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Operative Techniques in
Orthopaedics

Surgical Approach to Metastatic Bone Disease

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The treatment of metastatic cancer that has spread to the bone is predicated on palliation, not cure. Patients can still derive great benefit from surgical intervention. The prevention of fracture, maintenance of function, and relief of pain are the primary objectives of surgical intervention. Orthopaedic surgeons possess several techniques by which these goals may be realized. This article presents a general strategy for approaching patients with metastatic bone disease and the manner in which different implants may be used to attain the goals of palliation. As with the treatment of primary bone and soft tissue neoplasia, the care of patients with metastatic bone disease should be a multidisciplinary approach that includes orthopaedic surgeons, medical and radiation oncologists, nurses, social workers, physical therapists, the patients, and their families.
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The treatment of metastatic cancer that has spread to the bone is predicated on palliation, not cure. The disease did not start at the site of metastasis and thus cannot be cured by treating that site. However, patients can still derive great benefit from surgical intervention. The prevention of fracture, maintenance of function, and pain relief are the primary objectives.[1,2] The patient's life may even be prolonged by the treatment of metastatic bone lesions.[3]

The surgical approach to skeletal metastases became popular in the 1970s as fixation devices improved and orthopaedic surgeons became more comfortable with the use of polymethyl methacrylate (bone cement).[3-7] This, coupled with improvements in diagnostic imaging and anesthesia, provided opportunities for earlier and more aggressive interventions. Over time, the norm has shifted from treating patients with a life expectancy of 6 months or more to treating patients who can be expected to survive the surgery itself. Addressing pain relief and functional maximization has altered our ability to predict life expectancy. Advances in radiation therapy and systemic chemotherapy have also prolonged life and made it more challenging to predict longevity. Therefore, the requirements for more durable solutions to metastatic bone disease have also increased.

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Evaluation

Bone metastases are best treated in the "impending-fracture" stage.[5,8,9] There is less functional loss and rehabilitation is greatly enhanced if the bone has not broken. Pain with weight bearing, rotational stress, and light activity should be concerning findings in the cancer patient's history and physical examination. Night pain that awakens the patient from sleep and is not alleviated by positional change is another key diagnostic component. Patients may or may not report a soft tissue mass in the painful extremity and are notoriously unreliable at recognizing and reporting soft tissue changes. A simple tape measure can be very useful in this portion of the physical examination.

Routine plain-film radiographs are often sufficient for diagnosis in patients with known malignancies, especially those that historically show a predilection for bone metastases.[2,10,11] These include lung, breast, thyroid, prostate, colon, kidney, and uroepithelial cancers.[12,13] Other bone malignancies that may present with impending pathologic fractures include sarcoma, myeloma, and lymphoma. Destructive changes in the bone are appreciated on radiographs only after approximately 50% of the bone mineral density has been obliterated. This represents a relatively late finding, but it may

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be sufficient to make the clinical determination to proceed with surgery. If radiographically apparent bone destruction correlates with clinical findings in a patient with known malignancy, additional imaging may not be required. In instances of uncertainty, a non-contrast computed tomography (CT) scan can demonstrate the extent of a metastatic lesion and its resultant bone destruction. CT scan will also display the soft tissue extent of metastatic bone lesions.

Radionuclide bone scans are not particularly helpful in helping the surgeon to decide whether to operate. They are effective at total body assessment of the burden of metastatic disease but should not be taken as diagnostic for any one lesion. Bone scan evaluates bone remodeling at the lesion and therefore may yield a false-negative result in cases of myeloma or other aggressively lytic processes. Positron emission tomography scanning is more sensitive for these lesions as it is based on metabolism, but it must be remembered that even these scans are not absolutely specific. Magnetic resonance imaging is an excellent tool for the evaluation of bone marrow and soft tissue changes, but it is less definitive for bone evaluation. If there is concern for joint involvement, magnetic resonance imaging can be quite helpful.[14]

The dictum "Do not perform a cancer operation without a cancer diagnosis" always applies. All bone lesions should be histologically identified before any definitive surgery is undertaken. This can be accomplished via biopsy as a separate procedure or as the first step in definitive surgery. Surgeons unfamiliar with safe principles of biopsy should not perform them.

Implants

Musculoskeletal oncologists may employ a wide variety of devices for the treatment of impending or completed pathologic fractures. Intramedullary devices include standard intramedullary nails, cephalomedullary nails, Rush rods, and flexible nails (Fig. 1). Plating devices include both standard and locking plates or hip plate devices.[1-9,13,15] Lesions larger than 3 cm with loss of cortical bone should be considered for supplemental fixation with bone cement. This may be accomplished while inserting an intramedullary device or cementing around a previously placed device. With plates, it is often best to curette the lesion, fill the defect with cement, and place a neutralization plate and screws. Screws placed into a bone-and-cement composite are exceptionally stable. Antibiotic-impregnated cement has not been shown to provide additional benefit compared with regular cement. Cement impregnated with chemotherapeutic agents has been investigated, but thus far it has shown limited efficacy in terms of limiting local disease progression. Postoperative weight bearing or motion must be a clinical judgment based on the surgeon's assessment of stability. That being said, the musculoskeletal oncologist should strive to attain constructs that lend themselves to immediate weight bearing and minimize the burden on the patient's biology.[2] This guideline respects both the disease and the patient.

Nonoperative Treatment

Patients presenting with small, asymptomatic lesions, particularly those in non–weight-bearing bones, may be treated without surgical intervention. These lesions may be destressed by brace or sling application in the upper extremity and braces and the use of assistive devices (walker, crutches, or cane) in the lower extremity. Radiation or chemotherapy, or a combination of both, may be used as local and systemic treatments, respectively, for the underlying malignancy.[8] In the upper extremity, bracing or external support should be instituted before radiation therapy and continued until the patient is asymptomatic during activities of daily life. In the case of lower extremity and pelvis metastases, the patient's weight bearing should be protected for approximately 6 weeks after the cessation of radiation therapy and resolution of symptoms.

Figure 1 Intramedullary fixation of an impending pathologic fracture. Panel A (left) demonstrates a lytic lesion in the tibia of a 56-year-old man with known lung cancer. Open biopsy confirmed metastatic disease. The lesion was thoroughly curetted and a statically locked intramedullary nail was placed (B) and (C). He was immediately made weight-bearing as tolerated. After 2 weeks, he received adjuvant external beam radiotherapy to the tibia.