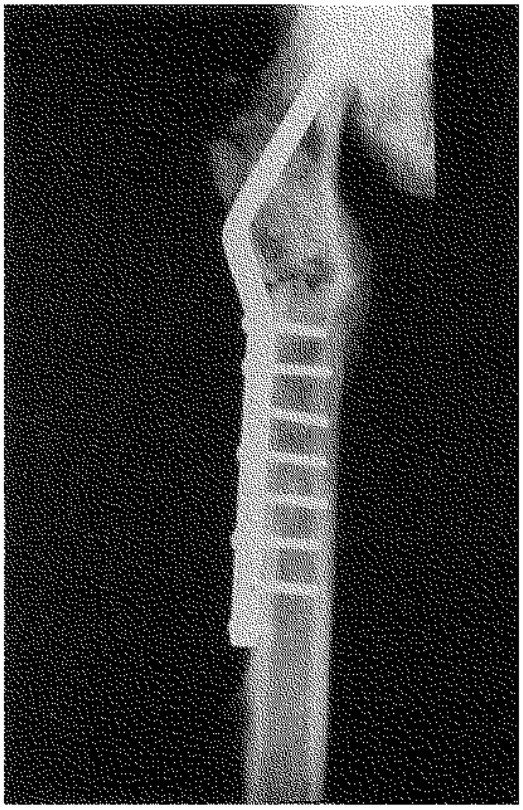

Fig. 5. — Osteosynthesis of a subtrochanteric fracture with a 130° angular plate, bent to 150°. The defect has been filled with allograft.

cement was used (table V). In our series more allografts were used in the lower extremity, while in the upper extremity we used mostly methylmethacrylate (table VI).

Postoperative radiotherapy was applied at the operation site, starting approximately the fifth postoperative day, if wound healing appeared satisfactory. In most cases 2 000 cGy were administered over 10 days.

RESULTS AND COMPLICATIONS

Five patients died in the hospital (table VII), and three fractures needed a second operation before they finally consolidated. All these complications, except one, occurred in fracture treatment and not in prophylactic internal fixation.

One patient with a preventive osteosynthesis died 8 weeks postoperatively from a perforated gastric ulcer.

Pain was satisfactorily relieved in most patients, and mobility was restored in 47 patients. Forty-four were discharged home, temporarily or definitively, after an average stay in the hospital of 34 days, ranging from 9 to 123 days.

The average admission to the hospital was 43 days in the fracture group and 28 days in patients with prophylactic fixation. The average postoperative survival time was 11 months ; the maximum survival time 48 months.

DISCUSSION

The life expectancy of patients with metastatic neoplastic deposits in bone is limited ; therefore it is important that these patients be mobilized as quickly as possible. For that reason internal fixation has to be rigid and if possible capable of sustaining weightbearing.

In order to relieve pain, to achieve rigid fixation and if possible to stimulate callus formation and consolidation of fractures, it seems important that as much tumor tissue as possible be removed and the residual defect filled up.

Sabato and Stein (1983) (10) found that only those patients in whom the metastatic region was not filled up complained of residual pain. We saw three patients, treated elsewhere, with osteosynthesis without removal and filling of the metastasis. There was residual pain and no fracture healing. Two patients needed a reosteosynthesis with filling of the metastatic cavity (figs. 2, 4), while one patient refused reintervention.

In our opinion the operative treatment of bone metastases should consist of five consecutive steps :

1. fracture reduction.
2. osteosynthesis proximal and distal to the metastasis.
3. removal of metastatic tissue.
4. filling of the residual bone defect.
5. finishing of a rigid osteosynthesis, possibly through the filled cavity.

For prophylactic osteosynthesis the first step is not necessary. Because it is easier to remove the metastasis and to fill up the defect, we usually performed an osteosynthesis with a plate and not with an intramedullary nail.

Intramedullary nailing without resection of the metastases and without filling up the defect should be used only in patients with a very short life expectancy.

