

METASTATIC INVOLVEMENT OF THE HUMERUS : A RETROSPECTIVE STUDY OF 51 CASES

M. GEBHART¹, D. DEQUANTER², E. VANDEWEYER³

The authors performed a retrospective review of 53 patients with 56 completed or impending pathological fractures of the humerus. Sixteen cases were treated with a proximal and one with a distal humeral prosthesis, 38 with an intramedullary device with cement and one with plate fixation. Forty-eight patients with 51 humeral metastases were available to follow-up. No or only occasional pain was observed in 92% of the operated extremities and adequate postoperative function in 90%. No major complications occurred, except one rod migration.

Keywords : bone metastasis ; humerus ; Hackethal's technique ; isoelastic prosthesis.

Mots-clés : métastase osseuse ; humérus ; technique de Hackethal ; prothèse isoélastique.

INTRODUCTION

Tumor involvement of the humerus may be seen occasionally by any orthopedic surgeon ; unless the patient has already been diagnosed as having metastatic disease from a known primary tumor, the question always arises, whether this is a primary or a secondary tumor (7). Metastatic disease becomes more and more frequent over the age of 40 and is the most frequent origin of neoplastic involvement of the humerus. If one considers solitary bone metastases, 20% will first occur in the humerus, especially in the proximal part (14). However, primary tumors such as chondrosarcomas, malignant fibrous histiocytomas, as well as osteosarcomas and others may be erroneously taken for a metastatic lesion. The treatment of those lesions is quite different, so that absence of a clear

diagnosis may lead to mismanagement, especially in cases with primary and possibly curable bone tumors. It is of crucial importance that in any doubtful case a biopsy be taken prior to any decisive final treatment.

The most frequent primary tumors to cause metastases to bone are those of breast, prostate, kidney, thyroid and lung origin (10, 12, 13). Prostate and breast metastases develop most often within the medullary cavity of bone, whereas metastases secondary to kidney, lung and thyroid neoplasms may cause pronounced swelling or lesions infiltrating into soft tissue mimicking the usual appearance of a primary bone tumor.

Metastatic involvement of bone will progressively destroy bone, creating areas of lysis or sclerosis within the cancellous or cortical bone. Pathological fractures are reported to occur in only 10% of metastases to the humerus (13, 14). The usual end result especially with lytic lesions is a weakend bone, prone to fracture at any moment ; quite often the orthopedic surgeon is called for excruciating pain or after a spontaneous fracture has occurred.

¹ Department of Orthopedic Surgery, ² Department of General Surgery and ³ Department of Plastic and Reconstructive Surgery, Jules Bordet Institute, Centre des Tumeurs de l'Université Libre de Bruxelles, 1, rue Héger-Bordet, B-1000 Brussels (Belgium).

Correspondence and reprints : M. Gebhart, M.D., Jules Bordet Institute, Department of Orthopedic Surgery, 1, rue Héger-Bordet, B-1000 Brussels (Belgium). E-mail : suzanne.devaux@bordet.be (secretary).

Fracture may be caused by minor trauma. In any event, the potential of these fractures to heal is very low except for rare cases, which respond to radiation, chemo- or hormonotherapy. Radiation therapy by itself further weakens the underlying bone (20), so that bone healing can only be explained by its antitumoral action consistently decreasing the destructive behavior of neoplastic cells on bone. An exceptionally good fixation of these fractures is required because one cannot expect normal bone healing by callus formation (20). On the other hand, persistent pain, and major joint dysfunction at the shoulder and elbow are to be relieved rapidly in order to improve comfort, to facilitate nursing care and, in cases with widespread metastatic disease, to restore the capacity to use crutches.

SURGICAL TREATMENT OF BONE METASTASES TO THE HUMERUS

Quite often in the past the diagnosis of metastatic disease to bone was supposed to be associated with a rapid deterioration of the patient's condition with only a short period of survival. Therefore, no special care was given except sling immobilization and palliative radiation therapy (3, 17).

More recently, fixation of pathologic fractures with surgical techniques derived from the treatment of traumatic fractures led to a very high complication rate, mainly due to migration of intramedullary rods, protrusion of nails, loosening of plate-screw fixation and repeated surgical procedures to correct these complications. The natural history of metastatic disease and the outcome of treatment by cytostatic medications, hormonal modulation and irradiation has improved considerably by now with longer survival especially in patients with breast, prostate and thyroid cancer as well as in patients with multiple myeloma (10).

