

# Soft Tissue Tumors Around The Knee Joint

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## Abstract

Knee joint is a common site for many of the soft tissue tumors. Lipoma and hemangioma are the most common. Knowledge of individual tumors is of utmost importance in differentiating one from the other as each tumor demands unique management. MRI is the imaging modality of choice as it best characterizes the soft tissue. In this pictorial essay we describe morphology, imaging findings and clinical significance of each of the soft tissue tumors.

## INTRODUCTION

Soft tissue tumors around the knee joint can be classified as benign and malignant. Benign tumors include lipoma, synovial hemangioma, synovial chondromatosis and pigmented villonodular synovitis. Malignant tumors include synovial sarcoma and soft tissue sarcoma. Knee joint is the most common site for majority of these soft tissue tumors. These tumors being superficial are usually felt on clinical examination and imaging is necessary to evaluate its morphology, extent, differential diagnosis and post operative follow-up. MRI is the modality of choice as it can characterize the soft tissue better than all other modalities.

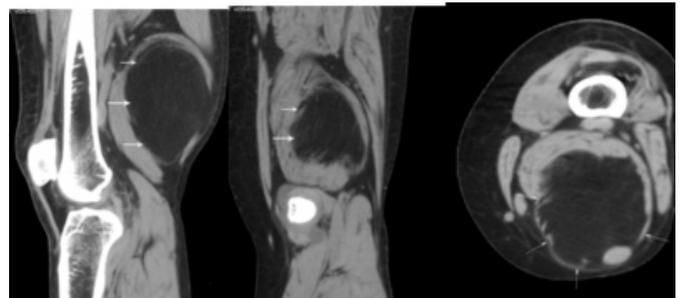
## LIPOMA

It is the most common soft tissue tumor seen in the extremity<sup>(1)</sup>. Lipoma can be classified as cutaneous and deep seated, based on its location. Intra muscular lipoma is a rare deep seated lipoma<sup>(2)</sup>. It can be classified as well circumscribed type and infiltrating type, on histology<sup>(3)</sup>. Intra muscular lipomas may compress the adjacent neurovascular bundle causing symptoms. Lipoma and well-differentiated liposarcoma are difficult to distinguish on imaging. Radiological evaluation is mainly aimed at differentiating lipoma from well-differentiated liposarcoma and also to look for fat plane between it and surrounding structures in cases of compression.

On CT, lipoma appears as fat density lesion compressing and displacing adjacent structures (Figure 1A-C)<sup>(1)</sup>. On MRI, lipoma displays hyperintense signal on T1 and T2W images and are suppressed on STIR images. Presence of thick septa and solid component which show enhancement on post contrast T1 W images goes on favor of well-differentiated liposarcoma rather than lipoma<sup>(4)</sup>.

## Figure 1

Intra muscular Lipoma: CT Sagittal(A) and coronal image(B) showing a well defined fat density lesion in the biceps femoris muscle(arrows). CT axial (C) image showing peripheral sleeve of biceps femoris muscle(arrow) around the lesion.



Hemangioma: Hemangioma is the most frequently encountered vascular soft tissue tumor<sup>(5)</sup>. Soft tissue hemangioma can be classified as cutaneous, subcutaneous, intra muscular and synovial based on the site of origin<sup>(6)</sup>. Based on the size & type of predominant vessel; Hemangioma can be classified as cavernous, capillary, venous and arteriovenous<sup>(7)</sup>. Further based on the anatomical relationship to a joint it can be classified as juxtra-articular, intra-articular and intermediate types. Synovial hemangioma is usually seen in early adolescents. Knee is the most common site. It is also reported in elbow, wrist & ankle<sup>(8)</sup>.

Hemangioma may be well-circumscribed or have poorly defined margins, with varying amounts of hyperintense T1 signal owing to either reactive fat overgrowth or haemorrhage<sup>(5)</sup>. Hemangioma appears as a bunch of grapes on T2W images (Figure 2A, B). This appearance is due to cavernous vascular spaces containing stagnant blood. Some hemangiomas demonstrate fluid-fluid levels (Figure 2C,

D)<sup>(8)</sup>. Areas of signal void correspond to phleboliths. Post contrast T1 W images demonstrate extra-articular involvement<sup>(9)</sup>. Open or arthroscopic surgical excision is the treatment of choice.

