Juxtaarticular Soft Tissue Masses

Mark D. Murphey, MD, FACR

Soft Tissue Masses In and About Joints

- Tumorlike: tumoral calcinosis, pigmented villonodular synovitis (PVNS), ganglion, synovial cyst, myositis ossificans
- Benign: synovial lipoma, myxoma, synovial chondromatosis/chondroma, nodular fasciitis
- Malignant: synovial sarcoma, clear cell sarcoma

Tumoral Calcinosis: Clinical Features

- Usually children/young adults
- Increased incidence in Blacks
- Familiar tendency (33% of cases)
- Autosomal dominant with variable expression
- Large calcified paraarticular mass: hip, elbow, shoulder, foot, wrist
- Can be associated with calcium pyrophosphate dihydrate (CPPD) arthropathy, pseudoxanthoma elasticum-like syndrome
- Also skin ulceration, marrow and dental changes
- Etiology: metabolic (few hyperphosphatemia, normal calcium, and increased vitamin D) trauma, idiopathic

Tumoral Calcinosis: Pathology

- Gross-encapsulated multilocular mass, filled with viscous calcium hydroxyapatite
- Fibrous septations
- May have inflammatory elements

Tumoral Calcinosis: Radiology

(Figures 1 to 7)

- Calcified paraarticular mass
- Extensor surface
- Radiolucent septations ("chicken wire")
- Extraarticular (bursae); no loss of range of motion (ROM)
- Average 3 lesions/individual
- CT/MRI: calcium fluid levels (liquefied calcium "sedimentation" sign)
  - More active disease
- Bone scan: best for detection and localization
- MRI: low-signal T1-weighted images
  - Variable low- to high- signal T2-weighted images
- Pseudoxanthoma elasticum: skin/vascular calcification, retina angioid streaks
- CPPD arthropathy
- Dental abnormalities: root enlargement, intrapulp calcification
- Marrow involvement: calcific myelitis

**Musculoskeletal Radiology**

**Juxtaarticular Soft Tissue Masses**

**Periarticular Calcification:**
- Scleroderma
- Other collagen vascular diseases
- Chronic renal failure (secondary tumoral calcinosis)
- Milk-alkali syndrome
- Synovial sarcoma

**Tumoral Calcification: Treatment**
- Phosphate depletion therapy
  - Aluminum hydroxide
  - Acetazolamide
- Surgical excision

**Pigmented Villonodular Synovitis:**

**Clinical Features**
- Proliferative disorder of synovium of joint, tendon, or bursa
- Young adults third and fourth decades
- Two types: diffuse (15%–25%) and localized/focal (75%–85%)
- Symptoms: pain, swelling, ROM loss

**Pathology**
- Etiology unknown: inflammatory/neoplasm/trauma
- Probably neoplastic with cytogenetic aberration translocation t(1;2) 6A3 gene
- Variable degree of villous/nodular synovial proliferation, pigmentation (hemosiderin), and inflammation components
- Giant cells, fibrous tissue, xanthoma cells

**Location**
- Localized form: usually extraarticular
  - Giant cell tumor of tendon sheath (GCT – TS)
  - Hand (80%), feet, knee (12%)
- Diffuse form (monoarticular) – knee (60%–80%), hip, ankle, shoulder, elbow

**Localized (Giant Cell Tumor – Tendon Sheath): Radiology**
- Second most common mass hand/wrist
- Lobulated soft tissue mass <2 cm
- More common volar surface
- Osseous erosion uncommon (10%–15%)

**Diffuse Form: Radiology**
- Erosive bone lesion (50%): hip (93%), shoulder (75%), knee (26%)
- Geographic IA lytic lesion: extrinsic erosion
- Joint effusion
- Arthrography: brownish or chocolate fluid, multinodular filling defects

---

**Figure 4 A & B**

Tumoral calcinosis about the elbow extensor surface. Contralateral elbow revealed identical findings (not shown).

**Figure 5 A, B, C & D**

Tumoral calcinosis about the hip with calcium fluid levels (arrowheads) on CT images.

