Metastasis size in pathologic femoral fractures

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Radiographic assessment was made of metastases in 69 consecutive patients with pathologic femoral fractures. The following variables were considered: width of metastasis, ratio between width of metastasis and bone, axial length of cortical destruction, and proportion of cortical bone destroyed of the circumference. Differences in size of the metastases were not related to location in the femur or histologic type. In 62 of 69 fractures the ratio between width of the metastasis and bone was ≥ 0.60, axial cortical destruction in the neck was ≥ 13 mm and in other parts of the femur ≥ 30 mm, and cortical destruction of the circumference ≥ 50 percent. Prophylactic internal fixation need not be considered for femur metastatic lesions that do not reach these limits.

To identify metastatic lesions of the femur requiring prophylactic internal fixation because of high fracture risk, several investigators have proposed that an assessment should be made of metastatic size and extent of cortical destruction (Beals et al. 1971, Fidler 1981, Lane et al. 1980, Parrish and Murray 1970, Schurman and Amstutz 1973).

We have assessed the extent of metastatic femoral lesions that had led to fracture and compared different modes of measuring the metastases. To find criteria for prophylactic surgical treatment, we analyzed the size of the metastases in relation to histologic tumor type, location in the femur, and pain before fracture.

Patients and methods

Sixty-nine patients with 69 pathologic femoral fractures were treated from 1971 to 1980. There were 46 women and 23 men with a median age of 63 (44–89) years. The primary tumors were breast in 37 patients, lung in 10, myeloma in 8, bladder in 4, prostate in 4, kidney in 3, and colon in 3 patients.

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The patients were classified into four groups according to the fracture location: neck, trochanteric or subtrochanteric region, and diaphysis. The metastatic size was measured at fracture level on anteroposterior and lateral radiographs. The following measurements were made (Figures 2 and 3): largest width of the metastasis (M), largest ratio between M and width of bone (B), axial length of cortex involved (H), and percentage of cortex involved in the circumference of the bone according to Fidler (1981). A metastasis was considered excentrically located (anterior or posterior, medial or lateral) when the difference in cortical involvement was more than one quarter: viz., $A_1/C_1 - A_2/C_2 > 1/4$ (Figure 2). In a pilot study of 10 fractures, a difference in any of the measurements of the metastases of up to 14 percent was recorded between 2 individual observers. In 12 permeative metastases with less clear-cut borders, the limits of the lesion were estimated according to visible changes in radiographic lucidity when compared with normal bone texture. At referral, the patients were asked about femoral pain before fracture.

The Spearman rho test was used for correlation analyses, the Mann-Whitney test for nonpaired analyses of two groups, and the Kruskal-Wallis test for more than two groups. In case of significant differences, the Kruskal-Wallis test was combined with a multiple comparison procedure (Dunn test) to find the group(s) that differed. $P < 0.05$ was regarded as significant.

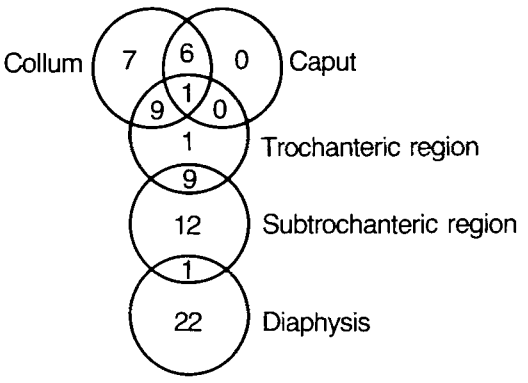


Figure 1. Distribution of the metastases. One metastasis involved the entire proximal femur.

Table 1. Size of metastases in pathologic fractures of the femur

	Median (range)	Value exceeded by 90% of the fractures
M	30 (14–40)	24
M/B	0.86 (0.47–1.00)	0.63
H	40 (10–149)	25
C	65 (20–100)	50

Anteroposterior and lateral radiographs. M largest width (mm). M/B largest ratio between width of metastasis and of bone (B). H maximal length of cortical destruction in axial bone length (mm). C percentage of cortex destroyed in the circumference of the femur.

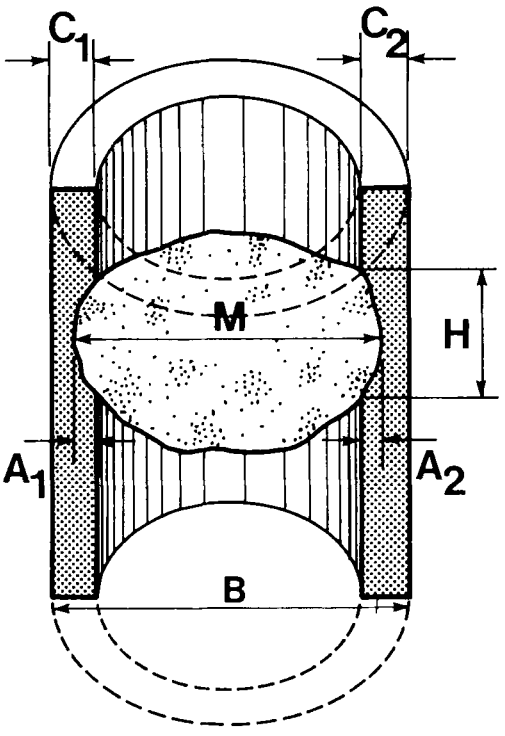


Figure 2. Size of the metastases. M, width of metastasis. C_1 and C_2, width of cortex. A_i and A_2, width of cortical destruction. B, width of bone.

