Orthopedic Management of Skeletal Metastases

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General

- Approximately 1.4 million new cancer patients diagnosed each year
- Incidence of skeletal metastases varies: 12-70%
- Bone---3rd most common organ involved by mets, behind lung and liver (In breast cancer it is the second most common site)
- Autopsy studies of breast cancer patients have demonstrated skeletal metastases in 90% of patients
- The quality of life of patients with skeletal metastases is compromised by pain, forced immobilization and pathological fractures
Most skeletal mets involve the axial skeleton and lower extremities (More heavily vascularized parts of skeleton)

- Thoracolumbar spine
- Pelvis
- Proximal femur/lower limb
- Skull
- Upper extremities 10-15% of skeletal metastases
General

- 7-10% of patients with skeletal metastases develop pathological fractures.
- Pathological fracture may be the first sign of disease.
- When the primary site is unknown, the most likely origin of the metastasis is from the lung or kidney.
- The primary site is not discovered in 3-4% of patients who present with a pathological fracture.
Most Common Metastases to Bone

- Myeloma
- Breast
- Lung
- Prostate
- Kidney
- Lymphoma
- Thyroid
- GI tract
- Melanoma
Presentation

- Pain, usually localized and intermittent at first; progressive increase in intensity over time
  - (Mechanical Pain and Biological Pain from cytokines and chemical mediators)
- Pain at Night
- Rotator cuff symptoms or frozen shoulder with shoulder girdle mets
- Referred pain, motor weakness, sensory deficits or bowel and bladder dysfunction from spine mets
Evaluation

- **Laboratory Studies**
  - CBC—anemia, bone marrow suppression, neutropenia
  - Chemistries—hypercalcemia, elevated alkaline phosphatase
  - PT/PTT, LFTs
  - Serum Protein Electrophoresis (SPEP)
  - Urinalysis
  - PSA, CEA (GI Cancer), CA129 (breast)

- **Radiological Studies**
  - Plain Radiographs
  - Bone Scan
  - MRI/CT Scan
  - PET Scan
Radiographic Studies

- Identify site of disease and extent of local disease
- Amount of bone involved
- Multiple lesions in a bone
- Presence of soft tissue component
- Other sites of disease (precautions during surgery)
- Important to determine optimal surgical approach, amount of tumor to be removed and method of reconstruction
X-Ray

- First test ordered for evaluating bone pain
- Usually permeative, sometimes geographic or well circumscribed
- Lytic, Blastic, Mixed
- Prostate Mets---blastic
- Breast Mets---usually mixed
- Lung Mets---usually lytic
- Renal cell and Thyroid---lytic, expansile
X-Ray

- Evaluate overall bony quality, structure
- Entire bone is radiographed so that all lesions can be identified and addressed during the same surgery
- Monitoring response to treatment, disease progression and local recurrence
- Skeletal survey for tumors that may not be detected on bone scan (multiple myeloma, renal cell carcinoma)
- 30% of bone must be destroyed in order for a lytic lesion to be evident on a plain x-ray
Breast -- Mixed
Renal Cell—Permeative, Lytic
Lung--Lytic
Thyroid—Lytic, Geographic, Blown Out
Prostate---Blastic
Myeloma
Bone Scan

- Demonstrates skeletal involvement much earlier than plain radiographs
- Occult bone lesions and metastatic disease
- Does not tell anything about the specific anatomic characteristics of a lesion (bony integrity)
- Monitoring response to treatment and disease progression
- Flare phenomenon occurs in 15% of patients
  - Initial increase in radioisotope uptake with treatment
  - Reflects new bone formation in response to treatment
CT Scan

- Confirm presence of metastatic disease especially when a patient presents with a pathological fracture as the initial presentation (r/o pseudopathologic fracture)
- Bony integrity/ cortical details
- Evaluating pelvis, shoulder girdle and spine that are often not well visualized on x-rays
MRI

- Extent of intramedullary and marrow involvement
- Extraosseous component
- Spine involvement and epidural extension, spinal cord compression
- Pathological fracture through neoplasm vs. osteoporotic bone vs. infection
- Evaluating adjacent joints/other pathology causing pain
PET Scan

- New Tool
- (18F)fluorodeoxyglucose---radiolabeled glucose
- Identifies metabolically active areas
- Nonspecific
- Must correlate with other studies
- May be useful for monitoring response to treatment
Biopsy Indications