The low potential of metastatic bone to heal, the longer life expectancy and the need for rapid relief of pain and restoration of function have initiated new surgical techniques in the fixation of bone by using methylmethacrylate (5, 8, 9, 10, 12, 13, 16, 19, 20). Methylmethacrylate has been used in association with intramedullary nails or plate-screw

devices in order to fill the gap resulting from the excision of the metastasis. Methylmethacrylate is directly introduced into the bone defect. The method used here is different insofar as methylmethacrylate is injected into the medullary cavity through drill holes made proximally and distally to the curetted cavity (fig. 1).

Cement fills the medullary cavity and glides in a centripetal manner toward the metastatic cavity. The resulting association of remaining healthy bone, cement and the intramedullary device results in immediate rigid fixation. Another advantage is sufficient hemostasis in these hemorrhagic lesions. Major disadvantages are the possibility of an acute respiratory distress syndrome due either to the release of monomer during cement hardening or to the mechanical propulsion of fat emboli to the lungs and the difficulties in subsequent surgery, should a new intervention be necessary. The use of intramedullary devices surrounded by cement implies that there is good quality bone proximally and distally to the metastatic lesion in order to assure the maintenance of this fixation system. If metastatic bone or pathological fractures are too close to joints, a prosthetic device must be used: a proximal humeral prosthesis for proximal humeral metastases and an artificial elbow joint for distal lesions. We have used the isoelastic humeral prosthesis designed and manufactured by Mathys,

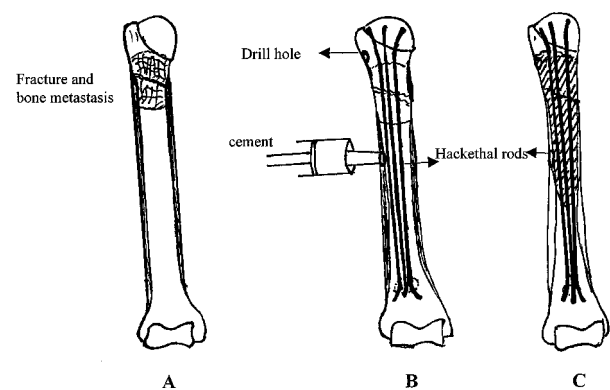


Fig. 1. — a) Pathological fracture and bone destruction of the proximal humerus.
 b) Intramedullary nailing with Hackethal rods and proximal and distal cement injection.
 c) Final situation.

Bettlach, Switzerland (2, 4, 11, 18), which is fixed either with transverse screws or with bone cement. Soft tissues, especially the rotator cuff, should be reattached to the prosthesis. In case of distal humeral destruction involving the elbow-joint, we use a similar isoelastic elbow prosthesis connecting the distal humerus to the ulna with a hinged joint and to the radius with a ball and socket joint. This therapeutic approach has been used at our institution since 1986 without fundamental change in the surgical technique.

MATERIALS AND METHODS

All patients treated surgically for metastatic disease of the humerus were reviewed either directly during follow-up visits or from chart review. Not all patients were treated surgically, because some had major operative contraindications or far-advanced neoplastic disease, and others were treated by the radiation therapy department without the orthopaedic surgeon being consulted. Others had metastatic involvement of the entire skeleton, so that the humeral involvement became a secondary problem. The proportion of surgically treated patients is unknown, as we do not know the number of those, who were treated medically or by radiation therapy.

Patients were evaluated for age, sex, underlying disease, impending and completed fractures, site of the lesion, local extension, relationship to the adjacent joint, involvement of bone by one or more metastases, presence of visceral or cerebral metastases, as well as timing of pre- or postoperative radiation therapy.

Two treatment modalities were used: some metastases were treated using an intramedullary device with bone cement, and others by resection and reconstruction with a prosthetic device. Operative time and intraoperative blood loss were registered.

After the operation, patients were evaluated for pain relief, restoration of function, and immediate and late postoperative complications.

The intensity of pain was divided into no pain (level 1), occasional (level 2), pain necessitating nonsteroidal anti-inflammatory medication (level 3) and severe pain (level 4).

Restoration of function was divided into four levels:

Level 1: normal function: active abduction and antepulsion > 90°, active internal and external rotation of the shoulder, normal elbow function.

