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Palliative Orthopaedic Surgery

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Abstract

Metastases to bone are the most common cause of destructive lesions to the skeleton in adults. Primary goals in the palliative management of metastatic bone lesions include controlling pain, preserving function, and helping to maintain or improve quality of life. These goals may be accomplished through various non operative and operative means. While some patients may not need surgical fixation of pathologic fractures or impending fractures, many will require durable bone fixation or replacement. Thoughtful evaluation of these patients by orthopaedic surgeons in collaboration with other members of the oncology team will help optimize treatment.

Keywords: Orthopaedic; Palliative surgery

Introduction

Metastases to bone are the most frequent cause of destructive lesions to the skeleton in adults [1]. The most common primary malignancies that metastasize to bone are breast, lung, kidney, and prostate carcinoma. The typical distribution of metastatic lesions is to the spine, ribs, pelvis, and proximal limb girdles [2]. However, almost any primary malignancy may metastasize to bone and any bone may be involved. While these patients are rarely cured of their disease they do require a multidisciplinary team approach to optimize treatment. The orthopaedic surgeon is an integral member of this team that offers palliative care to these patients, with a goal to reduce pain and improve the quality of life. The diagnostic possibilities for bone lesions with radiographic evidence of bone destruction include benign aggressive, primary malignant (with or without distant metastatic disease), or metastatic from carcinoma, lymphoma, and myeloma. The implications for patient survival for each of these categories of disease are vastly dissimilar, and each should be handled differently.

Obviously benign aggressive (noncancerous) tumors such as giant cell tumor of bone, aneurysmal bone cyst, and chondroblastoma to name a few may cause local bone destruction but are usually not life threatening. They are traditionally treated with intralesional curettage without need for aggressive margin-free surgery and systemic treatment is routinely not needed.

Primary malignant bone tumors, on the other hand, are cancers. Those that are high grade have a significant risk for systemic metastasis. Prompt surgical treatment is needed to remove these malignancies with surgical margins free of tumor. This surgery is performed as part of an overall approach to cure these patients. Patients with metastatic carcinoma and multiple myeloma are unlikely to be cured of their disease [3]. These cancers have already spread beyond their site of origin. Systemic treatment for these patients is rendered to achieve the goals of prolonging survival rather than cure. The role of the orthopaedic surgeon as a member of the treatment team is to help with efforts for prolonging survival, controlling pain, and preserving function.

Evaluation and Work-up

Work-up of patients with known or suspected metastatic bone disease begins with a thorough history and physical exam. Personal or family history of carcinoma in any patient with musculoskeletal pain should alert the physician to the possibility of metastatic disease. Lung, thyroid, breast, prostate and renal carcinoma account roughly for about 80% of skeletal metastases [4]. Patients typically complain of deep, aching pain experienced both at rest and with activity. If a lesion is present at or near a joint, pain can often be elicited with range of motion testing.

Laboratory studies can be a useful adjunct in patient evaluation. While rarely diagnostic of the primary carcinoma, they can help rule out other potential sources for pain or radiographic abnormality such as infection or diffuse marrow abnormalities (leukemia, myeloma). Routine blood work should include CBC with differential, chemistry panel including ionized calcium and alkaline phosphatase, and CRP sedimentation rate (ESR). Serum protein electrophoresis and PSA levels should be checked especially in cases of metastatic disease of unknown origin. Tumor serum markers such as CEA, AFP, CA-125 are not routinely used due to their lack of specificity [3].

Imaging studies are crucial to both diagnosis and treatment planning for patients with metastatic bone disease. Plain radiographs provide an abundance of information, and when combined with laboratory and clinical exam findings should allow the orthopedists to establish an accurate differential diagnosis in the majority of cases. Metastases to bone often appear as a lucent or radiolytic lesion with ill-defined borders. Surrounding bone sclerosis or periosteal reaction is uncommon. Soft tissue masses are seen infrequently. Some carcinomas, such as breast and prostate, can present with a mixed or blastic pattern of bone involvement.

