Lipoma arborescens of the knee.

Poster No.: C-0999
Congress: ECR 2015
Type: Educational Exhibit
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Keywords: Tissue characterisation, Inflammation, Arthritides, Diagnostic procedure, MR, Musculoskeletal joint
DOI: 10.1594/ecr2015/C-0999

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Learning objectives

1) Identify key clinical features and abnormal findings on MR studies that are critical to make the diagnosis.

2) Construct a logical list of differential diagnoses based on the MRI findings, focusing on the most probable differential diagnoses.

Background

Lipoma arborescens is a "lipoma-like" benign villous proliferation of synovium with replacement of the subsynovial connective tissue by mature fat cells. It is not a neoplasm, but rather thought to be a nonspecific reactive response to chronic synovial irritation, whether from mechanical or inflammatory insults (1). Other terms that have been used in the literature include diffuse lipoma of the joint, diffuse synovial lipoma, diffuse articular lipomatosis, fatty infiltration of the synovial membrane, or villous lipomatous proliferation of the synovial membrane. The latter two emphasize the non-neoplastic nature of this lesion.

The condition is frequently described as rare, but imaging diagnosis was very difficult prior to the advent of MRI (1,2). It turns out that mild subsynovial fatty infiltration is not uncommon, although more extensive lesions which acquire the term lipoma arborescens are less common.

Lipoma arborescens should be included in the differential diagnosis of recurrent joint swelling and effusion among other synovial pathologies such as pigmented villonodular synovitis, synovial lipoma, rheumatoid arthritis, synovial hemangioma, synovial chondromatosis.

Lipoma arborescens is a benign entity of which radiologists and pathologist should increase their familiarity about it and MRI is the problem solving tool before biopsy arthroscopy or synoviectomy.

Findings and procedure details

Introduction
Lipoma arborescens is a rare condition affecting synovial linings of the joints and bursae, with 'frond like' depositions of fatty tissue. They account for less than 1% of all lipomatous lesions. Patients typically present in the 5\textsuperscript{th}-7\textsuperscript{th} decades \textsuperscript{(1)}.

Usually these lesions are sporadic; however they can be seen in the setting of osteoarthritis, collagen vascular disorders or previous trauma \textsuperscript{(2, 3)}.

Clinically, presentation is with painless joint swelling, frequently with an associated effusion. The most frequent site of involvement is suprapatellar bursa of knee joint, and the disorder is usually unilateral \textsuperscript{(1, 2, 3)}. Occasional reports of hip, shoulder, wrist elbow are also reported. Other joint involvement is uncommon.

**Pathology**

The normal synovium is replaced by hypertrophied villi demonstrating marked deposition of mature lipocytes within them \textsuperscript{(4-5)}.

**MRI findings**

MRI is the modality of choice for diagnosis. The lesion follows the signal intensity of fat on all sequences \textsuperscript{(4-5)}.

MRI demonstrates frond-like areas projecting inward from the synovium with signal equal to fat on all imaging sequences (fig. 1, 2, 3). If intravenous Gadolinium contrast is administered, enhancement can be seen of the chronically inflamed overlying synovium, but no enhancement is seen in the underlying fat (fig. 4, 5).

Villi may be small and feathery in appearance (Fig. 6, 7, 8) or they may be more bulky fatty lobules.

The fatty proliferation may be of such degree that it forms a mass (Fig. 9, 10), but mild cases with a pattern of diffuse villous proliferation are much more common (Fig. 4). Osseous erosions have been reported secondary to lipoma arborescens \textsuperscript{(8)}, although when present they are more often due to underlying arthritis.

**Differential diagnosis on MRI**

Lipoma arborescens has characteristic features that usually make it a straightforward MRI diagnosis. However, other entities occurring as filling
defects in the suprapatellar recess may cause confusion.