We have no rigid rules for the choice between allografts and bone cement. However, some circumstances can influence this decision. As bone cement gives more initial stability, it might be more indicated when the life expectancy is short or in fracture treatment. Meary *et al.* (8) found that the cemented plate gave satisfactory results for 1 year, after which there was progressive osteolysis. Deep frozen allografts still have osteogenic potential (11, 12), and can therefore stimulate callus formation and fracture healing. In many cases we observed even a considerable overproduction of callus (6).

For this reason, allografts might be more indicated than methylmethacrylate, when the life expectancy is longer than one year, especially in the lower extremity when weightbearing is necessary for a longer period, and in prophylactic internal fixation, where initial stability is usually higher than in fracture treatment.

Furthermore, the possibility that allografts produce nonspecific stimulation of the host resistance should be considered, at least in some cases (7).

In 14 cases, we have used bone cement and allografts together : methylmethacrylate on the medial side gives more stability especially for the fixation of screws, the plate being located on the lateral side ; in between the allografts.

Metastases located in the neck of the femur or the acetabulum are treated with cemented total hip prostheses, with or without reconstruction of the acetabulum by means of a metallic reinforcement ring, bone cement or allografts.

Theoretically in the subtrochanteric region we have the choice between a tumor prosthesis and osteosynthesis. Usually we preferred osteosynthesis, because the complication rate is lower and the postoperative recovery faster (1). Meary *et al.* (8) considered arthroplasty in general less satisfactory than osteosynthesis.

The advantages of prophylactic internal fixation are obvious. There is relief of pain and restoration of mobility, facilitating further therapy, such as radiotherapy.

Furthermore the operation is easier to perform, the recovery of the patient is faster and the complication rate is lower than in fracture treatment. Possible effects on local and general tumor spread are not considered to be a contraindication (3, 5).

The indication for prophylactic internal fixation is theoretically simple : only those metastases which are susceptible to fracture should be operated on, while the life expectancy of the patient should be more than six weeks minimum. Nevertheless it is not always easy to determine when a metastasis is likely to fracture or how long the patient will survive.

Concerning the fracture incidence, Fidler (2) found no differences, in primary tumors or in metastases between upper and lower extremities. However, there was a sudden rise in fracture incidence when over 50% of the cortex was involved. This can be estimated on an anteroposterior and lateral radiograph, but can better be visualized on CT scan.

Hipp *et al.* (4) have found in experimental defects that the determining factor consists of the thickness of the thinnest part of the cortex, if the defect does not penetrate the entire cortex, and that the properties of the surrounding bone are critical to the strength of that bone when the defect is of full thickness.

Why bone metastases cause pain is poorly understood, although it has been suggested that pain can be a sign of an impending fracture (9). We also have the impression that increasing pain (despite radiotherapy) often precedes a fracture, especially when over 50% of the cortex is involved.

Treatment of neoplastic deposits in bones should not be limited to orthopedic measures. Each case must be individualized, and the best method of treatment determined after a careful evaluation of the problem.

However, a pathologic fracture is a distressing event and requires adequate orthopedic treatment. If possible these fractures should be prevented, and prophylactic osteosynthesis, when indicated, should be undertaken.

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SAMENVATTING

L. LINCLAU en G. DOKTER. Osteosynthese van pathologische fracturen en preventieve interne fixatie van botmetastasen in de lange pijpbeenderen.

Een osteosynthese werd uitgevoerd bij 36 pathologische fracturen, en 21 botmetastasen werden preventief gefixeerd.
De principes van de operatietechniek bestaan uit een stabiele osteosynthese met verwijderen van zoveel mogelijk tumorweefsel en opvullen van het botdefect met allogeen bot of botcement.
De indicaties en voordelen van een preventieve osteosynthese worden besproken.

RÉSUMÉ

L. LINCLAU et G. DOKTER. Ostéosynthèse des fractures pathologiques et synthèse préventive des métastases osseuses des os longs.

Les auteurs ont traité 36 fractures pathologiques par ostéosynthèse et pratiqué une stabilisation métallique préventive de 21 métastases osseuses.
L'intervention consiste essentiellement en une ostéosynthèse stable et un curettage aussi étendu que possible du tissu tumoral, suivi de comblement de la perte de substance par une allogreffe ou par du ciment à os.
Discussion des indications et avantages des ostéosynthèses préventives.