**Figure 6 A & B**

Tumoral calcinosis about the shoulder with large calcified periarticular mass (*) showing peripheral and septal enhancement after contrast (arrowheads).

**Figure 7 A & B**

Radiograph of tumoral calcinosis about the shoulder and intense radionuclide uptake on bone scintigraphy.
Pigmented Villonodular Synovitis:
Radiology (Figures 8 to 15)
- Bone scan: mild increase activity (statics)
- PET may be markedly increased standardized uptake valve (SUV)
- Angiography: can show impressive vascularity
- CT: soft tissue mass, increased attenuation
- MRI: T1-weighted image – low-intensity mass, T2-weighted image – variable – usually prominent low-intensity regions and may reveal prominent enhancement

Figure 8
Localized form of pigmented villonodular synovitis (giant cell tumor of tendon sheath) with volar thumb mass (*) on sagittal T1-weighted MR image.

Figure 9 A & B
Same patient as previous MR image with intermediate signal intensity in the giant cell tumor of tendon sheath (*) of the thumb on axial T2-weighted MR image.

Figure 10 A & B
Localized form of pigmented villonodular synovitis with underlying bone erosion (arrows) as seen on the radiograph and intraoperative photograph.

Figure 11
Pigmented villonodular synovitis of the hip (diffuse type) with radiograph showing erosions on both sides of the joint (arrows) and maintained joint space.

Figure 12
Pigmented villonodular synovitis hip (same patient as previous radiograph) with marked low-signal intensity tissue on coronal T2-weighted MR image (*).

Figure 13
Typical villonodular morphology (arrows) and brown appearance resulting from hemosiderin deposition (*) in diffuse intraarticular pigmented villonodular synovitis.
**Pigmented Villonodular Synovitis: Treatment and Results**
- Surgical resection/synovectomy
- Recurrence rate
  - GCT – TS (10%–20%)
  - Diffuse form (up to 40%–50%)
- Radiation – internal synovectomy – yttrium 90 and dysprosium 165

**Soft Tissue Ganglion: Clinical Features**
- Young adults (25–45 years old)
- Most common mass hand/wrist (60% of masses)
- Pain, tenderness, or functional impairment (50%), rarely nerve palsy

**Soft Tissue Ganglion: Pathology**
- Etiology: unknown – neoplasm, inflammation, trauma
- Thick-walled unilocular/multilocular cystic spaces
- Gelatinous – mucinous fluid rich in hyaluronic acid and mucopolysaccharides

**Soft Tissue Ganglion: Radiology**
- Soft tissue mass (1.5–2.5 cm) – dorsum hand/wrist
- Attached to tendon sheaths or neck (pedicle) toward joint but usually no communication with joint
- Intraarticular lesions (0.2%–1.9% at knee)
- Rarely cause adjacent bone erosion; periosteal reaction, wall calcification
- CT/US/MRI: cystic mass
- US: Complex appearance 57% these are larger, wrist location, 15% internal echoes and 12% blood flow
- May have higher attenuation on CT or signal T1-weighted MR image – high protein mucin
- May fill with contrast following joint injection on delayed CT/MRI
- Wall/septae may show mild enhancement

**Synovial-Based Lesion: Differential Diagnosis**
- PVNS/synovial chondromatosis
- Arthritis: inflammatory
- Infection: unusual low-grade
- Amyloid
- Synovial sarcoma

**Figure 14 A, B, C & D**
Diffuse intraarticular pigmented villonodular synovitis of the ankle with extensive involvement of the anterior and posterior recesses (*) with contrast enhancement and low-signal intensity on T2-weighted images and “blooming” artifact on the gradient-echo sequence.

**Figure 15**
Pigmented villonodular synovitis knee (diffuse type) with large amount of low-signal intensity intraarticular hemosiderin laden tissue (*).

