

## **MRI Soft Tissue Pseudotumors**

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The educational objective of this presentation is to be able to distinguish some patterns of benign lesions that can be mistaken for neoplastic lesions on MRI.

Musculoskeletal pseudotumors on MRI are not infrequent due to the increased availability of MR imaging and expanding clinical referral basis. A large variety of MRI pseudotumors exist. A recent review of seventy-seven patients referred to our ambulatory MRI unit for tumor imaging of the shoulder and upper limb region, showed forty-six ( 60%) were due to pseudotumors. Very commonly a forgotten minor past injury, whether related to sport, work or trauma, not immediately perceived as being related to the current clinical problem, is often the cause of the pseudotumor. This insult may then be complicated by secondary infection. Contributory features include the presence of normal variants with overuse syndromes, body habitus and inappropriate training and equipment or overwork. In other cases, characteristic locations and patient age may be suggestive of the diagnosis, such as elastofibroma dorsi of the infra-scapular posterior thoracic wall.

The commonest variants will be reviewed with imaging examples, some background theory and correlation with histology will be provided to reinforce this and comparison will be made with real soft tissue tumors. Some more unusual, though diagnostically classical pseudotumors with MRI will also be demonstrated.

Improved MRI diagnosis for pseudotumor is possible with increased awareness by the radiologist to the imaging appearances of commoner types of pseudotumors, correlation with radiographs and an appropriate clinical history. Either with the use of a small questionnaire before MRI or quick check by the reporting radiologist with brief review of the patient's clinical history and clinical appearance, the MRI diagnosis may be quite specific. Often this diagnosis may be a surprise to the referring clinician.

Correlation with conventional radiographs is extremely important as many masses or focal abnormalities on MRI simulating neoplasms may have characteristic radiographic appearances and be easily diagnosed [1, 2]. Examples include the peripheral calcific rim of myositis ossificans, retained radio-opaque foreign bodies, stress fracture of bone and hydroxyapatite deposition within tendons.

Musculoskeletal pseudotumors on MRI can be subdivided anatomically into those related to superficial and deep soft tissues both muscle, tendon, ligament, nerve and vascular structures in origin and into those related to osseous structures both epiphysial, apophysial, periosteal and medullary bone and to joint structures. They can also be subdivided by etiology such as trauma acute, subacute and chronic; sports and work related activities or overuse; infection and symptomatic normal variants.

The commoner types of musculoskeletal pseudotumors on MRI include: myositis ossificans, tears and overuse of ligaments and muscles, stress reactions or stress fractures of bone and soft tissue

hematomas and abscess formation. Other not uncommon pseudotumors include those associated with the overuse of normal variants, inflammatory calcium deposition disorders of tendons, joints and bursa and foreign body reactions.

Fat necrosis, muscle hematoma and myositis ossificans of muscle may give rise to MRI pseudotumors. Fat necrosis after minor trauma may result in a clinically palpable mass due to organized hematoma formation, fat necrosis and fibrosis. Only one quarter of children with an MRI fat necrosis pseudotumor recalled a history of trauma [3]. On MRI there was linear signal intensity within the subcutaneous tissues of either the anterior tibia or of the buttock region, an absence of a mass, though there was commonly a volume plus of the subcutaneous region [3].