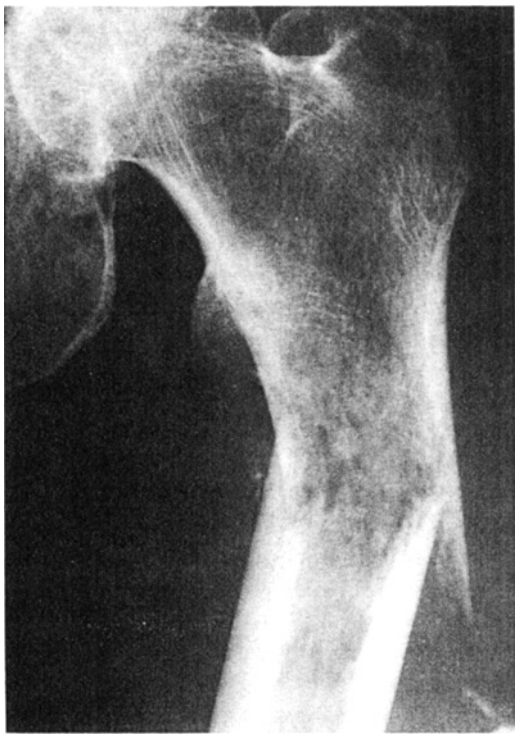
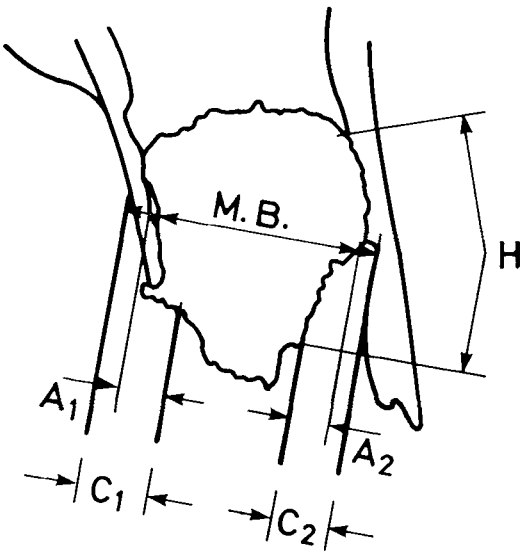


Figure 3. Measurement of a pathologic subtrochanteric fracture.



Results

Sixteen fractures were located in the neck, 10 in the trochanteric region, 20 in the subtrochanteric region, and 23 in the diaphysis (Figure 1). Twenty-three metastases were located centrally in both planes. In the anteroposterior view, 19 metastases were medial and 20 were lateral. In the lateral view, 17 metastases were located posteriorly and 17 anterior. All the metastases involved the cortex.

A correlation was found between the four different methods of measurement (rho = 0.60–0.41, $P < 0.001$) except between axial cortical destruction and width or relative width (Table 1). According to all four methods of measurement, there was no relationship between the size of the metastases and histologic tumor type. Nor was there any difference in size between lateral and medial metastases or of the posterior or anterior ones.

Metastases were wider in the trochanteric region than in the rest of the femur ($P < 0.01$), but taking into account the width of the bone (M/B), this difference disappeared. Similarly, no differences were found between the four femoral regions regarding absolute and relative width of metastases and percentage of cortex destroyed in the circumference.

Metastases located in the neck showed less axial cortical destruction (median 25 mm, range 10–40; 90 percent were ≥ 13 mm) than those in the other three femoral regions (median 50 mm, range 20–149; 90 percent were ≥ 30 mm); $P < 0.0001$.

Fifty-eight patients complained of femoral pain between 1 and 12 months before fracture. There were no differences in metastatic size or location between painful and painless lesions. Pain was not related to histologic tumor type.

