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Osteolytic cortical destruction: an unusual pattern of skeletal metastases*

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Abstract. Twenty-two histologically proven cortical metastases in 11 patients with bronchogenic carcinoma (10 squamous cell and one adenocarcinoma) were studied. The intracortical foci could be classified according to four distinctive patterns of bone destruction: small focal intracortical lesions ("cookie-bite" or "cookie-cutter" pattern); large osteolytic lesions; saucerized intracortical lesions with well-defined periosteal reaction; and lesions with predominant cortical destruction extending into the soft tissue as well as the medullary cavity. All lesions were located in the femoral bones.

Key words: Bone metastases – Cortical metastases – Bronchogenic carcinoma – Osteolytic metastases

The development of osteolytic metastases from bronchogenic carcinoma has been documented in the literature [9]. Recently, Deutsch and associates reported that metastasis to the cortex from a primary bronchogenic carcinoma was not an unusual event [3, 4]. The authors also reported two cases of osteolytic cortical metastases from primary tumors in the lung [6, 7]. Additionally, in 1986, Davis and his associates presented 27 cases of solitary and multiple cortical metastases. In their material, cortical metastases not only developed from bronchogenic carcinoma, but also from primaries in the breast, kidney, and pancreas [2]. A review of the literature, however, disclosed only scattered references to cortical metastases from a primary source other than the lung [1, 5]. This prompted us to review our material on skeletal metastases from various primary tumors from the files of the Hospital for Joint Diseases-Orthopaedic Institute. The result of this study is the subject of this presentation.

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Materials and methods

We reviewed a total of 100 cases from the files of the Hospital for Joint-Diseases-Orthopaedic Institute for the years 1979–1986. Patients ranged in age from 38–88 years, (46 females and 54 males) and had various primary neoplasms including lung, breast, gastrointestinal tract, prostate, kidneys, thyroid, and uterus associated with skeletal metastases. In 33 patients, bone metastases were secondary to a bronchogenic carcinoma (30 squamous cell, 2 adenocarcinoma, and 1 oat cell carcinoma). In all patients conventional radiographic studies of affected bones were performed and, in the majority of cases, the evaluation included computed tomography. Only 11 patients presented with cortical metastases. The site and type of cortical destruction in these patients were recorded: small cortical destruction – "cookie-bite" or "cookie-cutter" lesions, large osteolytic cortical lesions, saucerized intracortical lesions with well-defined periosteal reaction, and lesions with predominant cortical destruction extending into the soft tissue as well as the medullary cavity. All cortical lesions were subjected to biopsy and proven to be metastatic lesions, ten from squamous cell carcinoma and one from adenocarcinoma of the lung.

Results

Of the 100 cases reviewed, cortical metastases were found only in the patients with carcinoma originating in the lung. In 11 out of 33 patients, the lesions were either purely cortical or predominantly cortical with some involvement of either cancellous bone or adjacent soft tissues. Five patients had one metastatic lesion, three patients had two lesions, two patients had three lesions, and one pa-

Table 1. Eleven patients (22 lesions) with cortical metastases from bronchogenic carcinoma

Patient	Age (years)	Sex	No. of lesions	Type of destruction
MP	38	F	1	Cortical with soft tissue involvement
MB	40	M	1	Saucerized, intracortical
LC	45	M	2	Osteolytic cortical (1) Saucerized, intracortical (1)
ES	46	F	1	Osteolytic, cortical
DS	51	M	2	Osteolytic, cortical (1) Cortical, focal destruction ("cookie-cutter") (1)
RH	53	F	1	Saucerized, intracortical
LR	62	F	3	Cortical, focal destruction ("cookie-cutter") (1) Saucerized, intracortical (1) Cortical with medullary involvement (1)
GK	63	F	2	Osteolytic cortical (1) Cortical with medullary involvement (1)
MK	67	F	1	Saucerized, intracortical
MG	72	F	3	Cortical with medullary involvement
UM	82	M	5	Cortical, focal destruction ("cookie-cutter")