**Figure 2**

Synovial Hemangioma: PD fat saturated Sagittal(A) image showing bunch of grapes appearance(arrow). TIRM Sagittal (B) & T2 Coronal(C) images demonstrating hyperintense lesions involving the medial retinaculum and extending into quadriceps muscle. This can be characterized as synovial and intramuscular type and juxtra-articular type of hamangioma. T2 Medic Axial(D) image demonstrating fluid- fluid levels(thick arrow).



Synovial chondromatosis: synovial chondromatosis is a benign mono-articular neoplastic process of the synovium. Pathologically, it is characterized by chondroid metaplasia of synovium with formation of multiple cartilaginous nodules<sup>(10)</sup>. It can be primary or secondary. Secondary synovial chondromatosis is seen in patients with arthritis or other mechanical joint conditions<sup>(9)</sup>. Primary synovial chondromatosis is usually seen adults of 3<sup>rd</sup> to 5<sup>th</sup> decade. It is more common in men. Knee is the most common joint involved followed by elbow, hip & shoulder<sup>(11)</sup>. Clinically patient presents with pain, swelling and restriction of motion of the affected joint.

Radiological diagnosis is usually straight forward on plain radiographs with presence of multiple loose bodies in the affected joint showing ring and arc type of matrix

mineralization (Figure 3A,B)<sup>(10)</sup>. Cross sectional imaging is required in patients where there is no mineralization of loose bodies (Figure 3). In addition we can also demonstrate the bony erosions and extent of the disease process. MR is indicated to look for extent of lesion and also follow-up of patients with suspected recurrence<sup>(12)</sup>. On MRI, multiple loose bodies are seen in the affected joint which display variable signal depending on the amount of mineralization (Figure 3D,E). Well mineralized lesions display hypointense signal on T1 W and T2W images. Surgical resection is the treatment of choice. Synovial chondromatosis is known to recur after treatment and recurrence rate is between 3-23%<sup>(10)</sup>.

**Figure 3**

Synovial Chondromatosis: AP(A) & LATERAL(B) radiograph of knee joint demonstrating multiple loose bodies in the supra patellar recess, popliteal fossa & proximal leg(arrow). CT Sagittal reconstructed image(C) demonstrating multiple loose bodies. T2 Sagittal (D) & Coronal(E) images showing extension of loose bodies into the gastrocnimius-semimembranosus bursa(arrow) with sedimentation.



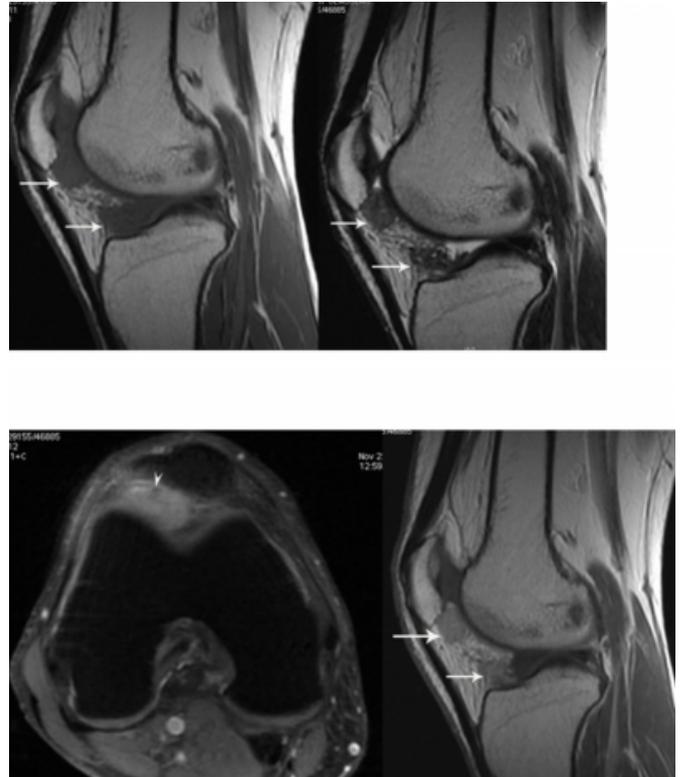
Pigmented villonodular synovitis[PVNS]: it is a benign neoplastic process of the synovium. It may also involve the bursa, joint and the tendon sheath<sup>(13)</sup>. Synovial involvement

can be diffuse or focal. Pigmented villonodular synovitis of tendon sheath is also called giant cell tumor of tendon sheath<sup>(14)</sup>. Pathologically PVNS is characterized by villous, nodular & villonodular proliferation of synovium with hemosiderin pigmentation<sup>(15)</sup>. Hemosiderin pigmentation is detected very well on MRI which makes it imaging modality of choice. PVNS is usually seen in middle age adults. Knee is the most common joint involved followed by hips. Clinically it presents as pain and swelling in the affected joint. Unlike other soft tissue tumors, imaging in PVNS is done to look for specific diagnosis, apart from specific diagnosis we can also evaluate whether the disease is diffuse or localized and its extent and also post surgical follow-up to look for recurrence.