**Figure 16 A & B**
Large ganglion in the most frequent location dorsal to the proximal carpal row with low- to intermediate-signal intensity mass (*) on axial T1-weighted MR image and homogeneous high-signal intensity on T2-weighted image.
Myxoma: Clinical Features
- Location: heart, subcutaneous, intramuscular, juxtaarticular
- Adults 40–70 years old
- Slightly more common in women
- Painless palpable mass

Myxoma: Pathology
- Ovoid/globular whitish appearance
- Contain gelatinous material
- Unusual to have cystic spaces
- No fibrous capsule, but edema and muscle atrophy surround mass

Myxoma: Radiology
- Soft tissue mass; location: thigh, shoulder, buttock, upper arm
- Fluid characteristics CT/MRI
- US: hypoechoic with internal echoes
- High protein material may increase CT attenuation or signal on T1-weighted MR images
- Enhancement: peripheral rim/septae (thick 43%) or mild diffuse pattern (57%)
- Septations (43%) thick and mildly nodular regions
- Small rim of fatlike tissue CT (25%), MR (71%)
- Edema surrounding mass MR (79%)
- PET mild increase SUV (1.3–2.6)
- Rare to recur after removal (partial or complete)
Myxoma: Differential Diagnosis
- Abscess
- Chronic hematoma
- Ganglion/synovial cyst/bursa
- Other myxomatous neoplasms malignant fibrous histiocytoma (MFH)/liposarcoma/neural tumors

Synovial Cyst: Definition
- A herniation or continuation of the synovial membrane through the joint capsule

Synovial Cyst: Location and Etiology
- Most commonly recognized: popliteal
- Shoulder, elbow, hip, hand, foot, and ankle
- Types
  - Primary: unknown cause – children
  - Secondary: any cause joint distention
  - Rheumatoid arthritis and juvenile idiopathic arthritis (60%–70%)

Synovial Cyst: Pathology
- Fluid filled may be multilocular
- Dense fibrous wall
- Lined by synovium

Popliteal Cyst (Baker Cyst)
- Results from communication between knee joint and gastrocnemius – semimembranosus bursa
- Increase incidence with age – 50% autopsy series
- Incidence varies – arthrography (7%–42%), US (15%), MRI (5%)
- Often asymptomatic or pain from other causes
- Uncommon to present as mass
- May dissect in calf simulate deep vein thrombosis (DVT)
- Imaging shows infiltration of calf (long fusiform lesion) caused by extension of cyst with dissection and surrounding edema

Synovial Cyst: Radiology
- Fluid-filled mass – US/CT/MRI
- May have septations
- Arthrography can show joint communication
- Can have solid components if complicated (rupture) with hemorrhage, dissection, or superimposed infection
- Contrast enhancement of rim/septae
  - Noncomplicated – thin walls
  - Contrast enhancement more complex in complicated/ruptured popliteal cysts
- Complicated cysts difficult to exclude other causes of mass; must look at morphology
Meniscal Cyst: Clinical Features

- Adults (20–40 years); male > female = 2:1
- Cystic masses related to meniscal tears (1.7%–4% incidence); 84%–100% association with meniscal tear; except anterolaterally (64%)
- Fluid accumulates from joint through tear
- Pain at night or after exercise
Meniscal Cyst: Radiology
- Radiographs: soft tissue mass
- CT/US/MRI: fluid collection adjacent to meniscus
- Lateral > medial 3–10:1 now more equal
- Medial: small cystic mass within or adjacent to meniscus
- Lateral: larger fluid collection filling potential space between meniscus and collateral ligament
- MRI: best to evaluate meniscal tear and extension into cyst
- Must repair tear and resect cyst

Synovial Lipoma
- Two types
  - Localized form
  - Diffuse form: lipoma arborescens

Synovial Lipoma: Localized
- Rare: knee most frequent
- Solid fatty intraarticular mass
- Filling defect on arthrogram
- CT/MRI: lipomatous tissue

Lipoma Arborescens: Clinical Features
- Diffuse infiltration of synovium by fat
- Monoarticular – knee (0.3% incidence on MRI) most common (94% of cases)
- Often secondary (but can be primary) to chronic arthritis from trauma or inflammatory disease

Lipoma Arborescens: Radiology
- Radiographs – soft tissue swelling/joint effusion
- Osteoarthritis (87%), meniscal tears (72%)
- Arthrography – multiple filing defects
- CT fatty infiltration
- MRI best to identify frond-like fatty projections

Figure 31
Lipoma arborescens with villonodular fronds of fatty tissue (arrows) extending into the knee joint on sagittal T1-weighted MR image.