Localized myositis ossificans is a common MRI pseudotumor [4]. Usually the heterotopic formation of bone occurs within muscle and in approximately one quarter of cases due to an identified trauma. It may rarely occur in association with other structures such as tendons and fascia. During the active initial phase the mass-like region may be clinically warm, painful and woody in consistency. Biopsy during the early phase of development may give a false osteosarcoma diagnosis as there is florid osteoblastic activity. Serial radiographs demonstrate the development of a peripheral rim of calcification of the mass at usually 6 to 8 weeks after injury and that the calcification is separate from bone. If the trauma involves deep muscle injury in some cases there may be an associated periosteal reaction of the adjacent bone. The appearances on MRI reflect the phase of development of the myositis ossificans and the zone phenomenon of the histology. In the early phase before ossification the lesion is usually isointense to muscle on T1-weighting with no distinct borders and increased in signal intensity on T2-weighting centrally [5], with marked adjacent soft tissue edema. At this stage there may or may not be a subtle peripheral rim, like a tide mark. In subacute lesions with early peripheral calcification there is a low signal intensity rim, like a tide mark on the beach, reflecting this calcification. The center of the lesion may be isointense to muscle or slightly increased in signal intensity on T1-weighting. On T2-weighting the central portion of the lesion is very high in signal intensity and the rim's decreased signal is more clearly evident [1, 5]. At this subacute stage the adjacent edema of soft tissues may be very prominent. A common feature to myositis ossificans in the acute and subacute phases, is the marked adjacent soft tissue reaction, which is very unusual in primary malignant tumors which have not been previously biopsied or undergone intratumoral hemorrhage [1]. In the chronic phase, the central portion of the lesion is slowly ossifying, so eventually the signal intensity is similar on T1 and T2-weighting to that of fatty marrow of bone [5]. Though less common, multiple muscles and the regions between muscles may be involved. A variant of myositis ossificans occurring in the fingers and less commonly in the toes is fibro-osseous pseudotumor of the digits or florid reactive periostitis. Inflammatory myopathies are most usually diffuse in nature, commonly bilateral in the thighs or calves and associated with weakness or tiredness, though quite rare some forms may be focal such as nodular myositis, sarcoid associated myopathy [6] and diabetic muscle infarction.

Nodular fasciitis or pseudosarcomatous fasciitis commonly occurs in 20 to 35 year old athletic patients presenting with a focal clinical mass with pain. There are three forms: subcutaneous the commonest, intramuscular which may appear as a focal mass and MRI pseudotumor, and fascial which usually spreads along superficial fascial planes. Early lesions typically have a high T2 signal intensity reflecting the myxoid histology [1, 2] and older lesions may have more decreased signal intensity on T2-weighting reflecting the more predominantly fibrous histology [1]. Overall the MRI appearance is nonspecific.

Tears and overuse of ligaments and muscles, both acute and chronic, may cause MRI pseudotumors. Partial avulsion of the adductor muscles of the thigh from the femoral diaphysis

in children due to sports injuries or overuse may cause an MRI pseudotumor which may simulate a malignant sarcoma [7]. In five young patients, who presented with a provisional clinical and radiological diagnosis of femoral sarcoma, review of MRI from three patients showed a periosteal reaction on the posteromedial aspect of the femur centered on the muscle-bone interface of the vastus medialis and intermedius and adductor muscle insertions on the femoral shaft. There was wide spread intramedullary edema and an absence of bone or soft tissue mass. Stress fractures lines were excluded. This condition has been studied using bone scans in adults, in army training and called “adductor insertion avulsion syndrome” or “thigh splints” [8]. The cause is thought to be due to excessive adductor contraction with stripping of the femoral periosteum anteromedially [8]. Knowledge, particularly of the MRI findings with an appropriate clinical setting can help physicians to make the correct diagnosis and eliminate unnecessary biopsy. Proximal adductor avulsions near the symphysis pubis [9] and intramuscular strains [10] have been described in adults. Chronic muscle avulsive injuries in a variety of lower limb sites in children have been described [11]. Overuse with excessive prolonged carrying of large babies may rarely lead to masses of the wrist, found to be due to de Quervains tenosynovitis [12].

Post-traumatic stress and impingement entities may cause MRI pseudotumors. In the clinical history review for work, trauma and sports related injuries with questioning for altered or excessive training and changed equipment may be helpful. Excessive training with suboptimal shoes in figure ice skaters and professional snow boarders may cause MRI pseudotumors of soft tissues around the ankle associated with the shoe-rim [14]. Some sites for stress fractures are practically pathognomonic for specific sports such as spinal pars defects of the thoracic and lower lumbar spine in cricketers particularly in fast spin bowlers with unilateral defects often involving the side opposite to the bowling arm [15]. Any periosteal reaction associated with muscle hypertrophy in a sports person should prompt review of type of training and accurate history of pain, as the MRI findings may be due to overuse. Radiographic correlation and follow-up are important. Any linear low signal intensity on T1 weighting associated with increased signal intensity of T2-weighting, which becomes more obvious with contrast enhancement and fat suppression should prompt a diagnosis of stress fracture. Radiographic and clinical correlation and follow-up are important.