Level 2: active abduction and antepulsion between 40°, and 90°, active internal and external rotation, normal elbow function.

Level 3: abduction and antepulsion less than 40°, decreased active internal and external rotation and normal elbow function.

Level 4: same as level 3 with deficient active internal and external rotation and impaired elbow function.

According to the MSTS scoring (16) system essential functions necessary for activities of daily life were recorded: restoration of activities like dressing, eating and, if the dominant upper extremity was concerned, the possibility of writing. The length of survival after surgery was recorded.

Fifty-three patients with 56 humeral lesions were treated between 1986 and 1999. Among the 56 lesions, 59% occurred in females and 41% in males. Mean age was 62 years with a range from 41 to 83 years. A completed fracture was seen in 31/56 (55%) and an impending fracture in 25/56 (45%). Underlying primary neoplasms responsible for the bone metastases are shown in fig. 2. Of the 56 treated lesions, 45% were secondary to breast cancer, 18% to multiple myeloma, the others to lung, kidney, prostate or bladder neoplasms, melanoma, sarcoma and cancers of unknown origin. Forty-three per cent had metastases to the bone alone and the remainder had at least one visceral (40%) or several visceral or cerebral metastases (17%). Of the 53 patients, three (6%) had a solitary bone metastasis within the humerus.

With regard to localization most of lesions were encountered in the proximal part of the humerus. In 16 cases, there was not sufficient healthy bone tissue proximal to the metastasis; they were treated by a humeral prosthesis with length of replacement between 4 and 12 cm. Proximal localization occurred in 66%,

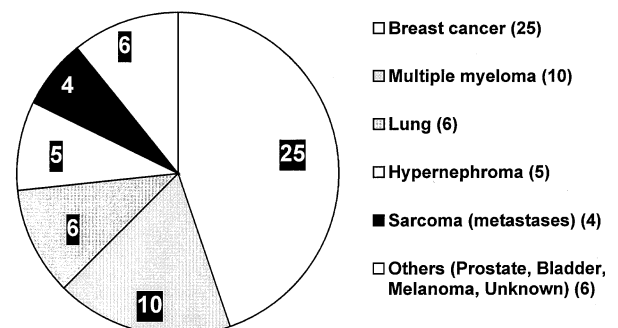


Fig. 2. — Underlying diseases of 56 completed or impending pathological fractures of the humerus.