Figure 32
Lipoma arborescens (same patient as previous MR image) showing high-signal intensity fluid surrounding fatty nodules (arrows) on sagittal T2-weighted MR image.

Synovial Chondromatosis: Clinical Features
- Formerly synovial osteochondromatosis and due to cartilage metaplasia in synovium
- Knee (50%–65%), hip, elbow, any joint can be involved
- Male > female = 2–4:1; third to sixth decade
- Joint pain (85%–100%), swelling (42%–58%), decrease ROM (38%–55%)
Synovial Chondromatosis: Pathology

- Hyaline cartilage neoplasia in synovium
- Cartilage nodules (2–3 cm) can break away into joint, grow, reattach to synovium
- Cytogenetics – chromosome 6 abnormalities
- Osteoid absent in up to 45% of cases
- Hypercellularity and nuclear atypia simulate cartilage malignancy

Synovial Chondromatosis Pathology: Milgram Stages

- Stage 1 (27%): active chondroid neoplasia in synovium but no intraarticular bodies
- Stage 2 (33%): active synovial chondroid neoplasia and intraarticular bodies
- Stage 3 (40%): no active synovial chondroid neoplasia but intraarticular bodies (inactive)
- Poor documentation of disease progression

Synovial Chondromatosis: Radiology

- Radiographs: calcified bodies (70%–95%), may ossify, extrinsic erosions (30%), joint widened, OA changes
- Radiographs normal (5%–30%)
- Bone scan: mild increased activity
- Arthrography: filling defects
- US: heterogeneous mass with hyperechoic foci that may show posterior acoustic shadowing
- CT: low-attenuation thickening about joint, effusion often small if present, calcification/ossification
- MRI: variable depending on degree of mineralization, some hyperintensity T2-weighted images
- Can also involve tendons and bursa
- Secondary chondromatosis: trauma, osteoarthritis (OA), rheumatoid arthritis (RA), avascular necrosis (AVN), osteochondritis dissecans

Figure 33
Synovial chondromatosis with multiple round filling defects on hip arthrography. No calcification was seen on pre-arthrography radiographs (not shown).

Figure 34
Synovial chondromatosis of the shoulder with innumerable calcified intraarticular osteochondral bodies all similar in size and shape on radiograph.

Figure 35
Synovial chondromatosis of right hip with subtle calcifications (arrowhead) difficult to detect on radiograph, although joint is widened (arrow).

Figure 36
Synovial chondromatosis of right hip (same patient as previous radiograph) with multiple calcifications (arrowheads) about hip on CT image.

Figure 37
Synovial chondromatosis of right hip (same patient as previous radiograph and CT image) with extensive high-signal intensity intraarticular tissue (*) about the femur (F), but calcification is not apparent on T2-weighted MR image.
Synovial Chondromatosis: Treatment and Prognosis
- Surgical synovectomy removal of fragments
- Recurrence common (3%–23%)
- External radiation therapy (RT)
- Internal RT: nuclear medicine synovectomy?
- Rare degeneration (5%) into chondrosarcoma
  ➢ Look for marrow invasion

Soft Tissue Chondroma: Clinical Features
- Less common than synovial chondromatosis
- Third and fourth decades, male > female
- Slow-growing masses, painless
- Fingers (80%), hands, toes, feet, trunk

Soft Tissue Chondroma: Pathology
- Usually <3 cm, often attached to tendon
- Mature hyaline cartilage lobular pattern
- Can show ossification
- Fibrous capsule not tenosynovium unlike synovial chondromatosis

Soft Tissue Chondroma: Radiology
[Figures 38 to 41]
- Nonspecific soft tissue mass related to interphalangeal (IP) joint
- Also common in infrapatellar fat pad
- Chondroid matrix can ossify
- Unusual to erode underlying bone

Figure 39
Soft tissue chondroma of the finger on CT with large calcified mass (arrowheads). Noncalcified portion is low attenuation, consistent with a chondroid lesion (same patient as previous radiograph).