Muscle abnormalities [16], soft tissue hematomas, abscess formation and ischemic- compression syndromes are common MRI pseudotumors. Superficial soft tissue hematomas may be associated with minimal trauma and the event little thought of at the time of presentation to MRI. Whereas deep muscle hematomas are more commonly associated with more obvious trauma, coagulation disorders such as hemophilia or difficulties with acute or chronic anticoagulation therapy can also cause such hematomas. Often the MRI appearances may be complex as there is repeated hemorrhage within soft tissues and muscle movement. The MRI appearances of hematoma depends on the state of the hemoglobin molecule, whether it is intra- or extracellular in nature [2, 17- 19]. In the hyperacute phase blood is isointense on T1-weighting and decreased on T2-weighting, reflecting the earliest phase of oxygenated hemoglobin to deoxyhemoglobin. With cell lysis, in the subacute phase (1 week to 3 months old), the hemoglobin molecule becomes extracellular methemoglobin and is characteristically increased in signal intensity on T1 and T2-weighting. Weeks to months later the methemoglobin breaks down into hemosiderin with decreased signal intensity on T1 and T2-weighting. Breakdown of blood products in the hematoma is not uniform with accelerated peripheral breakdown reflecting a low signal rim and centrally there is a more inhomogeneous signal intensity. It may sometimes be difficult to distinguish simple hematoma from a large hemorrhage into a malignant mass [2]. A tumor nodule or rim of irregular tumor, or contrast enhancement within an irregular nodule may be helpful to distinguish the two [2]. Hematomas may become secondarily infected and present a more complex MRI appearance with more peripheral and surrounding soft tissue reaction.

Pyomyositis may occur in healthy individuals, however the clinical picture prior to MRI strongly suggests infection. However patients with immunosuppression may present to MRI with a mass. MRI features [20, 21] suggesting an abscess include a thickened peripheral rim on T1 and T2-weighting, which may be increased in signal intensity on T1-weighting and demonstrates marked contrast enhancement. Immunosuppressed patients commonly have an absence of marked adjacent soft tissue and subcutaneous edema. Fortunately atypical organisms may rarely cause abscess formation with a mass like appearance on MRI such as *cysticercosis* [22, 23], *Echinococcus granulosus* in hydatid disease and *Coccidioides immitis* in Coccidioidomycosis [2]. In Human Immunodeficiency patients rarely *Bartonella henselae*, a gram negative bacillus, may cause bacillary angiomatosis- focal infection in soft tissues which is highly vascularized and may erode and involve adjacent bone, mimicking a sarcoma [24]. This organism may also be involved in 'cat scratch disease' [25], as the carrier is usually a cat. When causing cat scratch disease, it is usually associated with single lymph node enlargement.

Normal variants and their overuse may present as MRI pseudotumors. Supernumerary bones (styloid bone, accessory ossification centers for scaphoid tuberosity) [26], tarsal coalition, accessory soleus muscle, and extensor digitorum manu brevis muscle [26] are some targets. Occasionally tarsal coalition and calcaneal spurs associated with peroneal tendon inflammation and partial tear may be associated with a marked synovial reaction and tenosynovitis, prompting a pseudotumor. Awareness of these syndromes and review of the radiographs usually allows correct diagnosis. Schmorl's nodes may rarely present as giant cystic-like lesions of the vertebral bodies in young patients [27]. Additional computerized tomography may confirm these diagnoses. Ruptured Baker's cysts with perifascial fluid medial to the medial calf muscles, may appear as a mass on MRI, however extension to the posteromedial knee joint should allow for the correct diagnosis.