Overall, the spine is the most frequent site of metastases followed by the pelvis and long bones, particularly the proximal femur and humerus. Metastatic lesions distal to the elbow or knee are rare and usually herald a poor prognosis. Lung and renal carcinoma are the most commonly seen cancers metastasizing to these distant sites. If a patient is suspected of having metastatic bone disease by initial history, physical exam and imaging studies, whole body bones scan are useful to gauge extent of disease. Previously asymptomatic lesions can be diagnosed, monitored, and treated appropriately.

Computed Tomography (CT) imaging is useful to evaluate lesions in the spine and pelvis where complex anatomical structures are better visualized in three dimensions. Furthermore, CT scanning can assist in surgical planning where resection and arthroplasty reconstruction is being considered such as the hip or proximal humerus. Finally,

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CT scans of the chest, abdomen, and pelvis are useful in detecting a primary cancer when the patient has a presumed metastatic lesion of unknown origin. Magnetic resonance imaging (MRI) has limited utility for metastatic bone disease. Excluding cases with soft tissue extension or spinal lesions with questionable cord or nerve root involvement, MRI is not routinely indicated.

Principles of Management

Palliative management of metastatic bone disease involves both operative and non operative measures. Careful consideration of the patient's prognosis and expected survival should be made to avoid placing a terminally ill patient at unnecessary surgical risk. This prognosis for survival depends to a large extent upon the specific tissue diagnosis of origin for metastatic carcinoma and the extent or stage of disease. A collaborative effort between the orthopaedic surgeon and the medical oncologist is necessary in most cases for a meaningful assessment of the patient's overall prognosis. Understandably, the short-term outcome of patients with metastatic bone disease cannot always be predicted but good communication between physicians and patients will help to avoid either over or under treatment.

The assessment of impending pathologic fracture risk especially for weight-bearing long bones is crucial to identify those patients who would benefit from prophylactic stabilization. Scoring systems, while imperfect, have been published to aid in the prediction of fracture risk (Table 1) [5]. In general, those patients with destruction in a lower extremity bone, especially about the hip, with a radiolytic process that are painful with weight bearing are at highest risk [6]. For those patients with a pathologic fracture due to metastatic disease, any fixation construct or reconstruction should allow the patient to bear weight immediately or have functional use of the involved extremity without restriction in the immediate post-operative period. For this reason, fixation should be as rigid and durable as possible. Usually this goal is achieved best with careful planning for fixation or reconstruction that will survive much longer than the predicted longevity of the patient. Protective fixation for the entire involved bone should be considered. Often cement fixation should be considered to augment fixation particularly when large destructive tumor voids are present [3].

The principles of traumatic (non-pathologic) fracture treatment with fixation do not apply to those that are pathologic. Unlike traumatic fractures, pathologic fractures due to metastatic disease usually do not heal. Fracture non-unions, due to a hostile bone environment secondary to cancer, radiation, or chemotherapy are the rule rather than the exception. Any patient with metastatic disease of unknown origin or diagnosed primary carcinoma with suspected skeletal metastasis requires biopsy to establish a diagnosis of metastatic carcinoma. In many cases, a biopsy can typically be done at the time of definitive surgical management with a frozen section analysis of tissue obtained during the same anesthetic. The biopsy should be performed in a manner consistent with recommended biopsy technique to avoid unnecessary contamination in the event the diagnosis proves to be a primary malignant bone tumor. If the pathologist cannot confirm metastatic disease or if the tissue is not optimal for frozen section analysis, then the surgeon should provide enough representative tissue for permanent section analysis and delay any further surgery until a definitive diagnosis is confirmed [3].

Score	1	2	3
Site	Upper limb	Lower limb	Peritrochanteric
Pain	Mild	Moderate	Functional
Lesion	Blastic	Mixed	Lytic
Size	<1/3	1/3 to 2/3	> 2/3

Table 1: Mirels Criteria; Score >8 suggests prophylactic fixation.

In general, palliative treatment of orthopaedic manifestations of metastatic disease must be planned with the timing of other neo-adjuvant or adjuvant treatments in mind. It is recommended that after surgery, further treatment with radiation or chemotherapy be delayed by a minimum of 2 weeks and in some cases up to 6 weeks to allow for incisional healing and decrease rates of wound dehiscence. It has been shown previously that there exists no difference in rates of wound complications if radiation is given prior to surgical intervention versus post surgery.