Figure 40 A, B & C
Soft tissue chondroma of the finger on MR imaging with high water content soft tissue mass (arrowheads) consistent with a chondroid lesion (same patient as previous CT and radiograph). Note that the mass is adjacent to the flexor tendon (T) but does not extend along as it would be expected in tenosynovial chondromatosis.

Figure 41
Soft tissue chondroma in Hoffa fat pad on radiograph with large calcified mass.
Heterotopic Bone Formation: Myositis Ossificans
- Young adults, male > female, usually trauma history
- No history trauma 25%–50%; also paraplegics
- Can involve muscles, fascia, tendons, subcutaneous fat
- Initially pain/tenderness and localized mass; pain decreases with time

Heterotopic Bone Formation: Location
- Extremities: 80%, anterior compartments
- Lower extremity: quadriceps muscle
- Upper extremity: brachialis muscle
- Subcutaneous fat: 30% of cases

Heterotopic Bone Formation: Pathology
- Zonal pattern of maturation
  - Central immature osteoid/fibroblastic tissue
  - Periphery calcifying osteoid to mature lamellar bone
- Cortical bone with further maturation

Heterotopic Bone Formation: Radiology
- Early soft tissue mass and edema
- Calcification 2–4 weeks then matures (zonal phenomena) to central trabecular and peripheral cortical bone
- Usually separable from cortex but may be attached
- Bone scan marked increased activity
- Angiography: staining and neovascularity early
- CT: best to see early ossification pattern with peripheral rim – enhances with contrast

Heterotopic Bone Formation: MR Imaging
- Early to intermediate
  - Normal with displaced fascial planes (T1-weighted imaging)
  - Increased intensity mass with prominent edema (T2-weighted imaging)
- Late: heterogeneous well-defined mass marrow fat on T1-weighted/T2-weighted MR images, no edema, low-intensity rim
- Often misinterpreted as malignant tumor

Heterotopic Bone Formation: Treatment and Prognosis
- May resorb or be asymptomatic
- Resect after maturation (12–18 months)
- Premature resection – recurrence with vengeance
- Rare report malignant transformation
- Malignant myositis (mucinous carcinoma)
Nodular Fasciitis: Clinical Features
- Very common; most frequent tumorlike lesion fibrous tissue
- Most common benign mesenchymal lesion misdiagnosed as sarcoma
- Rapidly growing mass 1–2 weeks duration
- Young adults (20–40 years old), male < female
- History of trauma (10%–15%)

Nodular Fasciitis: Location
- Upper extremity (50%): volar forearm
- Trunk (20%): chest wall and back
- Head and neck (18%) in children
- Rare hand/feet/lower extremity (16%)

Nodular Fasciitis: Pathology
- Subcutaneous type (70%): soft tissue nodule
- Intramuscular type (15%): not circumscribed, multinodular
- Immature fibroblasts in irregular fasicles
- Reticulin meshwork, collagen minimal, inflammatory and mucoid component

Nodular Fasciitis: Radiology and Treatment
- Nonspecific small soft tissue mass (<4 cm); may show fascial extensions
- CT/MRI: mass with irregular margins and heterogeneous on MRI, surrounding edema
- May suggest malignancy on imaging and pathology
- Surgical resection: recurrence rare (1%–2%) even if incomplete

Synovial Sarcoma: Clinical Features
- Malignant mesenchymal tumor
- Young adults 15–40 years old (mean age 37 years old) (30% <20 years old)
- Fourth to sixth most common soft tissue sarcoma
- Painful deep soft tissue mass
- Often indolent slow-growing mass (average 2–4 years to diagnosis)

Musculoskeletal Soft Tissue Sarcoma: Incidence
- MFH/Fibrosarcoma (20%–30%)
- Liposarcoma (16%–19%)
- Rhabdomyosarcoma (10%–19%)
- Nonspecific spindle cell sarcoma (5%–15%)
- Leiomyosarcoma (5%–10%)
- Dermatofibrosarcoma protuberans (DFSP) (5%–10%)
- Synovial sarcoma (2%–10%): the most common nonrhabdomyosarcoma soft tissue sarcoma in children/adolescents