Calcium deposition disorders- hydroxyapatite, gout and calcium pyrophosphate dihydrate crystal deposition disorders with calcium deposition in tendons, ligaments and bursae may create MRI pseudotumors. Patients with a provisional clinical diagnosis of tumor associated with ligament calcification may be referred for MRI [28]. Three of four patients had MRI with focal thickening of the lateral collateral ligament associated with adjacent marked soft tissue reaction with intravenous gadolinium contrast enhancement, which on review of the radiographs correlated to soft tissue calcifications. With its acute clinical onset and dissipation on follow-up radiographs, this entity is presumed to be due to hydroxyapatite deposition. Review of radiographs at the time of MRI reporting and awareness of this entity and others like it, is critical for correct MRI diagnosis of pseudotumor.

Metabolic disorders may be associated with MRI pseudotumors such as amyloid deposition and hyperparathyroidism. Secondary amyloidosis is the commonest, usually seen in association with chronic renal failure. It is due to the deposition of beta-2 microglobulins within joint capsules and tendon sheaths and may rarely be associated with pseudotumors near joints. Characteristically there is a decreased signal intensity on T2-weighting, which appears to reflect the collagen-like nature of the amyloid [2]. Primary, or now more commonly, secondary hyperparathyroidism may be associated with brown tumors of bone which are nonspecific on MRI. The most common clinical setting is chronic renal failure and laboratory results are diagnostic with high serum calcium, low serum phosphorus and a high parathormone level. Idiopathic tumoral calcinosis may present as an MRI pseudotumor with large septated regions of variable signal intensity in periarticular regions on both T1 and T2-weighting, however review of the radiographs allows for this diagnosis.

Foreign body reactions due to trauma and retained surgical swabs (“cottonballoma”) [30], fortunately are less common, though should be considered in the appropriate clinical setting. Close inspection for traces of intramedullary screws, subtle metallic artifacts or direct evidence of retained foreign bodies, such as glass, should be sort for.

Less common MRI pseudotumors include hand pseudoaneurysms [31]. Ten of twenty-five cases presented clinically as soft tissue masses without other symptoms. These are usually caused by acute trauma with direct arterial injury, however they may be due to chronic repetitive trauma and the hypothenar hammer syndrome [32]. This syndrome describes signs and symptoms associated with ischemia of the hand and fingers secondary to blunt repetitive injury of the ulnar artery and superficial volar arch against the hook of hamate. Arterial wall damage may lead to pseudoaneurysm formation and or vessel thrombosis, micro emboli formation [33] and compression of the sensory branch of the ulnar nerve [33]. Usually described in men of working age with industrial occupations involving repetitive blunt trauma to the hands [34, 35] it has also been described in sports-related injuries in handball players and baseball catchers [33- 36]. The thenar hammer syndrome [37] involves acute or chronic compression of the radial artery between the first and second metacarpal where the artery is more superficial in location and covered only by the muscle of flexor pollicis brevis and subcutaneous fat. The commonest pseudoaneurysms involve the popliteal artery, and if due to arteriosclerosis they will be bilateral in up to 75% of cases [2].

Post therapy including post radiation MRI appearances may be associated with a MRI pseudotumor. Post-surgical denervation muscle finding at MRI may mimic a tumor, particularly in the acute phase where this swelling and edema within muscle, however there is an absence of a mass. Radiotherapy MRI findings of altered soft tissue and bone marrow signal intensities may be suspicious, however on close review there is usually no real mass and review of the radiotherapy details and port positioning usually allow a correct diagnosis [38].

### **Pitfalls**

Ensure thorough review of radiographs correlating closely with MRI and if needed add additional computerized tomography (CT) scan. Review all regions of MRI as there may be a second lesion. Metastases to soft tissues, such as from esophageal adenocarcinomas, may hemorrhage and mimic MRI soft tissue pseudotumors

### **Recommendations**

Marking pain and the mass site with a marker is recommended as the abnormality may be subtle on MRI or there may be a need to confirm the MRI finding such as a normal variant, is the cause for the patient’s clinical mass. Either additional clinical information in the form of a questionnaire before the MRI, or at the time of the MRI readout, with brief review of the clinical history and clinical findings in relation to the MRI, may be very useful and increase the likelihood of diagnosing an MRI pseudotumor.