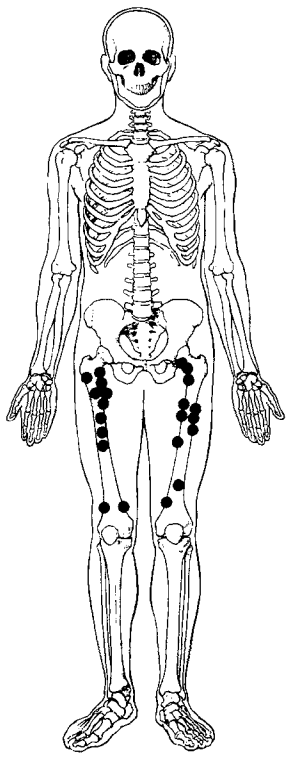


Fig. 1. Distribution of cortical metastases in 11 patients (M = 4, F = 7) ages 38–82, 22 lesions. 5 patients-1 lesion, 3 patients-2 lesions, 3 patients-3 and > lesions

Table 2. Four patterns of bone destruction identified in 11 patients (22 lesions)

Type I	Small focal lesions, marginal cortical destruction – scalloping ("cookie-bite" or "cookie-cutter") (7 lesions)
Type II	Large osteolytic cortical destruction (4 lesions)
Type III	Saucerized intracortical destruction with well-defined periosteal reaction (5 lesions)
Type IV	Predominantly cortical destruction extending into the soft tissues as well as the medullary cavity (6 lesions)

tient had five metastatic bony foci (Table 1). Seven of the 11 patients presented with bone metastases as an initial symptom. The lesions were distributed between right and left femora (Fig. 1). Four patterns of bone destruction have been identified from radiographic studies and CT appearance (Table 2): I. small focal lesions of marginal cortical destruction (referred to by Deutsch and Resnick [3] as "cookie-bite" or "cookie-cutter" lesions) (Fig. 2); II. large osteolytic cortical lesions (Fig. 3); III. saucerized intracortical lesions with well-defined periosteal reaction (Fig. 4); IV. lesions with predominant cortical destruction extending into the soft tissue and the cancellous bone (Fig. 5). Open biopsy confirmed the pathology in all cases.

Discussion

Review of the literature and our experience points to a high incidence of cortical metastases from carcinoma of the lung [3, 4, 6, 7]. Hematogenous spread is the usual pathway by which malignant cells reach the skeleton in systemic dissemination of the primary tumor. In such instances, the bulk of the tumor deposit will lodge in the bone marrow and cancellous bone [8]. Thus the initial radiologic appearance of a metastatic lesion in the skeleton consists of destruction of spongy bone with secondary involvement of the cortex.

It is a well-documented fact that the cortex of the long bones receives a unique blood supply through a vascular network originating in the overlying periosteum. Investigations by Trias and Fery showed the blood supply of cortical bone to arise from intercommunicating capillaries entering the cortical bone [10]. This vascular anatomy explains