Disease of the Lower Extremity

While the spine is the most common site of metastatic bone disease, lesions in the pelvis and lower extremities are often more debilitating. These areas are subjected to high physiologic stresses and response to radiation therapy is less predictable. Although amputation in the lower extremity can be performed in an attempt to control local tumor burden, consideration is given to limb salvage whenever possible in order to maximize function and quality of life.

Femoral Head/Neck

Femoral head and neck lesions rarely heal and generally require resection and arthroplasty reconstruction [7]. If the patient's general heath permits, hemi-arthroplasty or total hip arthroplasty is recommended depending on the presence or absence of acetabular disease and/or arthritic changes. A CT scan of the pelvis is particularly useful in this setting to evaluate the hip joint, as acetabular metastatic lesions can go unrecognized in a large percentage of patients [8]. The decision to augment acetabular fixation with screws or cement should be dictated by overall bone quality and extent of metastatic disease.

On the femoral side, cement fixation of the stem is generally recommended. This allows for immediate full weight bearing and eliminates the need for biologic fixation that may be significantly impaired by adjuvant radiation treatment or metastatic disease. Whether to use a long or conventional length stem is controversial and continues to be debated. Proponents argue that long stemmed prosthesis offer the advantage of prophylactically stabilizing the entire femur in the event of disease progression. Those opposed to this concept argue that the risk of pulmonary complications from a large cement load outweigh the theoretical benefit of a long stem in the absence of documented non-contiguous metastatic lesions.

Intertrochanteric/Subtrochanteric Region

Both impending and realized fractures in this location can be treated with a variety of techniques including Open reduction and Internal Fixation (ORIF), use of an intramedullary device, or arthroplasty. The appropriate choice of technique depends on overall patient health and life expectancy, size of the lesion, amount of fracture displacement, condition of the hip joint, and experience of the treating surgeon. Use of a sliding hip screw and side plate (ORIF) requires lateral cortical integrity to be a viable option. Debate continues regarding the issue of tumor debulking and cement augmentation. Removing gross tumor at the fracture site has the advantage of decreasing tumor burden but often necessitates a larger exposure and increased blood loss. The residual tumor cavity should be packed with bone cement in conjunction with fracture reduction and fixation. Unfortunately, even with cement augmentation, this technique has a moderate incidence of failure.

Intramedullary devices typically enjoy better success rates than

ORIF techniques in this anatomic location. Advantages include a shorter lever arm and the ability to stabilize the entire femur. Reconstruction or cephalomedullary screws should be used. Depending on fracture pattern and surgeon experience, intramedullary devices can often be inserted with less blood loss and operative time compared with ORIF techniques. If treating an impending fracture with this technique, the surgeon should be confident of the diagnosis before proceeding. If a skeletal metastatic lesion has not been documented previously, intra-operative frozen sections should be obtained to confirm metastatic carcinoma. If the diagnosis is uncertain, additional tissue should be obtained and sent for permanent analysis and further definitive surgery postponed. Primary bone sarcomas, while much less common, can masquerade as a metastatic lesion.

Arthroplasty can be used as a primary mode of treatment, especially in cases of extensive bone loss or as a salvage procedure for failed ORIF or prophylactic stabilization. Consideration for use of a calcar replacement stem should be given. Every effort should be made to preserve the greater trochanter and native abductor mechanism. If this cannot be done, aproximal femoral replacement prosthesis is indicated. Post-operative rehab and therapy must be tailored appropriately to allow for soft tissue healing.

Femoral Diaphysis

Intramedullary nail fixation is the treatment of choice for both impending and realized fractures. Consideration should be given for placement of reconstruction or cephalomedullary screws even in the absence of documented disease at the proximal femur or femoral neck, especially for patients with longer life expectancies. The largest diameter nail possible should be used and the nail statically locked.

Whether to debulk or curette the metastatic lesion and augment the bone with cement depends on the size of the lesion. This issue may be somewhat controversial but lesions that occupy greater than one diaphyseal diameter in the proximal to distal plane or that prevent cortical contact of at least two cortices may benefit from cement stabilization [9].