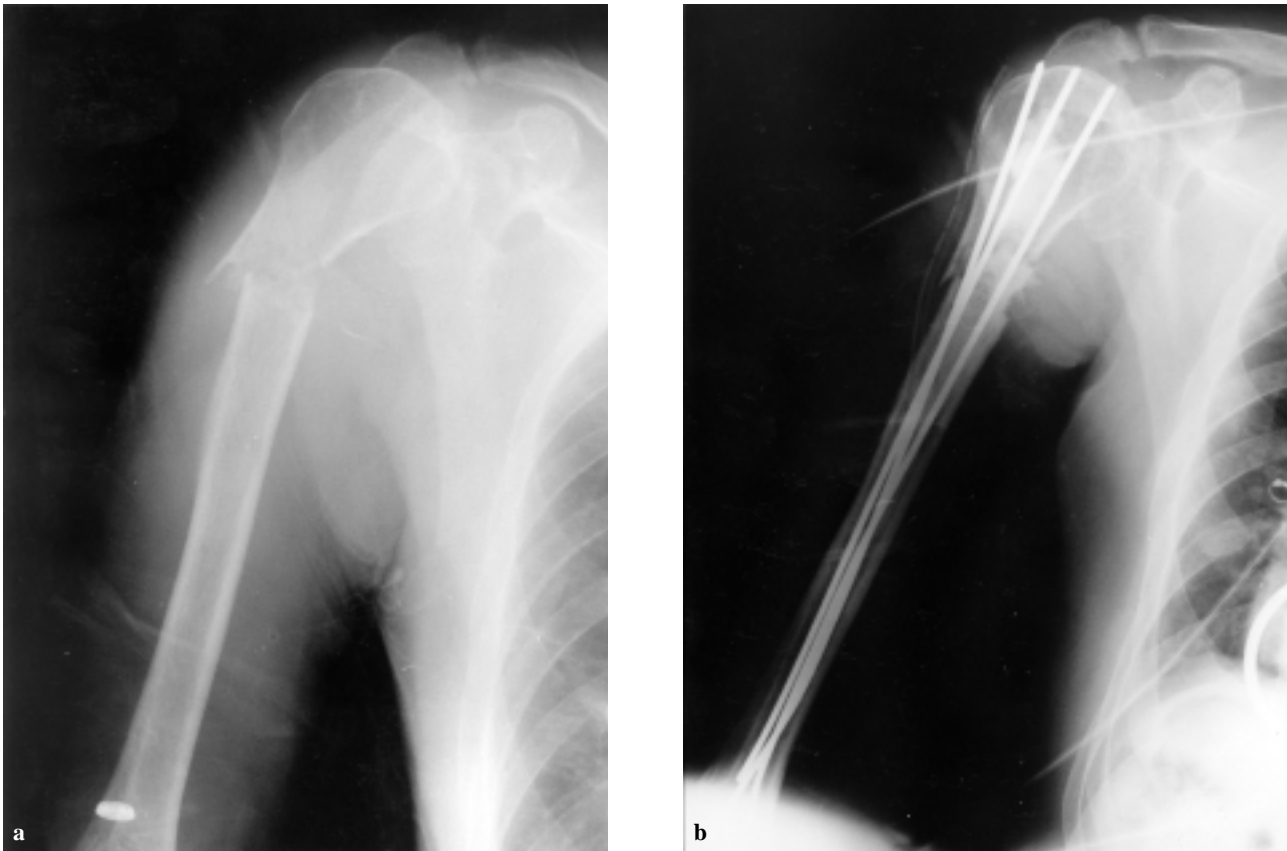


Fig. 3. — a) Pathological fracture of the proximal humerus.

b) Postoperative view of the fracture fixed by Hackethal rods and intramedullary injection of cement.

diaphyseal and distal in 29% and 5% respectively. The combination of Hackethal rods and cement was used in 34 of 38 lesions treated by an intramedullary device. In the other cases Rush (3/38) and Seidel rods (1/38) were used. One distal lesion was treated with a plate-screw device and cement. One patient with a large distal humeral lesion was treated by resection and replacement using an isoelastic elbow prosthesis. Mean operative time for these procedures was 117 minutes (range : 80 – 150 min.) ; mean blood loss was 440 ml (range : 100 – 1500 ml).

All patients have been presented in the radiotherapy department. There was not a clear-cut approach in this regard. Preoperative radiation therapy was administered in 9 cases, postoperative in 24 cases, especially in those cases treated with an intramedullary device and cement fixation. The usual dosage of radiation was between 3000 and 3500 rads. Twenty-three humeri were not irra-

diated, six owing to rapid degradation of the patient's general condition and 17 because they had undergone marginal or wide resection of the proximal humerus and reconstruction with a prosthetic device.

Results in terms of pain relief and restoration of function were evaluated based on either physical examination or on chart review of the deceased patients. Five patients with five humeral lesions died during the first or second postoperative week and could not be evaluated. The results were evaluated regarding 51 humeral lesions in 48 patients with a follow-up of one to 98 months. The patient with a solitary bone metastasis of the proximal humerus is still alive after 98 months ; he had undergone surgery for hypernephroma 10 years before. No other metastases were diagnosed at the present time. Pain was the most important feature in the decision on surgery, so that all patients had either severe (pathological fractures) or level 3 pain before surgery.