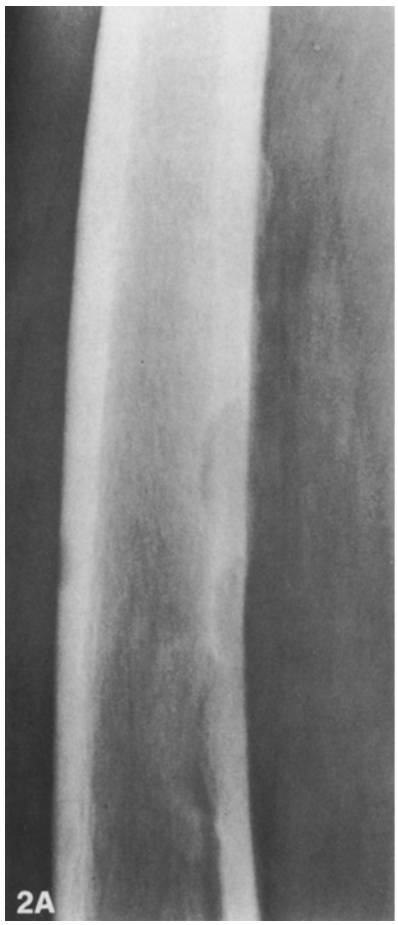
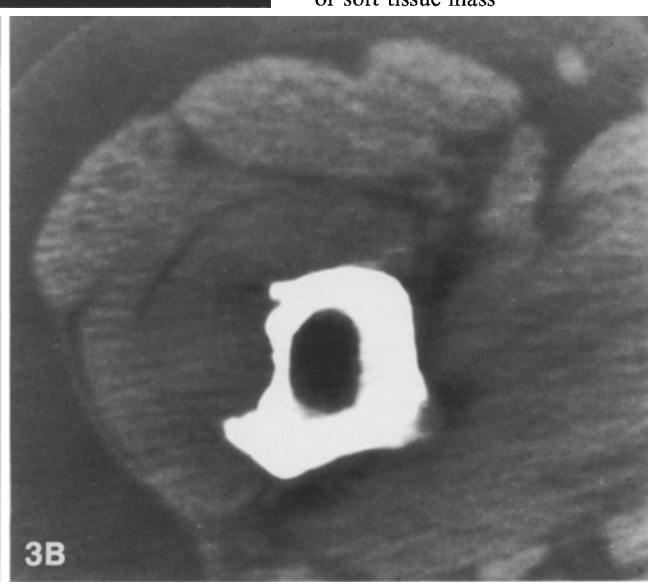


Fig. 2A, B. Eighty two-year-old man with a 3-week history of progressive pain in the left femur. **A** Lateral view of the left femur shows small cortical lesions, typical of "cookie-bite" pattern. **B** CT section demonstrates pure cortical involvement

Fig. 3A, B. Forty six-year-old woman with chronic cough for previous 6 months developed pain in the lateral aspect of the right upper thigh. **A** Anteroposterior view of the proximal femur demonstrates a large osteolytic lesion involving the lateral cortex. **B** CT section demonstrates sharply marginated cortical destruction. There is no evidence of either medullary involvement or soft tissue mass



why, in certain instances, the arterial dissemination of the tumor may lead to a metastatic focus in the cortex, without initial deposition in the spongy bone. Davis and associates hypothesized that, since metastases to the peripheral appendicular skeleton are the result of systemic arterial tumor dissemination, cortical metastases should occur, not only in bronchogenic carcinoma, but also in other primary malignancies capable of arterial dissemination. Their study of 27 patients with solitary and multi-