- Confirm metastatic disease in a patient with a known primary
- Solitary or multiple bone lesions in a patient without a known primary tumor (rule out sarcoma, dedifferentiated chondrosarcoma, paget’s disease, metabolic bone disease, brown tumor of hyperparathyroidism)
- Disease progression
- Hormonal/immunohistochemical studies
Types of Biopsies

- **CT guided core needle biopsy**
  - Preferred method; Minimally invasive; Less risk of infection and hematoma; Less soft tissue contamination
  - Diagnostic accuracy up to 90% (same as open biopsy when performed by experienced radiologist and pathologist)
  - Biopsy site in line with incision for definitive procedure
  - Needle directed to portion of lesion most likely to yield diagnostic tissue
  - Especially useful for pelvic and spine lesions
Types of Biopsies

- **Fine needle aspiration (FNA)**
  - Confirm presence of metastatic carcinoma in a patient with known metastatic disease *(Not for solitary tumor)*

- **Open biopsy**
  - At time of surgery, confirm metastatic carcinoma in pt with known mets
  - Failed CT guided biopsies
Nonsurgical Management

- Hormonal Therapy—Prostate and Breast Cancer
- Chemotherapy/Immunotherapy
- Bisphosphonates—pamidronate
- Radiation
- Radiopharmaceuticals (Strontium 89, Iodine 131)---end stage diffuse painful bone mets
Surgery

- Surgical intervention must be undertaken with the intention of avoiding future surgery and complications (poor medical condition and limited life expectancy of patients)

- Most patients without a fracture do not require surgery however fractures are best treated by operative internal fixation
Goals of Surgery

- Pain relief
- Preservation and maintenance of function
- Facilitation of nursing and custodial care
- Local tumor control
- Skeletal stabilization
  - Immediate weight bearing and return to activity
  - Do not rely on fracture healing
  - Presence of tumor negatively affects the ability of a fracture to heal
Principles of Surgical Management

- Preoperative embolization of suspected vascular lesions
- Administration of perioperative antibiotics
- Correction of hypercalcemia
- Transfusion to correct preexisting anemia, thrombocytopenia and coagulopathy
- Modify surgical approach to avoid previously irradiated fields and ensure adequate soft tissue coverage
- Curettage to remove all gross tumor
Principles of Surgical Management

- Immediate rigid internal fixation supplemented with PMMA or cemented prosthetic replacement
- Filling defects with PMMA
- Postoperative nutritional supplementation to promote wound healing
- Adjuvant radiotherapy and/or chemotherapy
Tumor Excision

- Biological Control
- Curettage if sufficient bone remaining for reconstruction with PMMA
- Resection for total bone loss or if single isolated metastasis
- Patients with an isolated bone met may be rarely cured or rendered with prolonged disease free survival following resection
Composite Osteosynthesis

- Internal fixation devices usually combined with PMMA
- Use of PMMA to fill the defect reduces risk of fixation failure
- Fixation of impending and pathological fractures of the shaft of long bones (humerus and femur)
- Fix and protect entire bone when feasible
- Intramedullary rods have lower rates of failure than plates
- Intramedullary rods may be impossible with extensively sclerotic lesions—like drilling cement
Joint Replacement

- Resection and reconstruction of a joint using a prosthesis combined with cement
- Most commonly used around the hip and shoulder
- Long stem prosthesis often utilized
- Tumor prostheses for extensively destructive lesions or for a single bone metastasis
Long Stem Cemented Hemiarthroplasty
Segmental Prosthetic Replacements
Cryosurgery

- Use of liquid nitrogen as an adjunct to surgical curettage to freeze and destroy any residual microscopic cells

- Indications
  - Failed radiation treatment
  - Hypernephromas, Metastatic Thyroid
  - Tumors in difficult anatomic locations or where XRT may cause problems
Amputation

- Limited role in treatment of metastatic carcinoma
- Advanced cancer results in uncontrollable, intractable pain, a functionless extremity, tumor fungation, venous gangrene, sepsis or uncontrollable hemorrhage
- Can improve a patient’s quality of life and provide palliation
Radiofrequency Ablation (RFA)

- Minimally invasive procedure
- CAT Scan guidance by a musculoskeletal radiologist.
- Needle or probe into lesion and destroying it with the use of heat.
- Outpatient procedure with the patient returning home the same day.
Radiofrequency Ablation (RFA)

- Indications (not well defined)
  - Small painful lesion with low risk of pathological fracture
  - At risk lesion; small lesion if progresses will place patient at risk of a pathological fracture
  - Failed radiation treatment
  - Tumor in area where it may be preferrable to avoid XRT (ie pelvis because of bone marrow suppression and need to get chemotherapy)
Percutaneous CT guided Cryoablation

