Pathologic Humerus Fractures

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INTRODUCTION

Bony lesions may result in pathologic fractures. These lesions, when not of mesenchymal origin, commonly include myeloma, lymphoma, and most commonly metastastic carcinoma. The axial skeleton is the third most common site of bony metastasis, after the lung and liver. Of the 1.2 million new cases of cancer each year in the United States, one half will metastasize to the skeleton.[1] The tumors most likely to metastasize to bone are prostate (32%), breast (22%), kidney (16%), lung and thyroid.[1]

Metastatic disease to the axial skeleton occurs much more frequently in the spine, pelvis, ribs, and lower extremities than in the humerus. Yet, metastasis to the humerus accounts for 20% of osseous metastasis. The humerus is the second most common site for long bone metastases, behind only the femur in its frequency of involvment. In multiple myeloma, the majority of patients have pathologic fractures at the time of diagnosis, and up to 30% of patients present with non-vertebral fractures.[2]

Metastasis to the long bones usually reflects an advanced disease state. It has been recommended that the majority of patients with metastatic bone tumors receive multidisciplinary care from a team including orthopaedic oncologists, radiotherapists, and oncologists.[1]

HISTORICAL PERSPECTIVE

Historically, pathologic humerus fractures have been treated non-operatively with casts, splints, or braces in conjunction with radiotherapy. However, the functional outcome for these patients was poor, as use of the arm was extremely limited. As a result, surgical techniques for fracture stabilization have been employed using endoprostheses, polymethylmethacrylate (PMMA), and modern methods of fracture management. The success in functional improvement and pain relief has led to the much broader use of operative treatment in patients with metastatic disease.

ANATOMIC AND PHYSIOLOGICAL CONSIDERATIONS

Anatomically and biomechanically, the humerus can be divided into its proximal, middle, and distal thirds. Although the humerus is not a weight-bearing bone in normal individuals, patients with metastatic disease often have lower extremity involvement resulting in a greater dependence on the upper extremities to aid in transfers and weight-bearing. The method of operative fixation depends upon several factors including the location and size of the lesion, as well as the quality of the bone surrounding the tumor mass.

In the proximal humerus, the bone is subject to extremes of bending and rotational forces from its various muscle insertions. Preservation of rotator cuff function, when possible, will help to maximize post-operative function. As a result, lesions in the proximal epiphysis are typically treated with cemented, long-stemmed endoprostheses with preservation of the rotator cuff insertions onto the greater tuberosity. The proximal metaphysis is mostly cancellous bone, and stable fixation is difficult to achieve. Lesions in the metaphysis are reconstructed using a modular prostheses, and the rotator cuff insertions are re-attached to the implant using non-absorbable sutures when possible.

In the narrow diaphysis, metastatic lesions place the humerus at greatest risk for fracture. Thus, operative fixation is used more aggressively than in the proximal or distal humerus. Intramedullary fixation with flexible or rigid constructs is the treatment of choice for these lesions. However, unlike the femur, the medullary canal in the humerus is short and narrow. As a result, rigid, interlocked intramedullary devices often require significant amounts of reaming, and the proximal and distal interlocking screws require good bone quality to achieve functional stability. If either of these criteria is not met, Rush rods or Enders nails are utilized for fracture or impending fracture stabilization.

Supracondylar lesions, like the proximal humeral metaphysis, are best treated with open reduction and internal fixation using PMMA augmentation if there is sufficient normal bone proximal and distal to the metastatic lesion. If not, endoprosthetic implants with cement fixation remain the treatment of choice for these lesions.

DIAGNOSIS

Evaluation of the patient with metastatic disease starts

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with a thorough history and physical examination. Quality plain radiographs are essential for formulating a differential diagnosis and should include a chest x-ray and orthogonal views of the involved extremity. Whole-body technetium-99m-phophonate bone scintigraphy should also be performed to evaluate the entire skeleton for other sub-clinical sites of metastasis. It is not uncommon for bone scans in patients with multiple myeloma to fail in identifying bony involvement. Computed tomography (CT) scans of the chest, abdomen, and pelvis should also be obtained to assess for the presence of visceral metastasis. A serum laboratory panel including a protein electrophoresis, complete blood count (CBC), lactate dehydrogensase, serum calcium, erythrocyte sedimentation rate and alkaline phosphatase should also be checked. Lastly, in the patient with suspected metastatic disease, CT scans of the involved extremity can be useful in assessing the extent of cortical bone involvement and determining the risk of impending fracture.

TREATMENT

The indications for non-operative treatment are dependent on the size and location of bony involvement and on patient factors. Asymptomatic and small symptomatic lesions which involve less than 50% of the cortex are generally felt to be at low risk for fracture. Patients with life expectancies of less than 3 months and profound metastatic involvement of the upper extremity prohibiting adequate bony stabilization are generally considered non-operative candidates. Also, patients who do not use external aids for ambulation may be managed non-operatively.

As with non-operative treatment, the indications for surgical intervention reflect the level of local disease progression and the overall condition of the patient. The goals of surgical treatment are pain relief and improved functional use of the affected extremity. Surgical stabilization of symptomatic impending or pathologic fractures is frequently provided, as the life expectancies of patients with metastatic disease can vary considerably, and patients with advanced disease may live for several months. Other indications for operative treatment include osteolysis of more than 50% of the cortical diameter of the humerus in either the longitudinal or coronal plane. CT scan may be the best modality for evaluation of cortical lysis. Also, symptomatic lesions in the proximal third or midshaft of the humerus occur in areas of high biomechanical stress and are at particular risk for fracture. Lesions in these areas should be treated more aggressively with surgical intervention. Finally, surgical stabilization is indicated if the humerus is persistently painful with weight-bearing or if local progression of the tumor continues despite the institution of chemotherapy or radiation.