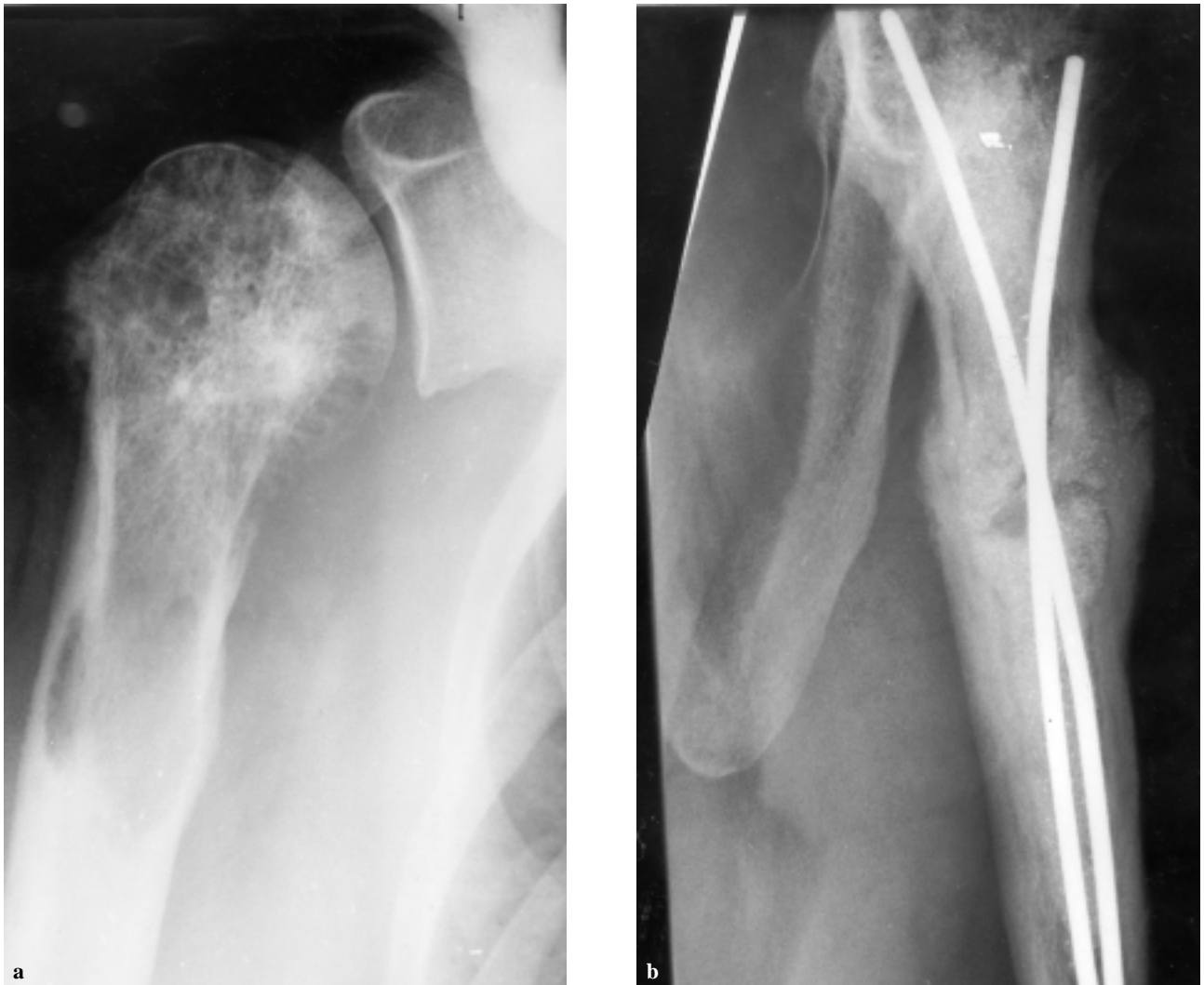


Fig. 4. — a) Impending fracture of an already irradiated proximal humerus
 b) Fixation by Hackethal rods and cement injection

RESULTS

Postoperatively, 68% had no pain, 24% occasional, 6% continuing and 2% severe pain. Pain in the last case was not necessarily caused by the surgical procedure (Hackethal and cement), but most likely was a consequence of lymph node removal from the axilla and intense radiation therapy to bone leading to lymphedema and erysipeloid skin reactions. With regard to restoration of function the best results were achieved in patients treated with intramedullary devices and cement: 30 cases

regained normal active internal and external rotation (59% of cases, 79% of cases treated by an intramedullary device), and antepulsion and abduction more than 90°, whereas 18 cases (36%), among them 15 of the 16 patients (94%) treated by a humeral prosthesis had active internal and external rotation with abduction and antepulsion between 45° and 90°. One patient with a large prosthetic replacement had almost no abduction or antepulsion and one case treated by fixation by cement and Hackethal nails had almost no mobility of the shoulder. This bad result (the same patient