On MR imaging localized PVNS is seen as asymmetric nodular thickening of the synovium with lobulated contours. These lesions display characteristic low signal on all sequences (Figure 4A, B) and blooming on gradient images (Figure 4C) due to presence of hemosiderin pigmentation<sup>(13)</sup>. On post contrast T1W images there is enhancement of the abnormal synovium (Figure 4D). Surgical excision is the treatment of choice. Localized disease could be excised on arthroscopy. PVNS has a high recurrence post surgery & recurrence rate is between 8- 56%<sup>(16)</sup>.

**Figure 4**

PVNS: T1Sagittal(A) image shows a hypointense mass in the Hoffa's fat pad (arrows). T2 Sagittal (B) image showing hypointense lesion in Hoffa's fat pad (arrows). PD fat saturated Axial(C) image showing a focal area of hypointensity (arrowhead) corresponding to hemosiderin pigmentation. Post contrast T1 Sagittal (D) image showing homogenous enhancement of the mass (arrows).



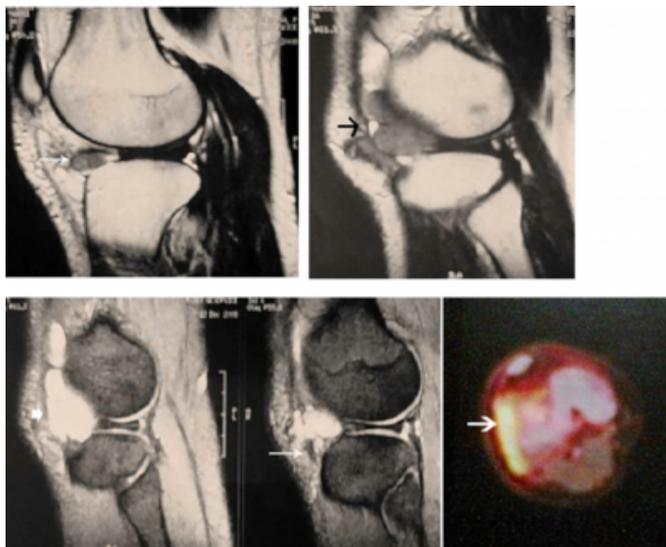
**Synovial sarcoma:** Synovial sarcoma is a primary malignant mesenchymal tumor found most commonly in the lower extremities<sup>(17)</sup>. It is a misnomer as it does not arise from the synovium, but from primitive mesenchymal cells in the extra articular soft tissue close to the synovium. Pathologically synovial sarcoma display dual epithelial and mesenchymal differentiation<sup>(18)</sup>. It has three main histological sub types namely; Biphasic, monophasic and poorly differentiated<sup>(19)</sup>. It usually affects adolescent and young adults between 5 – 40 yrs. Knee is the most common site followed by foot and ankle<sup>(20)</sup>. Clinically the patient presents with slowly growing palpable mass. Radiological evaluation is mainly aimed at evaluating the extent and staging of tumor besides suggesting a specific diagnosis. MRI is the imaging modality of choice.

On T1-weighted MR images, synovial sarcoma typically appear as a prominently heterogeneous multilobulated soft tissue mass (Figure 5A, B)<sup>(21)</sup>. On T2-weighted MR images it

appears heterogeneous with calcification, haemorrhage or necrosis and a solid component (Figure 5 C). This finding is characteristically called as triple sign<sup>(22)</sup>. The solid component show homogenous enhancement on post contrast T1 W images. Synovial sarcomas are known to invade into the adjacent bone and joint<sup>(18)</sup>. Synovial sarcoma shows high uptake of radio tracer on PET-CT (Figure 5D)<sup>(23)</sup>. Wide local surgical excision with removal of normal cuff of surrounding tissue is the treatment of choice.

**Figure 5**

Synovial Sarcoma: T1 Sagittal (A,B), T2 fat saturated Sagittal (C) images showing a mass lesion (arrow) anterior knee joint space at the Hoffa fat pad, lesion is predominantly hypointense on T1 with focal areas of T1 hyperintensity(arrow) suggestive of hemorrhage; and is hyperintense on T2 signifying cystic component(arrow & thick arrow). Fused PET-CT axial (D) image, demonstrating increased uptake of F FDG(arrow).