**Small filling defects (osseous loose bodies)** outlined by effusion in the suprapatellar bursa are most obvious on sequences where fluid is bright (such as T2-weighted or fat-suppressed proton-density imaging sequences). Correlation with T1-weighted images allows us to better assess the nature of this tissue (Fig. 11). Findings which remain isointense to fat on all imaging sequences are reliably confirmed as fat. If in addition a sclerotic peripheral rim is present, the appearance is typical for osseous loose bodies.

**If signal is intermediate on T1-weighted images, the tissue may be hyaline cartilage, such as from synovial chondromatosis:**

In this condition, multiple nodules of hyaline cartilage form in subsynovial connective tissue. The small lobules of hyaline cartilage may calcify centrally, forming areas with numerous punctate foci of very low signal (Fig. 12, 13). The cartilage is distributed throughout the joint, within the suprapatellar recess as well as low anterior and posterior locations, including within Baker's cysts (Fig. 14). Osseous erosions are often present.

**Intermediate signal intensity can also be seen with fibrinous tissue, such as "rice bodies" which may accompany rheumatoid arthritis.** These are typically very small in size and numerous. Dependent positioning reflects that they are free in the joint rather than fixed to the synovium (Fig. 15, 16). Very low signal on all imaging sequences may indicate the presence of calcium. Numerous small foci of calcification are often seen in synovial chondromatosis.

**Low to intermediate signal intensity on T1-weighted images and low signal intensity on T2-weighted or gradient echo sequences is more often seen with hemosiderin deposition:** Variable quantities of hemosiderin are deposited heterogeneously in larger areas in pigmented villonodular synovitis (PVNS) (Fig, 17, 18, 19) or hemosiderotic synovitis (such as from trauma or hemophilia). Hemosiderin deposition can also often be found in rheumatoid arthritis.

**Edematous fat pad may develop from quadriceps fat pad impingement:** With chronic mechanical impingement and inflammation, the fat pad may hypertrophy, causing an appearance compatible with lipoma arborescens (Fig. 20, 21).

**A true intraarticular lipoma** is a rare lesion characterized by a localized rounded mass of adipose tissue rather than multiple villi. There is no associated synovial proliferation, but rather a thin fibrous capsule. Intraarticular lipomas can be sessile or pedunculated.
Intraarticular liposarcoma is a rare lesion occurring in two main forms, most commonly low grade myxoid liposarcoma, found in young adults, and less commonly high grade pleomorphic liposarcoma, found in older patients. Low grade lesions are well-differentiated and have high fat content. A high-grade pleomorphic intra-articular liposarcoma has less fatty components and demonstrates a lesion more closely resembling PVNS, with multifocal nodules displaying intermediate signal in T1 weighted images with significant contrast uptake, not matching fat, and thus should not be mistakenly diagnosed as lipoma arborescens.

Other Locations

Although lipoma arborescens is most often found at the suprapatellar recess of the knee, it can occur wherever there is synovium. It occurs in other joints and bursae (hip, shoulder, wrist, elbow), and more rarely in the tendon sheaths (4).

Images for this section:
Fig. 1: 23 year old female with lipoma arborescens of the right knee joint. Sagittal non contrast T1 weighted image showed high signal intensity frond like synovial thickening in the suprapatellar bursal region (arrows) with joint effusion (flower).