Synovial Sarcoma: Location
- Extraarticular adjacent to joint, tendons, bursa, ligaments >90%
- Intraarticular <10%
- Lower extremity (60%–71%) around knee
- Upper extremity (16%–25%) around wrist

Synovial Sarcoma: Pathology
- Two cell lines
  - Epithelial (keratin positive)
  - Spindle cells
- Monophasic (50%–60%)/biphasic (20%–30%)/poorly differentiated (15%–25%)
- Variable: calcification, hemorrhage
- Cytogenetic abnormality t(X;18) (p11;q11) 90%

Synovial Sarcoma: Radiology
- Radiograph: normal (50%) or nonspecific soft tissue mass near joint
- Bone erosion or periosteal reaction (11%–20%), bone invasion (5%)
- Soft tissue calcification up to 30% – best by CT
- Bone scan: increased activity
- MRI
  - T1-weighted image: similar to muscle
  - T2-weighted image: usually high intensity
  - Triple sign on T2-weighted MR (35%–57%; nonspecific)
  - Very heterogeneous (“bowl of grapes” sign)
- Not uncommonly well-defined with pseudocapsule – “benign characteristics” (small lesions <5 cm)
- Fluid levels 10%–25% (hemorrhage 47%) worse prognosis in highly vascular lesions

Figure 45

![Image of nodular fasciitis on forearm](image-url)
Synovial Sarcoma:
Treatment and Prognosis
- Surgical resection/amputation
- Radiation therapy/chemotherapy
- Local recurrence (30%–50%)
- 5-year survival (36%–76%), with mets 10%; 10-year survival (20%–63%)
- Bad prognostic features – size >5 cm, local invasion bone/nerve, proximal location
- Metastases (16%–41%) – lung (94%), lymph node (4%–8%), marrow (8%–11%)

Clear Cell Sarcoma: Clinical Features
- Malignant melanoma of soft parts
- Arise in tendons/aponeurosis
- Deep tissue without skin involvement
- Foot/ankle (43%), knee, thigh, hand
- Adults 20–40 years old; female > male

Clear Cell Sarcoma: Pathology
- Cells with clear cytoplasm
- Framework of fibrocollagenous tissue
- Intracellular melanin (60%–75%)
- Hemosiderin also present
Clear Cell Sarcoma: Radiology
- Soft tissue mass at/in tendon/aponeurosis
- Bone erosion/destruction
- CT/MRI: infiltrative soft tissue mass
- MRI
  - T1-weighted image: intermediate intensity
  - T2-weighted image: may be low intensity

Calcified Juxta/Intraarticular Soft Tissue Masses Differential Diagnosis
- Myositis ossificans
- Aneurysm
- Gouty tophus
- Hyperparathyroidism/hemangioma
- Osteochondromatosis (synovial)
- Synovial sarcoma
- Tumoral calcinosis
- Soft tissue sarcoma

Clear Cell Sarcoma: Treatment and Prognosis
- Surgical resection/radiation/chemotherapy
- Poor prognosis
- Local recurrence and metastases
- Mets: lungs, lymph nodes, bone

Noncalcified Juxta/Intraarticular Soft Tissue Masses Differential Diagnosis
- Synovial/meniscal cyst
- Ganglion/myxoma
- Gouty tophus
- Hemangioma/PVNS
- Lipoma
- Synovial sarcoma

Figure 51
Clear cell sarcoma on MR imaging with origin in the quadriceps tendon as evidenced on the axial image with low signal intensity tendon both anterior and posterior to the mass (arrowheads). Sagittal T2-weighted MR shows nonspecific intermediate signal intensity.
Tumoral Calcinosis


PVNS


Soft Tissue Ganglion


Myxoma


Synovial Cyst


Meniscal Cyst


Synovial Lipoma


Synovial Chondromatosis

Heterotopic Bone


Synovial Sarcoma


Clear Cell Sarcoma