Discussion

Although 12 of the metastases in this material were permeative, the different modes of measurement showed a close agreement. Thus, it seemed reliable to estimate the size of them all. In contrast, Keene et al. (1986) found that approximately half of the metastatic lesions that had led to fracture were permeative and lacked clear-cut borders, making them unmeasurable on standard radiographs. Differences between the nonselected material by Keene et al. (1986) and this selected series, and the methods of measurement probably account for these contradictory results. The correlation between the methods of measurement used in our material suggests that a combination of the methods does not improve the size assessment of a particular neoplastic lesion. However, axial cortical destruction and width or relative width are complementary, possibly due to the fact that metastases are often eccentrically located in the femur, and often extend more in the vertical plane than in the horizontal plane. To evaluate metastatic size in the entire femur, it is recommended either to combine the measure of the relative width and axial cortical destruction or simply to use a measurement of percentage cortical destruction of the circumference. All the metastases engaged the cortex, suggesting that femurs without cortical destruction do not need prophylactic surgery. In accordance with the findings in the subtrochanteric region by Zickel and Mouradian (1976), eccentrically located metastases (medial or lateral, anterior or posterior) were not found to differ in size.

The concept of a "high-risk femur" has been introduced by Zickel and Mouradian (1976): pure lysis, development of an occult malignant lesion, involvement of cortex, and increasing pain. Other combinations of criteria for prophylactic surgery have been proposed, and generally it is claimed essential to assess the size and the extension of cortical destruction (Beals et al. 1971, Fidler 1973 and 1981, Harrington 1982, Lane et al. 1980, Parrish and Murray 1970, Ryan et al. 1976). However, Keene et al. (1986) in an unselected material of 203 breast cancer patients with 516 metastatic lesions of the proximal femur concluded that metastatic size was not of predictive value for fracture. Nevertheless, it was found that the average percentage involvement of the length of the proximal femur was higher for femurs that sustained fracture. According to an investigation by Fidler (1981), the incidence of fracture through metastases in long bones was 2.3 percent when less than 50 percent of the cortical circumference was involved and 68 percent when more than 50 percent was involved. This accords with our series, in which 90 percent of the fractures occurred in the group of metastases with more than 50 percent circumferential cortical destruction.

In this selected fracture material, 90 percent of the metastases had measurements coinciding with

the limits for prophylactic surgery proposed by other authors on an empirical basis (Beals et al. 1971, Lane et al. 1980, Schurman and Amstutz 1973, Parrish and Murray 1970). However, using these limits, prophylactic fixation might result in unnecessary surgery.

Prophylactic internal fixation for pathologic lesions of the femur should be considered when the metastatic size exceeds the following measurements: ratio between width of metastasis and bone ≥ 0.60 and/or cortical destruction in axial bone length ≥ 13 mm in the neck and ≥ 30 mm in other parts of the femur, or involvement of the cortex circumference ≥ 50 percent.

Femoral pain prior to fracture was recorded for 58 of 69 patients in this material and was independent of size and location of the metastasis. Many authors mention pain as a sign of imminent fracture and as a criterion for prophylactic surgery (Beals et al. 1971, Parrish and Murray 1970, Schurman and Amstutz 1973, Zickel and Mouradian 1976); others report that 11 and 50 percent, respectively, of painful metastatic lesions eventually fracture (Keene et al. 1986, Fidler 1973). Pain seems to be a questionable predictive sign of imminent fracture.

The high-risk criteria of imminent fracture through metastatic lesions in bone are still to be defined. Factors such as bone strength, shape of the lesion (Clark et al. 1977), and premorbid degree of osteopenia are probably of importance.

References

Beals R K, Lawton G D, Snell W E. Prophylactic internal fixation of the femur in metastatic breast cancer. Cancer 1971;28(5):1350–4.

Clark C R, Morgan C, Sonstegard D A, Matthews L S. The effect of biopsy hole shape and size on bone strength. J Bone Joint Surg (Am) 1977;59(2):213–7.

Fidler M. Prophylactic internal fixation of secondary neoplastic deposits in long bones. Br Med J 1973;1(849):341–3.

Fidler M. Incidence of fracture through metastases in long bones. Acta Orthop Scand 1981;52(6):623–7.

Harrington K D. New trends in the management of lower extremity metastases. Clin Orthop 1982;(169):53–61.

Keene J S, Sellinger D S, McBeath A A, Engber W D. Metastatic breast cancer in the femur. A search for the lesion at risk of fracture. Clin Orthop 1986;(203):282–8.

Lane J M, Sculco T P, Zolan S. Treatment of pathological fractures of the hip by endoprosthetic replacement. J Bone Joint Surg (Am) 1980;62(6):954–9.

Parrish F F, Murray J A. Surgical treatment for secondary neoplastic fractures. A retrospective study of ninety-six patients. J Bone Joint Surg (Am) 1970; 52(4):665–86.

Ryan J R, Rowe D E, Salciccioli G G. Prophylactic internal fixation of the femur for neoplastic lesions. J Bone Joint Surg (Am) 1976;58(8):1071–4.

Schurman D J, Amstutz H C. Orthopedic management of patients with metastatic carcinoma of the breast. Surg Gynecol Obstet 1973;137(5):831–6.

Zickel R E, Mouradian W H. Intramedullary fixation of pathological fractures and lesions of the subtrochanteric region of the femur. J Bone Joint Surg (Am) 1976;58(8):1061–6.