- Minimally invasive treatment of a lesion with use of argon probes that directly freeze the lesion to subzero temperatures
- Preoperative planning for probe placement
- Ice ball is observed under CT
- Indications are poorly defined
Percutaneous CT Guided Cryoablation
Pitfalls
Path Fx of Femoral Neck
Breast Cancer
Metastatic Renal Cell Carcinoma of Pelvis
Metastatic Renal Cell
Surgical Indications

- Pathological Fracture
- Impending Pathological Fracture
  - Pain
  - Location of lesion (weight bearing, pelvis/spine); Number of Lesions
  - Size of lesion
  - Medullary and/or cortical involvement
  - Primary tumor type and resposiveness to radiation
  - Undergoing chemotherapy?? Will systemic treatment be interrupted
  - Age
  - Health Status
  - Activity level; Weight of patient
  - Prognosis
  - Patient’s acceptance of risking a pathological fracture with nonoperative treatment
Prophylactic Fixation

- Many studies designed to assess risk of actually fracturing
- Can not accurately assess the risk of fracturing because of many confounding variables
- Endosteal resorption of $\frac{1}{2}$ cortical thickness reduces bone strength by 70%
Prophylactic Fixation

- Pain
- Site of lesion
- Blastic or lytic
- Size
- Medullary and/or cortical
Prophylactic Fixation

- Painful medullary lytic lesion resulting in 50% endosteal resorption of cortex
- Painful lytic lesion involving cortex that is more than 2.5 cm long or larger than the cross sectional diameter of the bone
- Lesion producing functional pain after radiation therapy
- Using these criteria, during surgical exploration the bone is found to be practically fractured
Conservative Management

- Braces
- Wheel chair
- Radiation
- RF Ablation
- Cryoablation
Type of Surgery/Fixation Method

- Depends on Site and Extent of Disease
  - Epiphyseal
  - Metaphyseal
  - Diaphyseal
Epiphyseal Fractures

- Arthroplasty-cemented
- Stem length chosen to treat existing or potential lesions in the same bone
- Usually Long Stem
Metaphyseal Fractures

- **Prosthetic replacement**
  - Can be difficult if bone is actually fractured and there is extensive bony destruction
  - Much easier for impending fractures

- **Intramedullary rods**
  - May not adequately control the proximal fragment
  - At risk for failure if tumor progresses proximally or does not respond to radiation
  - At risk for failure if fracture does not heal—augment with PMMA

- **Plate and screw combinations**
  - Does not fix entire bone
  - More prone to failure than intramedullary rods
  - Mostly for metaphyseal fractures with densely sclerotic bone
Diaphyseal Fractures

- Cephalomedullary intramedullary rods
  - Fixes entire bone
- Rush rods with cement
  - May be good for humerus if want to avoid shoulder pain/rotator cuff
- Flexible nails
Specific Anatomic Sites
Proximal Femur

- Long stem cemented hemiarthroplasty
  - Femoral Neck, Intertrochanteric, Subtrochanteric
- Cephalomedullary nail
- Compression screw and side plate
- Cannulated screws
Proximal Femur
Acetabulum

- Polyethylene Spacer, cement, threaded steinman pins
- Acetabular cage, total hip replacement, cement, steinman pins
- Saddle prosthesis
Acetabulum
3 Months After Saddle Prosthesis
9 Months Postop
Femoral Shaft

- Cephalomedullary nail (gamma nail)
- Fleible nails and cement
Distal Femur

- Cephalomedullary nails
- Retrograde femoral nail
- Flexible nails, Rush rods
Proximal Humerus

- Long stem hemiarthroplasty
- Cephalomedullary nail
  - No Distal Interlocking Screw
- Rush rods
Humeral Shaft

- Intramedullary (cephalomedullary) nail
  - Cemented
  - No distal interlocking screw
- Rush rods
Elbow/Distal Humerus

- IM Nail
- Rush Rods/Flexible Nails
Tibia

- Intramedullary rods
- Rush rods
Segmental Prostheses
Hip/Proximal Femur
3 Months Postop
1 Year Postop
Distal Femur
Elbow
12 Weeks Postop
Proximal Humerus
3 Weeks Postop
Rehabilitation

- Important to restore function and improve mobility as soon as possible
- Important for patient to gain independence
Thank You!!