OPERATIVE TECHNIQUES

The type of operative procedure used to treat patients with metastatic disease of the humerus varies depending on the location and extent of the lesion as well as the experience of the surgeon. The choices for operative fixation include: internal fixation with plates and screws with or without PMMA enhancement; intramedullary nailing with or without interlocking devices; prosthetic replacement of the proximal or distal humerus; and segmental replacement with intercalary spacers. While the primary goals of surgery are to restore function and relieve pain, the surgeon should also biopsy the lesion in question to confirm or clarify the underlying diagnosis.

INTRAMEDULLARY NAILS

In comparison to plate osteosynthesis, locked intramedullary nailing involves less soft tissue injury, a lower rate of infection, and a theoretically smaller risk of radial nerve injury. (Figure 1) Most rigid humeral nails are inserted in an antegrade fashion. Disadvantages of this technique include the risk for impaired shoulder function secondary to rotator cuff injury during nail insertion and shoulder impingement from prominent nails.

Figure 1: Intramedullary nail placed in the humerus for pathologic fracture.

When performing intramedullary fixation of the humerus, the patient is usually placed supine in the beach chair position, with the entire affected extremity prepped and draped. A skin incision of approximately 4 cm is made longitudinally over the greater tuberosity. The deltoid muscle is split and the subdeltoid bursa is exposed in line with the incision. Palpation is used to identify the sulcus medial to the greater tuberosity of the proximal humerus, and a 1 cm incision is made in the supraspinatus tendon over the sulcus. Prtoecting the rotator cuff, a 5mm drill bit is used to enter the medullary canal and a 2.5mm guide pin is then passed across the impending or pathological fracture site. The medullary canal is reamed sequentially in 0.5mm increments. If the patient has osteoporotic bone, reaming may be unnecessary. If the patient's bone is of good quality outside of the metastatic lesion, as little reaming as possible should be performed to place the rod within the medullary canal. It should be noted that guide pin placement and reaming may be difficult in cases of osteoblastic lesions. The intramedullary rod is passed over the guide wire until the proximal part of the nail is countersunk within the humeral head. Compression across the fracture is achieved manually or with the "backstrike" technique after the distal interlocking screw has been placed. Locking screws are placed lateral-to-

medial in standard fashion. Fluoroscopy is used to ensure that adequate compression across the fracture has been achieved prior to placing interlocking screws. Finally, fluoroscopy is employed to check bony alignment and implant position prior to the end of surgery.

Figure 2: Resection of the proximal third of the humerus with oncologic hemiarthroplasty for metastatic disease.

ARTHROPLASTY

Arthroplasty for pathologic fractures is utilized if the lesion involves the proximal 1/6th of the humerus, the distal 1/3 of the humerus, or if there is inadequate bone stock to allow for adequate bony fixation using conventional techniques. (Figure 2)

If the insertion of the rotator cuff or deltoid muscles is not preserved during proximal humeral hemiarthroplasty, the patient must rely upon scapulothoracic motion to abduct the arm unless myodesis of these muscles to the implant is performed. Amputation is rarely necessary for the treatment of metastatic disease of the humerus unless there is intractable pain or seeding of the soft tissues surrounding the metastatic lesion.

When performing hemiarthroplasty of the proximal humerus, the patient is placed in modified beach chair position. An extended deltopectoral approach is used. The cephalic vein may be ligated or mobilized away from the operative field. Total shoulder replacement is rarely performed, as hemiarthroplasty is associated with reduced operative time, blood loss, and technical difficulty.

If a lesion of the distal humerus is being addressed, the biceps is retracted medially and the brachialis is split in its midline. The radial nerve is identified below the level of the deltoid insertion and protected. The brachioradialis and common wrist extensors are detached from the lateral humerus. Total elbow replacement is usually performed.

PLATE AND SCREW FIXATION WITH POLYMETHYLMETHACRYLATE

This technique for operative fixation can be used as an alternative to intramedullary fixation of the humerus when endoprosthetic replacement is not indicated. (Figure 3)

When performing internal fixation, the patient is prepped and draped in the same manner as described above. An extended deltopectoral approach is used to apply the plate and screws to the humerus. In the proximal humerus, a 4.5 mm direct compression plate with 6.5mm cancellous and 4.5 mm cortical screws may be used. In the diaphysis, the use of two orthogonal plates increases the rigidity of the construct. Newer locking plates may also be used. PMMA is then injected into the osseous defect and around the fixation device prior to closure over suction drains.

Figure 3: Open reduction and internal fixation of a pathologic fracture with a 3.5mm LCDC plate and cortical screws.

Figure 4: Pathologic fracture of the humeral diaphysis secondary to metastatic breast cancer.

SUMMARY

Pathologic humerus fractures are potentially disabling and difficult problems. The location and size of the lesion and the overall patient prognosis dictate the plan of care for each patient. Surgical treatment of metastatic humeral lesions is an effective means of relieving pain from impending or fractured pathologic lesions. Surgical stabilization of these lesions improves the function of the affected upper extremity in these patients so that they are able to enjoy an improved quality of life, utilize the upper extremity in assisted weight-bearing, and reduce the need for nursing care by maximizing the patient independence.

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