### **References:**

1. Jelinek J, Kransdorf MJ. MR imaging of soft-tissue masses. Mass-like lesions that simulate neoplasms. *Magn Reson Imaging Clin N Am* 1995(4):727-741

2. Kransdorf M, Murphy M. Masses that may mimic soft tissue tumors. In: *Imaging of Soft Tissue Tumors*. WB Saunders Company 1997:373-420
3. Tsai TS, Evans HA, Donnelly LF, Bisset III GS, Emery KH. Fat necrosis after trauma: A benign cause of palpable lumps in children. *Am J Roentgenol* 1997;169:1623-1626
4. Boutin R, Fritz R, Steinbach L. MRI of Muscle Injury. *Radiologic Clinics of North America* 2002;40:333-362
5. De Smet AA, Noris MA, Fisher DR. Magnetic resonance imaging of myositis ossificans: analysis of seven cases. *Skeletal Radiol* 1992;21:503-507
6. Fujimoto H, Ikeda M, Shimofusa R, Terauchi M, Eguchi M. Sarcoidosis breaching the fascia and mimicking a sarcoma. *Skeletal Radiol* 2002;31:706-708
7. Anderson SE, Johnston JO, ODonnel R, Steinbach LS. MR imaging of Sports related pseudotumor in Children: mid femoral diaphyseal periosteitis at insertion site of adductor musculature. *Am J Roentgenol* 2001, 176: 1227-1231
8. Charkes ND, Siddhivan N, Schneck CD. Bone scanning in the adductor insertion avulsion syndrome (“thigh splints”). *J Nucl Med* 1987;28:1835-1838
9. Schneider R, Kaye JJ, Ghelman B. Adductor avulsive injuries near the symphysis pubis. *Radiology* 1976;211:233-236
10. Yoshioka H, Anno I, Niitsu M, Takahasi H, Matsumoto K, Itai Y. MRI of muscle strain injuries. *J Comp Assist Tomogr* 1994;18:454-460
11. Donnelly LF, Bisset GS, Helms CA, Squire DL. Chronic avulsive injuries of childhood. *Skeletal Radiol* 1999;28:138-144
12. Suzanne E. Anderson, Lynne S. Steinbach, Damir De Monaco, Harald M. Bonel, Yvonne Hurtienne, Esther Voegelin. The Baby Wrist: MRI of an overuse syndrome of mothers. *Am J Roentgenol* In Press 2003
13. Helene Pavlov, Physical Injuries: Sports Related Abnormalities. Ed. Resnick D. *Diagnosis of Bone and Joint Disorders*. 3<sup>rd</sup> Edit. WB Saunders 1995:3229-3263
14. Anderson SE, Weber M, Steinbach LS, Ballmer FT. Shoe rim and shoe buckle pseudotumor of the ankle in elite and professional ice figure skaters and snow boarders: MR imaging findings. In Press 2004
15. Hardcastle P, Annear P, Foster DH, Chakera TM, McCormick C, Khangure M, Burnett A. Spinal abnormalities in young fast bowlers. *J Bone Joint Surg [Br]* 1992;74-B:421-425

