MRI - Technique

- Obtain an adequate history
- Correlate with x-rays, CT and scintigraphy
- Always before biopsy (needle or open)
- Mark the lesion
- Make patient comfortable

Neurofibroma of median nerve 27F Sag T2FS
MRI - Technique

- High field strength helps - not essential
- T1 and T2 to characterize
- FS for sensitivity, cartilage, and fatty tumors
- Multiple planes
- Shaft
  - Axial,
    - Sagittal and Coronal
- Adjacent to Joint
  - Sagittal and Coronal
  - Axial
MRI Contrast

- May add a little to conspicuity
- Helps define tumour V's necrosis
- Greatly enhanced by T1FS
- Useful Post Chemotherapy/XRT
- Occasionally diagnostic

Neurofibroma T1FSGd
Gd-DTPA

- Substitute ultrasound

- Helpful in selected cases
  - Next to fluid
    - Epidural or intraarticular
  - Homogeneous solid vs cystic
  - Assess vascularity prior to biopsy
  - Post-treatment

- Indications are controversial for tumor imaging

Sag T1FS post Gd
Dynamic Enhancement

- 84% of malignant tumors had contrast enhancement slopes >30%
- 72% of benign tumors had contrast enhancement slopes <30%
- Areas of necrosis and peritumoral edema enhanced significantly less and more slowly than viable tumor

Erlemann et al, Radiology 171:767,1989
MR Angiography

- Defines anatomy of major vessels and their relation to neoplasms
- Differentiates masses from vascular pathology (eg. aneurysm or pseudoaneurysm)
Detection

- Initial examination
  conventional radiography

- Bone neoplasms
  Higher sensitivity with CT, scintigraphy and MR

- Soft tissue neoplasms
  Higher sensitivity with CT, ultrasound and MR
Histological Characterization

- Benign tumors, metastases, round cell tumors and pseudotumors are managed differently than sarcoma.

- Management of sarcomas depends on grade and anatomic extent rather than on histologic type.

Pseudotumor due to bone infarct
Histologic Characterization

- Emphasis of radiology training

- Surgeon more interested in where it is than what it is

- Biopsy necessary in sarcoma for accurate diagnosis
Osseous Tumors

- Metastatic disease most common
- Primary benign tumors more common than primary malignant tumors
- Most common primary malignancies are myeloma, osteosarcoma and Ewing sarcoma
- Other primary skeletal malignancies rare
Benign V’s Malignant

- Signal intensity
- Tumor margin
- Signal inhomogeneity
- Neurovascular invasion
- Growth rate
- Tumor size
- Tumor location
- Soft tissue extension
- Multicompartiment involvement
- Bone destruction

Kransdorf, AJR 153:541, 1989
Histological Characterization

- Epidemiology
  - Age of patient

- Distribution
  - Diffuse
  - Disseminated
  - Solitary

- Tumor features
  - Location
  - Biologic activity
  - Matrix

Primary Bone Tumors Age 0-10 from Senac et al, Radiology 160:491, 1986
Distribution

- **Diffuse**
  - All bone is histologically abnormal

- **Disseminated**
  - Multiple distinct lesions

- Few

- Solitary
Diffuse Distribution

- Radiographically, disease may appear diffuse, disseminated or even focal
- Pattern seen with dysplastic, metabolic and endocrine disease
- Less commonly, seen with neoplastic infiltration
Disseminated Distribution

- Normal intervening bone
- Lesions may be synchronous or metachronous
- Not all lesions may be evident radiographically

- Metastatic disease
- Multiple myeloma

- Paget disease
- Eosinophilic granuloma
- Fibrous dysplasia
- Enchondromatosis
- Multiple osteochondromatosis
Disseminated Distribution

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Metastases ST and bone
Distribution - Solitary lesion

- 10-15% of mets
- Ability to identify lesion radiographically depends on what it does to underlying osseous matrix
Location

• Osseous
• Soft tissue
• Intraarticular
Location

- Which bone is involved?
- Each neoplasm has a tendency to involve particular bones

- Enchondroma
- Simple bone cyst
- Chordoma
- Giant cell tumor
- Osteosarcoma
- Adamantinoma
Location

- Longitudinal
  - Epiphysis
  - Metaphysis
  - Diaphysis

- Transverse
  - Central
  - Eccentric
  - Cortical
  - Surface
Location - Joint

- PVNS
- Synovial osteochondromatosis
- Hemangioma
- Synovial sarcoma
Biologic activity

- Geographic
- Moth-eaten
- Permeative
• Difficult to distinguish tumor from peritumoral edema
• Benign and malignant tumors can have peritumoral edema
• Tumor and edema enhance with Gd
• Gadolinium flow rate may be helpful
Peritumoral edema

- Osteoid osteoma
- Chondroblastoma
- Eosinophilic granuloma
Expansion

- Deposition of solid periosteal layer around periphery of lesion
- Expansion implies loss of original cortex
- Generally seen in slowly growing lesions
- Does not mean that the lesion is benign
Expansile lytic lesions of bone

- Metastases
  - Renal, Thyroid, Breast, Lung, Melanoma, Phaeo

- Primary malignant
  - Plasmacytoma

- Primary benign
  - ABC, GCT, Enchondroma

- Non-neoplastic
  - Hemophilia, Brown, Hydatid, Fibrous dysplasia
Biologic activity

- **Mildly expansile**
  - Unicameral bone cyst
  - Giant cell tumor
  - Nonossifying fibroma

- **Markedly expansile**
  - Aneurysmal bone cyst
  - Plasmacytoma
  - Hemophiliac pseudotumor
Types of periostitis

- Uninterrupted solid
- Uninterrupted single linear
- Interrupted "onion-skin"
- Interrupted "Codman's triangle"
- Perpendicular "sunburst"
- Perpendicular "hair-on-end"
Soft tissues