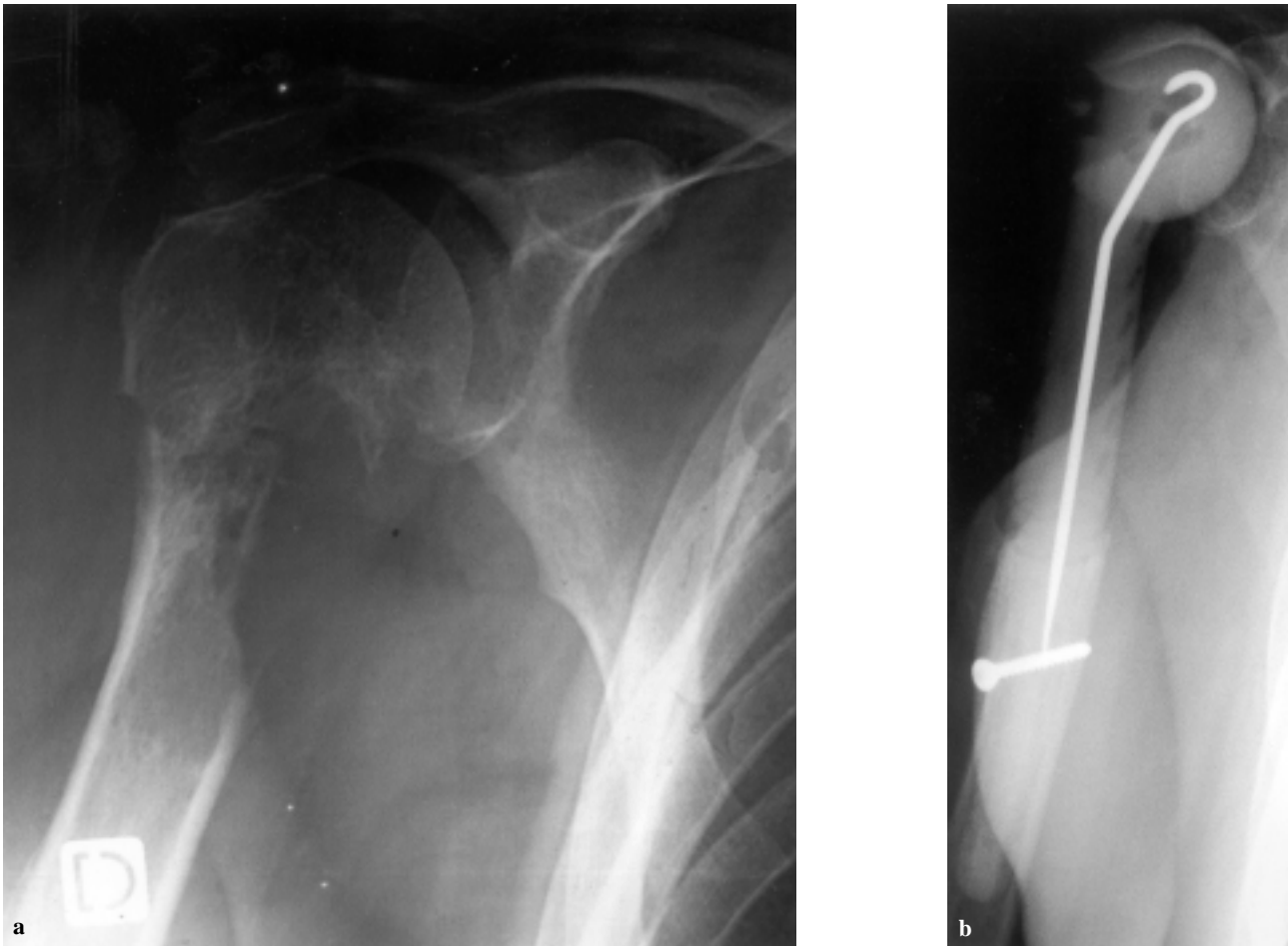


Fig. 5. — a) Destruction of the proximal humerus by a metastasis from a hypernephroma.
b) After wide resection, reconstruction was done with an isoelastic prosthesis.

with severe pain) had the multifactorial origin described above. The patient with the elbow prosthesis had a rather poor functional result according to our evaluation system, but active flexion of the elbow joint was possible, and the patient regained the use of dominant hand function. With regard to usual daily activities, the results was satisfactory for 46 extremities and unsatisfactory for the other five.

Complications were rather rare. There were no cases of infection, nerve or vascular trauma, refracture or prosthetic loosening. One patient demonstrated migration of nails, which had to be cut in a minor operative procedure. General complications, such as pulmonary emboli, acute respiratory

distress syndrome or cardiac failure, did not occur. Five patients died within the first months because of rapid progression of the underlying disease. Median survival was 9 months with a range from one to 98 months.

