Abstract
During a period of 5 years, 74 female and 27 male patients with an average age of 63.3 years underwent a total of 117 operations for the management of impending \( (n=41) \) or already existing \( (n=76) \) pathologic fractures due to osseous metastases. The average stay in hospital was 17.8 days, and the average postoperative survival 15.8 months. The patients whose limbs were stabilized as a preventive measure were discharged 1.5 days earlier and survived surgery 5.9 months longer than the patients with pathologic fractures. The large percentage of female patients is due to the predominant role of mammary cancer \( (50\%) \) and the comparatively long survival of patients after a primary diagnosis of this type of carcinoma. The other diagnoses involved were (in order of frequency): bronchial carcinoma \( (11\%) \), hypernephroma \( (8\%) \) and non-Hodgkin’s lymphoma \( (8\%) \). The metastases were mainly located at the proximal end or shaft of the femur \( (59.8\%) \) and in the humerus \( (18.8\%) \) so that in the majority of cases it was possible to implant weight-bearing prostheses or at least achieve enough stability to allow non-weight-bearing physiotherapy and thus early remobilization. The rate of systemic complications (excluding fatalities) was 14.5\%. Local complications in the operated area occurred in 24.8\% of cases. As a result, revision surgery was necessary in 10 cases \( (8.5\%) \), and the fatality rate in hospital (6 weeks) was 7.9\%. In view of the advanced stage of the disease in most of the patients, some of them with polypathia, we see these results as a basis for the generous indication for preventive stabilization of osseous metastases. Except in some cases, the primary intention of this therapy is not to cure the disease or prolong life but to improve the quality of life remaining for these patients while keeping their stay in hospital as short as possible and the rate of complications at an acceptable level.

Keywords Osseous metastases · Pathologic fractures · Surgical therapy

Introduction
Skeletal metastases are the result of hematogenous dissemination of cancer cells and the most frequent manifestation of tumours in the skeletal system. Solitary metastases are found in only about 5% of cases. As well as the filtering organs lung and liver, the skeletal system is one of the most frequent localizations of distant metastases of malignant tumours. This organotropism is explained by the drainage routes of the tumors, the large blood supply specific to this organ, and also by chemotactic factors and other, still partly speculative relationships between the medullary, bone and tumour cells \( [7, 11, 15, 16] \).

Increasingly differentiated diagnostic methods make it possible to detect metastases earlier than ever before. At the same time, improved methods of treatment lead to prolonged life expectancy accompanied by a rising incidence of bone metastases which are prone to fracture. The average life expectancy, however, is not determined by the treatment of the metastases, but by the nature of the primary tumour. The purpose of surgical therapy, therefore – with a few exceptions – is palliative, and the aim is to improve the quality of life remaining for the patient \( [9, 10, 13, 33] \) by:

- relieving pain
- preserving the function of the affected part of the skeleton
- preventing complications
- shortening the time spent in hospital,
- possibly facilitating care of the patient.
The choice of surgical procedure depends on the localization, number and size of the metastases, and the type of primary tumour and its malignancy. A retrospective analysis of 101 patients with bone metastases or pathological fractures was carried out in the Department of Traumatology and Reconstructive Surgery of the University Hospital Hamburg-Eppendorf (UKE) to investigate the possibilities open to the surgeon. The still surviving patients came for follow-up examination 6–12 months after the operation.

**Patients and methods**

During a 5-year period (1995–1999) 101 patients with bone metastases underwent 117 operations. Of these, 76 operations were performed to treat pathologic fractures, and 41 were performed in cases with impending fracture. Six patients were operated on twice during one stay in hospital, a further 6 underwent two operations during two stays in hospital, and 2 patients underwent three operations during three stays in hospital. Of the patients 50% had mammary cancer, 11% bronchial carcinoma, 8% renal cell cancer and 8% non-Hodgkin’s lymphomas. Carcinoma of the colorectum and female genital tract and metastases from a primary tumour unknown at the time of surgery were each diagnosed in 5% of cases. Of the primary tumours 2% were prostatic carcinomas and another 2% melanomas. Carcinomas of the thyroid, stomach, uretheral and floor of the mouth accounted for skeletal metastases in 1% of the patients.

A standardized questionnaire was used to evaluate the patients’ medical records. The data obtained from telephone interviews with patients were also classified by means of a standard questionnaire modified according to Enneking [6].

The date of death of the 62 already deceased patients was ascertained from the patients’ family doctor or the central registration office. The periods between primary diagnosis, operation date and date of death were necessary for the evaluation of the data according to the Kaplan-Meier method. All clinically relevant data were evaluated using a statistics programme. Analysis of qualitative parameters for the survival periods was carried out by using the log-rank test and with regard to the duration of the patients’ stay in hospital using the Wilcoxon-Mann-Whitney test. The significance level chosen for both test methods was $p=0.05$.

**Results**

**Age and gender**

The average age of the patients was 63.3 years (range 31–92 years). The majority were in their sixth or seventh decade. The patients were predominantly female (73.3%) with only 26.7% males (Fig. 1).

**Period between primary tumour and metastasis**

The period of time that elapsed between diagnosis of the primary tumour and evidence of osteolysis or pathologic fracture was 48.3 months on average. In the 1st year after diagnosis of the primary tumour, osseous metastases were diagnosed in 29 patients, and in the 2nd year in 14. From the 13th year on after primary tumour diagnosis, osseous metastases were detected in 15 further patients (Fig. 2). The average intervals between diagnosis of the three most frequent primary tumours and the first osseous metastasis/operation were: mammary cancer 62.8/80 months, hypernephroma 9.1/27.8 months, bronchial carcinoma 3.5/5.9 months. The average periods between manifestation of the first clinical symptoms of the metastasis and stabilization by surgery were: mammary cancer 17.2 months, renal cell cancer 18.7 months, bronchial carcinoma 2.5 months.

**Diagnostics and distribution of skeletal metastases**

In 35 patients local pain and tumour follow-up led to the diagnosis of an osseous metastasis prior to fracture. In 66 cases pathologic fractures had already occurred, some of them accompanied by deformity or neurological symptoms. Of the 117 operations, 41 (35%) were preventive measures and 76 (65%) were performed to treat the pathological fractures. In the previous 5-year period, the corresponding figures were 40% (preventive measures) and 60% (pathologic fractures).

In addition to anamnesis and clinical examination, standard radiography (Fig. 3) was the most important of the various methods of examination.

Bone scanning was very helpful, particularly in detecting cases for preventive stabilization. Computed tomography or magnetic resonance imaging were only necessary when adjoining structures (e.g. the spinal column) or the extent of soft-tissue involvement determined the therapeutic procedure. The surgically treated metastases were localized throughout the skeleton (Table 1, Fig. 4):