16. May DA, Disler DG, Jones EA, Balissoon AA, Manaster BJ. Abnormal signal intensity in skeletal muscle at MR imaging: patterns, Pearls and Pitfalls. *Radiographics* 2000;20:S:295-315
17. Dooms GC, Fisher MR, Hricak H, Higgins CB. MR imaging of intra-muscular hemorrhage. *J Comp Assist Tomogr* 1985;9:908-913
18. Gomori JM, Grossman RI, Golberg HI et al. High field magnetic resonance imaging of intracranial hematomas. *Radiology* 1985;157:87-93
19. Rubin JI, Gomori JM, Grossman RI, et al. High-field MR imaging of extracranial hematomas. *Am J Roentgenol* 1987;148:813-817
20. Soler R, Rodriguez E, Aguilera C, Fernandez R. Magnetic resonance imaging of pyomyositis in 43 cases. *Eur Radiol* 2000;35:59-64
21. Soler R, Castro JM, Rodriguez E. Value of MR findings in predicting the nature of soft tissue lesions: benign, malignant or undetermined lesion? *Comput Med Imaging Graph* 1996;20:163-169
22. Ogilvie MO, Ksten P, Rovinsky D, Workman K, Johnston JO. Cysticercosis of the triceps- An unusual pseudotumor. *Clinical Orthop and Related Research* 2001;382:217-221
23. Abdelwahab IF, Klein MJ, Hermann G, Abdul-Quader MA. Solitary cysticercosis of the biceps brachii in a vegetarian: a rare and unusual pseudotumor. *Skeletal Radiol* 2003;32:424-428
24. Biviji AA, Paiement GD, Davidson A, Steinbach LS. Musculoskeletal manifestations of the human immunodeficiency virus infection. *Journal of the American Academy of Orthopedic Surgeons* 2002;10:312-20
25. Dong PR, Seeger LL, Yao L, et al. Uncomplicated cat-scratch disease: Findings at CT, MR imaging, and radiography. *Radiology* 1995;195:837-839
26. Capelastegui A, Astigarraga E, Fernandez-Canton G, Saralegui I, Larena JA, Merino A. Masses and pseudomasses of the hand and wrist: MR findings in 134 cases. *Skeletal Radiol* 1999;28:498-507
27. Hauger O, Cotton A, Chateil JF, Borg O, Moinard M, Diard F. Giant cystic schwannomas: imaging findings in six patients. *Am Journ Roentgenol* 2001;176:969-972
28. Anderson SE, Bosshard C, Steinbach LS, Ballmer FT. Calcification of the lateral collateral ligament of the knee: a rare pathology and cause of lateral knee pain shown by MR imaging. *Am J Roentgenol* 2003;181(1):199-202.
29. Steinbach LS, Johnston JO, Tepper EF, Honda G, Martel W. Tumoral Calcinosis: Radiologic-Pathologic Correlation. *Skeletal Radiol* 1995; 24:573-578

30. Kalbermatten DF, Kabermatten NT, Hertel R. Cotton-induced pseudotumor of the femur. *Skeletal Radiol* 2001;30:415-417
31. Anderson S E, De Monaco D, Buechler U, Triller J, Gerich U, Dalinka M, Stauffer E, Nagy L, Niedecker A, Campbell R, Araoz PA, Steinbach LS. Imaging Features of Pseudoaneurysms of the Hand in Children and Adults. *Am J Roentgen* 2003;180:659-664
32. Conn J Jr, Bergmann J, Bell J, Hypothenar hammer syndrome: Posttraumatic digital ischaemia. *Surgery* 1970;68:1122-1127
33. Glichenstein J, Ohana J, Leclercq C, *Tumors of the Hand*. Berlin Springer 1988;147-150
34. Newmeyer W, Vascular Disorders. In: Green D, ed. *Operative Hand Surgery*, 3rd ed. New York, Churchill Livingstone 1993; 2251-2299
35. Little JM, Ferguson DA, The incidence of Hypothenar Hammer Syndrome. *Arch Surg* 1972;105:684-85
36. McCue FC, Soft tissue injuries to the hand, In: Pettrone F, ed *American Academy of Orthopedic Surgeons, Symposium on the Upper extremity injuries in athletes*. Washington: Mosby Company, 1986;79-94
37. Janevski BK, Angiography of the upper extremity. In: Green et al ed. *Pain in the shoulder and arm*. The Hague-Boston-London, Nijhoff M, 1979(3): 25-48
38. Richardson ML, Zink-Brody GC, Patten RM, Koh WJ, Conrad EU. MR characterization of post-irradiation soft tissue edema. *Skeletal Radiol* 1995;15:349-366