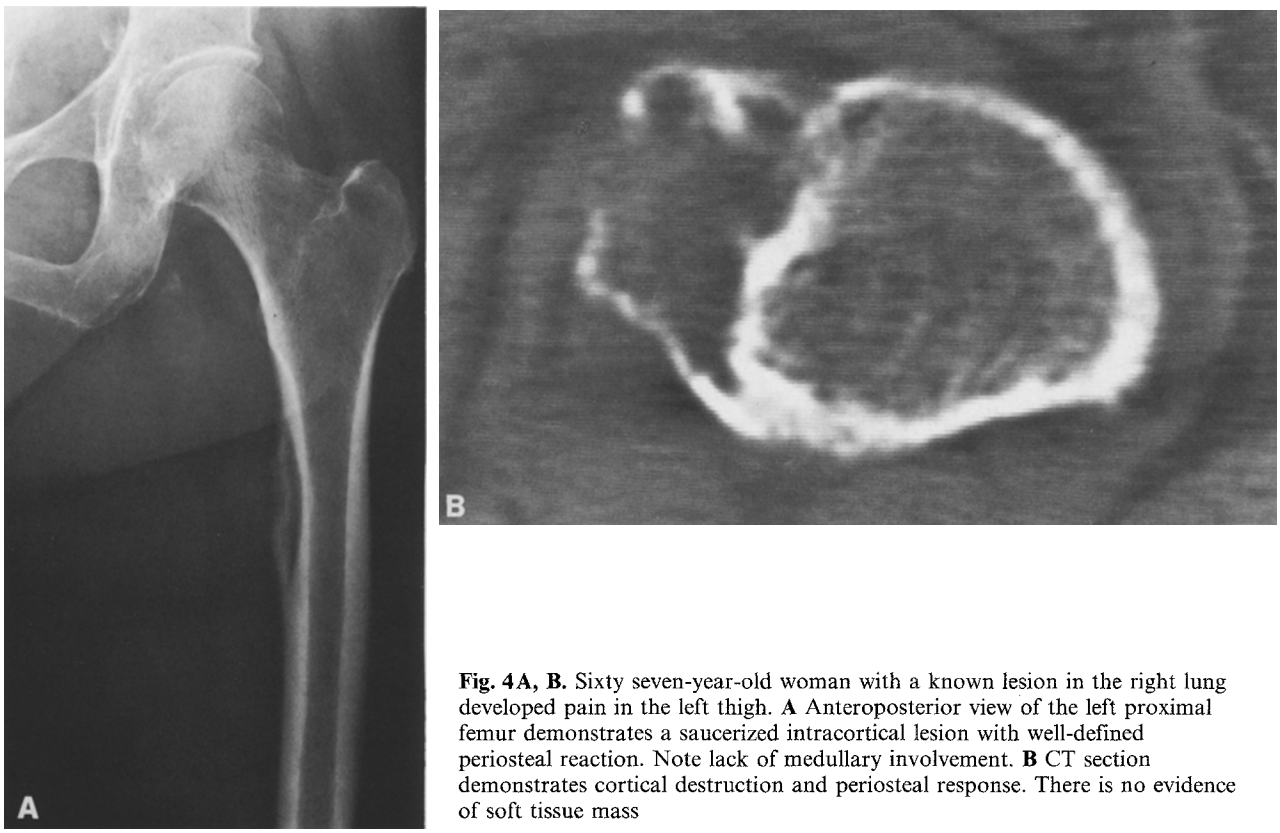


Fig. 4A, B. Sixty seven-year-old woman with a known lesion in the right lung developed pain in the left thigh. **A** Anteroposterior view of the left proximal femur demonstrates a saucerized intracortical lesion with well-defined periosteal reaction. Note lack of medullary involvement. **B** CT section demonstrates cortical destruction and periosteal response. There is no evidence of soft tissue mass