Supracondylar Region

Lesions in this area are often difficult to treat secondary to comminution and/or poor bone stock. Fortunately, this is a relatively uncommon area for metastatic involvement. Generally, lesions are treated with tumor curettage and debulking followed by cement augmentation and ORIF. Locked plate constructs can be helpful when host bone is of poor quality and offer the advantage of unicortical screw placement if a pre-existing femoral stem or IMN is in place.

If the lesion involves the epiphysis or joint, conventional knee arthroplasty or distal femur replacement and hinged knee arthroplasty is chosen depending on the size of the lesion. The use of a long stemmed tibial component in this setting depends on surgeon preference and disease status of the tibia.

Tibia

Fewer than 5% of metastatic lesions involve the distal extremities or feet. Treatment principles based on anatomic location are similar to the femur. Proximal, periarticular lesions are managed best with resection and arthroplasty. Metaphyseal lesions, both proximal and distal, can be treated with curettage, cement, and ORIF techniques. Diaphyseal lesions are treated with intramedullary fixation with or without curettage and bone cement. Distal tibia lesions that involve the joint may require resection with ankle fusion if there is significant bone and cartilage destruction.

Foot

Metastatic bone lesions in the foot are uncommon and portend a poor prognosis. Lung and genitourinary carcinomas account for the majority of distal metastatic disease. Reconstructive efforts are difficult especially if there is extensive bony destruction. Partial amputation or ray resection often provides a better outcome and less morbidity in these patients whose expected survival is generally less than one year.

Disease of the Upper Extremity

In general, patients with metastatic disease of the upper extremity may be treated more conservatively than those with lower extremity involvement because the problems of patient immobility are less for this group. For example, patients with an impending fracture of the humerus and fore arm may be treated with low profile functional braces or splints and external beam radiation in the hope of improved pain control and progress of bone consolidation. However, those patients with a pathologic fracture rarely heal their fracture without internal fixation. If these patients have a reasonable longevity, then internal fixation is usually indicated for pain control and improved function.

With the goal of palliative orthopaedic care being to maximize function and quality of life, attempts at limb salvage are preferred to amputation in the upper extremity. However, amputation may be preferred when the tumor burden present is resistant to other modes of management and causes a decrease in functionality or quality of life that the patient deems unacceptable.

Humerus

The humerus has three regions that may be involved with metastatic disease. Each is unique and requires consideration for different treatment. The proximal humerus is a common site for metastatic disease. For those without high risk for fracture, consideration should be given for radiation and protection in a sling with gentle motion and restricted weight-bearing. Those at high risk for impending fracture should be treated with adequate fixation that allows for early motion to avoid problems of shoulder joint stiffness. Often the region of the head and surgical neck requires plate and screw fixation approached though a deltopectoral incision. This fixation is generally more rigid than that achieved with intramedullary nails with transfixation screws. Unfortunately, this proximal plate and screw constructs do not protect the remainder of the humerus. Preoperative workup should therefore include radiographs of the entire bone.

The finding of multifocal disease in the humerus warrants the use of an intramedullary nail with transfixation screws [10]. Occasionally patients may present with destruction of the humeral head and require a cemented hemiarthroplasty. Those with severe destruction of the proximal humerus occasionally require resection and reconstruction with a proximal humerus replacement. Patients with disease of the humeral diaphysis are best treated with locked medullary nails that span the entire length of the humerus. Metastatic disease involving the distal humerus or supracondylar region should be treated with plate and screw fixation with early, gentle elbow motion.

Forearm

Metastatic bone disease involving the forearm is much less common than that found in the humerus. Those patients with fracture or impending fracture should be treated with plate and screw fixation.

Conclusion

Patients with metastatic bone disease frequently require orthopaedic

intervention to insure improved quality of life and pain control. While some patients may not need surgical fixation of pathologic fractures or impending fractures, many will require durable bone fixation or replacement. Thoughtful evaluation of these patients in concert with collaboration with other members of the oncology team will help the surgeon optimize treatment for these patients.

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