DISCUSSION

This retrospective study of patients treated for a humeral metastasis shows that surgical techniques using either an intramedullary device with cement or a prosthesis replacing the proximal humerus may provide good clinical outcomes in terms of pain relief and restoration of function and improvement of general life conditions. We cannot compare

our results with those of other operative methods, such as interlocking intramedullary devices alone, plate screw fixation with or without methylmethacrylate and external fixation (4, 7, 9, 10, 12, 13, 16, 20). These techniques have provided rather poor clinical results, but a conclusive comparison may not be possible because of the absence of randomized trials. We believe that use of cement has markedly improved bone and device fixation, leading to a much lower complication rate. Device loosening and migration was a very rare event in our series. Cement is the key to success, which will fix bone and metallic devices creating a very rigid three-compound fixation system. Besides, cement may have a very useful hemostatic effect in these rather hemorrhagic lesions.

Patients with metastatic disease differ insofar as life conditions and life expectancy are limited. It is of crucial importance to obtain a stable and functional extremity directly after surgery, because the healing potential of bone is low (8, 9, 10, 12, 13, 16). The addition of bone cement to more traditional surgical treatment leads to decreased pain and rapid restoration of function, in those patients who quite often need crutches to walk.

In our series, satisfactory relief of pain was achieved in 92% of the operated extremities and 90% regained function permitting daily activities.

Underlying primaries are most often breast cancer in women and kidney and lung cancer in men. In our series, there were 44% (75% of all females) of patients with breast cancer. This feature shows not only the great affinity of this tumor toward bone, but also reflects different levels of activities in different departments of a cancer center. This same statement is true, if one considers survival. Compared to other publications (9, 10, 12, 19), the median survival of 9 months is rather low, but reflects the fact that the neoplastic disease is generally more advanced in patients treated in a tumor center compared to those of a general hospital.

The usefulness of adjuvant therapies is often empirically admitted, but because of the heterogeneity of the lesions and patients' conditions and some ethical considerations, there is no evidence, that radiotherapy avoids local recurrence and improves function. Bomma *et al.* have demonstrat-

ed experimentally that osteosynthesis, especially intramedullary nailing, may lead to locoregional tumor dissemination, so that radiation therapy should be applied to the entire operative field (1). The same authors showed an increased incidence of pulmonary metastases in patients treated prophylactically by intramedullary nailing. We always recommended postoperative radiation therapy on a case-to-case basis. If the entire metastasis has been resected, as in most cases reconstructed by prosthesis, no radiation was generally recommended postoperatively. Radiation therapy with the dose of 30 to 35 gray did not result in any measurable changes in the quality of bone, like shear strength, compression deformation or durability (15).

Acknowledgments

The authors would like to thank S. Devaux, M. Boulet and M. Gustin for their help in preparing this manuscript.

REFERENCES

1. Bomma W. H., Mulder J. H., Hop W. C. J. The influence of intramedullary nailing upon the development of metastasis in the treatment of an impending pathological fracture : An experimental study. *Expl. Metastasis*, 1983, 1, 205-212.
2. Burrows H. J., Wilson J. N., Scales J. T. Excision of tumors of humerus and femur, with restoration by internal prostheses. *J. Bone Joint Surg.*, 1975, 57-B, 148-159.
3. Cheng D. S., Seitz C. B., Eyre H. J. Nonoperative management of femoral, humeral and acetabular metastases in patients with breast cancer. *Cancer*, 1980, 45, 1533-1537.
4. Cockx E., Claes T, Hoogmartens M. *et al.* The isoelastic prosthesis for the shoulder joint. *Acta Orthop. Belg.*, 1983, 49, 275-285.
5. Delépine G., Goutallier D. Etude critique des techniques d'ostéosynthèse des fractures métastatiques de l'humérus. Réflexion à propos de 39 cas consécutifs. *Rev. Chir. Orthop.*, 1985, 71, 412-413.
6. Enneking W. F., Spanier S. S., Goodman M. A. A system for surgical staging of musculoskeletal sarcoma. *Clin. Orthop.*, 1980, 153, 106-120.
7. Fery A., Horle G., Krakowski J., Metz R. *et al.* Traitement chirurgical des métastases de l'humérus. *J. Chir. (Paris)*, 1988, 125, 721-729.
8. Flemming J. E., Beals R. K. Pathologic fracture of the humerus. *Clin. Orthop.*, 1986, 203, 258-260.
9. Harrington K. D., Johnston J. D., Turner R. H. *et al.* The use of methylmethacrylate as an adjunct in the internal