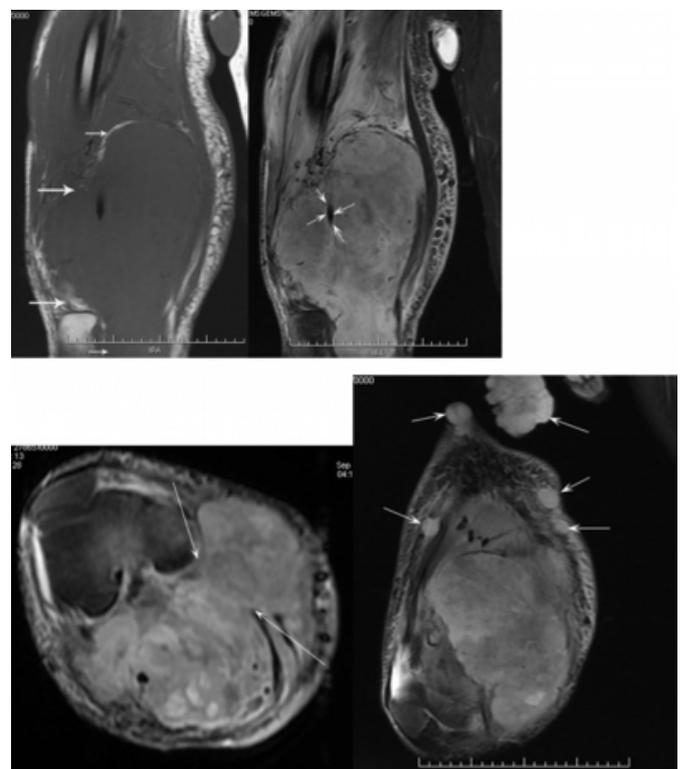
Soft tissue sarcoma: These are a histological diverse group of malignant tumors which predominantly arise from soft tissue. There are more than 50 various sub types described in literature<sup>(24)</sup>. Most common of them are liposarcoma, leiomyosarcoma, malignant fibrous histiocytoma [MFH], fibrosarcoma and synovial sarcoma<sup>(25)</sup>. Synovial sarcoma has been described earlier. Thigh is most common site for soft tissue tumors followed by pelvis, arm or trunk<sup>(26)</sup>. These tumors are usually seen in adults<sup>(27)</sup>. Imaging in these tumors is mainly indicated to evaluate the extent, staging; morphological characterization and post operative & post chemo- radiotherapy follow up. Specific diagnosis is arrived mostly after Histopathology.

MRI is the imaging modality of choice. Most tumors have

non-specific features in the form of hypointense signal on T1W images (Figure 6A) and hyperintense signal on T2W images. Hyperintense signal on T1W images points to fatty component; in this case diagnosis goes in favor of liposarcoma<sup>(4)</sup>. In addition look for encasement of vessels (Figure 6B), inter compartmental extension (Figure 6), extension into joint & skin (Figure 6D), multifocal lesions and marrow infiltration. Wide surgical excision is the treatment of choice. Entire muscle could be excised if the functional loss is not too great<sup>(28)</sup>. Encased vessels are bypassed and then resected along with the tumor tissue. If the fat plane between the lesion and the neurovascular structures is ill defined, then patient is subjected to pre and post operative radiotherapy<sup>(28)</sup>. These tumors are known to have high recurrence rate depending on the histological type and grade.

**Figure 6**

Soft tissue Sarcoma: T1 Sagittal(A) image showing a large hypointense mass in the posterior aspect of the thigh and extending into the popliteal fossa(multiple arrows). T2 W Sagittal (B) image showing a hetrogenous signal intensity mass encasing the Superficial Femoral Artery (arrows). PD fat saturated Axial(C) image demonstrating extension of mass into the medial compartment of thigh (arrows). T2 W Coronal(D) image demonstrating multiple skin nodules(arrows). Pathologically this was a recurrent spindle cell sarcoma.



**CONCLUSION**

Benign soft tissue tumors are much more common around the knee joint than malignant tumors. MRI is the imaging modality of choice in the evaluation of soft tissue tumors because of its superior soft tissue characterization. Many of the soft tissue tumors have risk of recurrence and they should be evaluated clearly looking for minute details to avoid recurrence. Imaging in malignant tumors is mainly aimed at evaluation of extent, staging and post treatment follow-up.

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