- Soft tissue component
- Distortion of fat planes
- Soft tissue edema
- Matrix in soft tissue
Histologic Characterization - Matrix

- Acellular substance produced by the lesion
- Helps define histology of lesion
  - Ossific
  - Chondroid
  - Lipoid
  - Myxoid
  - Collagenous
Matrix – MR signal - ↓T1, ↑T2

- Nonspecific

- Majority of benign and malignant lesions show this pattern

- History, location and configuration help establish differential diagnosis
• Fat
  • Lipoma
  • Well-differentiated liposarcoma
  • Hemangioma

• Subacute blood

• Paramagnetic substances
- Calcification
- Ossification
- Crystalline structures
- **Dense fibrous tissues**
- Hemosiderin
- Flowing blood
- Gas
- Foreign bodies

'T1, 'T2
Staging

- Assess anatomic extent of the lesion
- Guide treatment
- Provide prognosis
- Ultimately, improve longevity
## Staging

<table>
<thead>
<tr>
<th>Surgical Staging System</th>
<th>American Joint Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthopedic surgeons</td>
<td>Oncologists</td>
</tr>
<tr>
<td>Benign and malignant lesions</td>
<td>Malignant lesions only</td>
</tr>
<tr>
<td>Bone and soft tissue</td>
<td>Soft tissue only</td>
</tr>
<tr>
<td>Compartmental anatomy important</td>
<td>Tumor size important</td>
</tr>
<tr>
<td>Nodal metastasis treated same as distant metastasis</td>
<td>Nodes are evaluated separately</td>
</tr>
</tbody>
</table>
Surgical staging system

- The number describes the biological activity of the lesion
- The letter describes the anatomic extent of the tumor

<table>
<thead>
<tr>
<th>Stage</th>
<th>1A</th>
<th>1B</th>
<th>2A</th>
<th>2B</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>Grade</td>
<td>G1</td>
<td>G1</td>
<td>G2</td>
<td>G2</td>
<td>G1-2</td>
</tr>
<tr>
<td>Tumor</td>
<td>T1</td>
<td>T2</td>
<td>T1</td>
<td>T2</td>
<td>T1-2</td>
</tr>
<tr>
<td>Mets</td>
<td>M0</td>
<td>M0</td>
<td>M0</td>
<td>M0</td>
<td>M1</td>
</tr>
</tbody>
</table>

Malignant tumor staging using SSS
| T0   | True capsule surrounds tumor |
| T1   | Extracapsular, but still intracompartmental |
| T2   | Extracapsular and extracompartmental Abutment of NV bundle |

**SSS Tumor**

**T0 - Ganglion**
Stage - T1

- Extracapsular but intracompartmental
- Skin and subcutaneous tissues
- One muscle compartment
- Intracortical
- Paraosseous without muscle or bone invasion
- Single ray of hand or foot
Stage - T2

- Extracapsular extracompartmental
- Lesion no longer confined by periosteum or fascia
- Increases risk of metastasis and recurrence
Stage - T2

- Extracapsular extracompartmental
- Lesion no longer confined by periosteum or fascia
- Increases risk of metastasis and recurrence

Sciatic invasion by liposarcoma - Stage T2
Sarcoma metastasis

- Most common site of sarcoma metastasis is lung
- Lung staging part of initial tumor workup for sarcoma
- CT scanning more sensitive than radiography
- CT used for staging, biopsy, and follow-up
Sarcoma metastasis

- Next most common site is bone
- Axial and diaphyseal predominance
- Osteolytic in 88%, majority show moth-eaten pattern
- Cortical violation in 51%, high risk of pathologic fracture
- Bone scan has high false negative rate!
Bone mets from sarcoma

Wong et al, Radiology 143:71, 1982
Biopsy

- Metastatic disease
- Round cell tumor
- Primary bone or soft tissue neoplasm only after consultation with orthopedic surgeon
- Local staging should be completed prior to biopsy

Fibrous tumor of soft tissue parts
Biopsy

- Fluoroscopic
- US for soft tissue
- CT guidance for axial and deep lesions
- Fine needle aspiration
- Core biopsy with cutting needle or trephine
Diagnostic imaging

- Technique
- Detection
- Histologic characterization
- Anatomic staging
- Biopsy
- Follow-up

Neurofibromatosis
Follow-up

- Monitor therapy
- Identify complications
- Detect recurrence
- Detect metastases

AKA no recurrence. Bursa
Follow-up

- Clinical assessment limited
- Laboratory indicators limited
- Diagnostic imaging
- Histology and pathology
MRI Follow Up

- Be cost effective
- Have baseline 12 week post op
- Often and Limited rather then Infrequent and Extensive
- Limit scans to useful plane
- Limit scans to those previously shown to be Sensitive for the tumor
- Mainstay of follow up for low grade tumour
Improved prognosis

- Earlier detection
- More accurate staging
- Adequate surgical resection
- Adjuvant radiation and/or chemotherapy
Treatment

• Observation
• Intralesional injection
• Intralesional curettage
• Marginal excision
• Wide resection
• Radical amputation
• Chemotherapy
• Radiation therapy
Recurrence of Musculoskeletal tumors

- Low grade
  - Rarely recur

- Moderate grade
  - Local recurrence common

- High grade
  - Local recurrence and distant metastasis common
Local recurrence

- Increased size of lesion
- Development of new areas of osteolysis
- Cortical thinning and destruction
- Resorption of graft
- Arrest or failure of healing
Increased signal post therapy

- Residual or recurrent tumor
- Necrosis
- Lymphocele
- Hemorrhage
- Edema
- Granulation tissue

Post liposarcoma resection and radiation therapy