- fixation of malignant neoplastic fractures. *J. Bone Joint Surg.*, 1972, 54-A, 1665-1676.
10. Harrington K. D., Siu F. H., Enis J. E. *et al.* Methylmethacrylate as an adjuvant in internal fixation of pathological fractures. *J. Bone Joint Surg.*, 1976, 58-A, 1047.
 11. Hertlein H., Schurmann M., Mittlmeier T. *et al.* Experiences with the isoelastic prosthesis in treatment of humerus metastases. *Unfallchirurgie*, 1992, 18, 285-290.
 12. Lemaire R. Le traitement chirurgical des métastases menacées ou compliquées de fracture au niveau des os longs. *Acta Orthop. Belg.*, 1970, 40, 5-33.
 13. Lewallen R. P., Pritchard D. J., Sim F. H. Treatment of pathologic fractures or impending fractures of the humerus with Rush rods and methylmethacrylate. Experience with 55 cases in 54 patients, 1968-1977. *Clin. Orthop.*, 1982, 166, 193-198.
 14. Mast J. W., Spiegel P. G., Harvey J. P. Jr. *et al.* Fractures of the humeral shaft : A retrospective study of 240 adult fractures. *Clin. Orthop.*, 1975 ; 112 : 254-262.
 15. Murray J. A., Bruels M. C., Linberg R. D. Irradiation of polymethylmethacrylate. *In vitro* gamma radiation effect. *J. Bone and Joint Surg.*, 1974, 56-A, 311-312.
 16. Schatzker J., Ha'Eri G. B. Methylmethacrylate as an adjuvant in the internal fixation of pathological fractures. *Can. J. Surg.*, 1979, 22, 179-182.
 17. Sim F. H., Pritchard D. J. Metastatic disease in the upper extremity. *Clin. Orthop.*, 1982, 189, 83-94.
 18. Sim F. H., Chao E. Y., Pritchard D. J. *et al.* Replacement of the proximal humerus with a ceramic prosthesis. *Clin. Orthop.*, 1980, 146, 161-174.
 19. Sommelet J., Schmit D., Boileau F. *et al.* L'ostéosynthèse cimentée des fractures du vieillard et des fractures métastatiques des membres. *J. Chir. (Paris)*, 1973, 106, 257-264.
 20. Vail T. P., Harrelson J. M. Treatment of pathologic fracture of the humerus. *Clin. Orthop.*, 1991, 268, 197-202.

SAMENVATTING

M. GEBHART, D. DEQUANTER, E. VANDEWEYER.
Humerusmetastasen : een retrospectieve studie.

Deze retrospectieve studie slaat op 53 patiënten met 56 humerusmetastasen, hetzij met dreigend fractuurgevaar, hetzij met bestaande fractuur. Zestien metastasen werden behandeld met een proximale humerusprothese, en één met een elleboogprothese ; 38 werden opgevangen met een mergpen plus cement, en één met een osteosyntheseplaat. De auteurs zagen 48 patiënten met 51 metastasen terug. Volledige of bijna-volledige pijnvrijheid werd vastgesteld bij 92 % van de behandelde ledematen, en met een nuttige functie bij 90 %. Geen enkele grote verwikkeling deed zich voor, behalve migratie van de Hackethalpinen in één geval.

RÉSUMÉ

M. GEBHART, D. DEQUANTER, E. VANDEWEYER.
Atteinte métastatique de l'humérus : une étude rétrospective de 51 cas.

Les auteurs rapportent les résultats d'une revue rétrospective de 53 patients présentant 56 métastases humérales menacées ou compliquées de fracture pathologique. Seize cas ont été traités par une prothèse humérale proximale et un cas par une prothèse de coude, 38 par un enclouage centromédullaire avec injection de ciment et un par une plaque. Quarante-huit patients avec 51 métastases humérales ont pu être évalués. Une indolence complète ou quasi-complète a été obtenue pour 92% des membres supérieurs opérés et une fonction postopératoire adéquate a été recouvrée pour 90%. Il n'y a pas eu de complication majeure, à l'exception d'une migration de broches chez un patient.