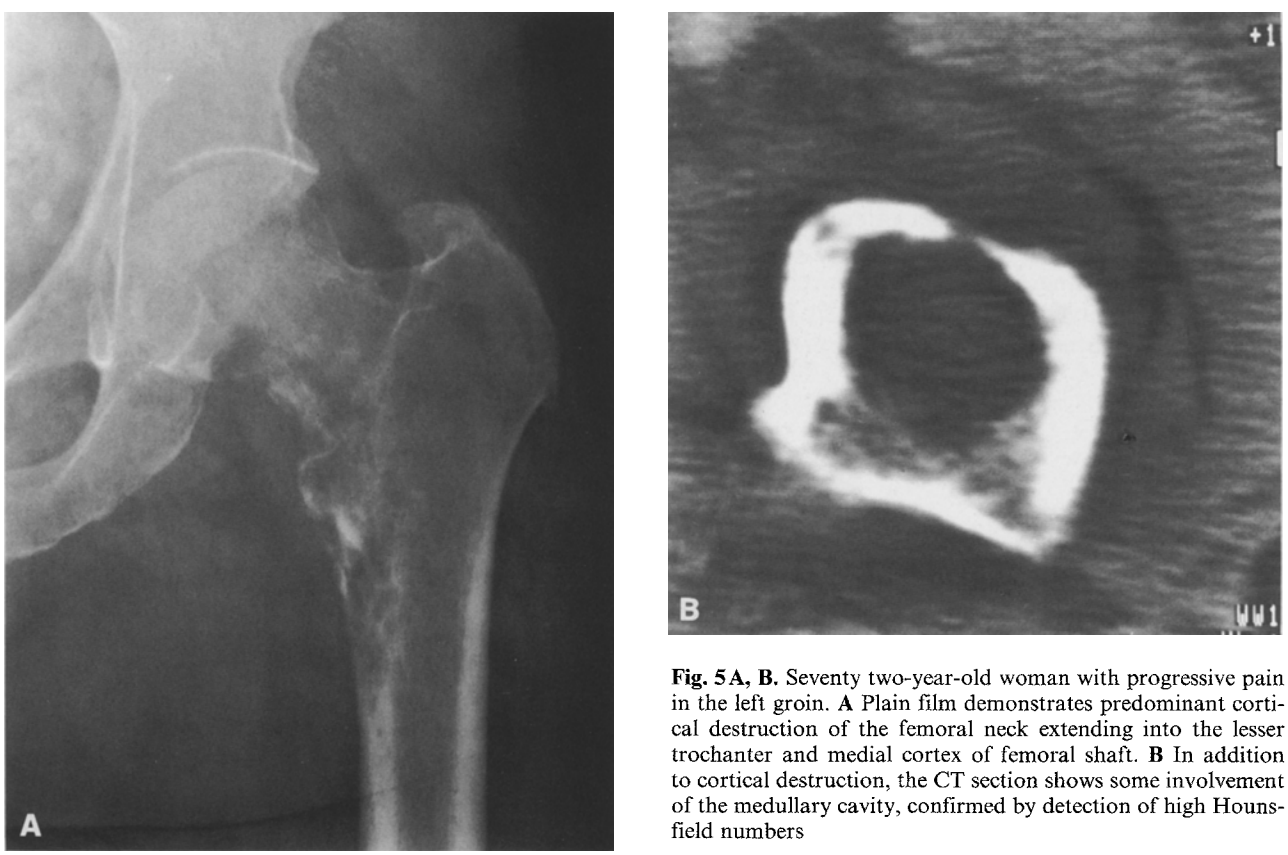


Fig. 5A, B. Seventy two-year-old woman with progressive pain in the left groin. **A** Plain film demonstrates predominant cortical destruction of the femoral neck extending into the lesser trochanter and medial cortex of femoral shaft. **B** In addition to cortical destruction, the CT section shows some involvement of the medullary cavity, confirmed by detection of high Hounsfield numbers

ple cortical metastases demonstrated that other primary tumors are also able to metastasize to the cortex [2]. Our study did not confirm this statement. Among the 100 cases of metastatic carcinoma, only those patients with lung cancer were found to have distinct cortical lesions. Although the radiographic and computed tomography (CT) examinations revealed cortical destruction in some of the patients with breast carcinoma and melanoma, in all those cases the spongy bone was affected at least to the same extent as the cortex. Hence, one can assume that cortical involvement was probably secondary to the bone marrow infiltration. Our results might have differed from the cited source for two reasons: this study was done retrospectively, hence the patients were not chosen consecutively; the institution it comes from represents a highly specialized orthopedic hospital that usually attracts unusual cases.

Four of our patients were known to have a bronchogenic carcinoma when the metastases were discovered. In seven patients, however, the first symptoms were related to skeletal involvement and only the characteristic appearance of cortical metastases prompted attention to the lung as a site of primary neoplasm.

Among the four types of cortical bone destruction seen in our patients (see Table 2), particularly characteristic were types I and III ("cookie-bite" and cortical saucerized lesions), which constituted 12 lesions or 55% of all cortical metastases (see Figs. 2 and 4). We believe that this type of lesion is highly typical of metastasis from bronchogenic carcinoma, since it was not associated with any other primary tumor. Another interesting fact was the exclusive involvement of the femora. This finding is not surprising, however, since predominance of femoral involvement was previously documented in the literature [2, 3, 4]. It is an interesting fact, however, that femora were exclusively affected only in those 11 patients with pure cortical metastases. In the remaining 22 patients with various types of lung cancer, the metastatic lesions were present in other bones as well, including the skull, vertebrae, pelvis, and long bones of the upper extremities. The question of why skeletal metastases from bronchogenic carcinoma have a predilection for implantation in the cortical bone, particularly the femur, is still open to speculation. Whatever the cause of this phenomenon may be, there is clinical evidence that the detection of such a characteristic pattern of cortical destruction should serve as a helpful hint in the search for an occult primary neoplasm, and the lung should be targeted for further work up without unnecessary delay.

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