Fig. 2: 23 year old female with lipoma arborescens of the right knee joint. Coronal T2 weighted (a) and axial T2 weighted (b) images showed intermediate to high signal intensity of the villous projections (straight arrows) similar to subcutaneous fat (flower).
Fig. 3: 23 year old female with lipoma arborescens of the right knee joint. Sagittal (a) coronal (b) and axial (c) fat suppressed proton density images revealed complete suppression of signal intensity of villous projections (arrow) in suprapatellar bursal region.
Fig. 4: Axial T1 weighted image shows diffuse irregular synovial thickening with fronde-like fatty lobules projections associated with large joint effusion
**Fig. 5:** Axial T1 FS after IV contrast injection demonstrates significant synovial enhancement delineating the fatty frond like synovial fatty projections which demonstrate hypointense signal after fat saturation.
Fig. 6: 42 year old with posterior left knee pain. Sagittal T1-weighted image demonstrates a large primarily fat-signal mass-like area (yellow arrows) filling much of the suprapatellar bursa. The innumerable individual villi are small in this case, with small quantities of interposed fluid, creating a feathery appearance.
Fig. 7: 42 year old with posterior left knee pain. Sagittal PD FS: An area posterior to the infrapatellar fat pad which resembles fluid on the T1-weighted sequence has intermediate signal on the sagittal PD FS sequence, compatible with an area of hypertrophic synovium little or no fat deposition (red arrows). When lipoma arborescens develops in patients
with chronic synovitis, patients also often have such areas of synovial thickening without fat deposition.

Fig. 8: 42 year old with posterior left knee pain. Axial PD FS MR image showing the large feathery-appearing lipoma arborescens filling the suprapatellar recess.
Fig. 9: 61 year-old male with worsening chronic diffuse knee pain. A sagittal T1-weighted image demonstrates severe medial compartment osteoarthritis with marginal osteophytes, subchondral changes, and an extensive complex tear of the medial meniscus (red arrows). Mild villous frond-like fatty subsynovial hyperplasia (yellow arrow) is present in the suprapatellar bursa.
**Fig. 10:** 61 year-old male with worsening chronic diffuse knee pain. The axial fat-suppressed proton density-weighted image confirms the villous tissue outlined by joint fluid. Cases like this are much more frequent than those manifesting as large fatty masses.
Fig. 11: Sagittal T1 weighted image showing An osseous loose body (red arrow) is located anteriorly, projecting into the posterior margin of the infrapatellar fat pad. This exhibits high T1 signal intensity from fatty marrow content. It has a thin surrounding cortex. A smaller loose body with less fat content is located posteriorly and one with very little fatty marrow is located superiorly (purple arrows).
**Fig. 12:** Primary synovial chondromatosis. 36 year-old male with chronic knee pain and locking. A sagittal PD FS weighted image showing innumerable small chondral bodies (blue arrows) throughout the joint are outlined by fluid on the fat-suppressed proton density images.
Fig. 13: Primary synovial chondromatosis. 36 year-old male with chronic knee pain and locking. The T1-weighted sagittal image shows no fat content except for a single tiny focus (yellow arrow) located in a posterior chondral body, from developing ossification. Small erosions (red arrowheads) are forming at the posterior and anterior margins of the lateral tibial plateau.
**Fig. 14:** Primary synovial chondromatosis. 36 year-old male with chronic knee pain and locking. Axial PD FS weighted image shows a popliteal cyst markedly distended by chondral bodies, several of which demonstrate central calcification (purple arrows).
Fig. 15: 41 year-old male with medial knee pain. Sagittal Fat-suppressed proton density weighted images demonstrate numerous tiny intermediate signal nodules (red arrows), layering dependently, outlined by joint fluid.
Fig. 16: 41 year-old male with medial knee pain. The T1-weighted image demonstrates no fat signal in the tiny bodies, which are made up of fibrinous tissue and cannot be distinguished from fluid on this sequence (red arrow shows corresponding location). The dependent layering indicates that these are mobile particles rather than affixed to the synovium.
Fig. 17: Pigmented villonodular synovitis. Sagittal PD FS weighted image: Extensive villonodular synovial proliferation (red arrows) throughout the knee, outlined by joint fluid, with low signal intensity from hemosiderin. Involvement of the suprapatellar recess, the infrapatellar fat pad, and posteriorly. Note that on the fat-suppressed proton density-weighted image, the signal intensity is moderately low in the lesion. Since it is isointense to fat, this can be misleading.
Fig. 18: Pigmented villonodular synovitis. Correlation with the T1-weighted sequence shows that this is clearly not fat.
Fig. 19: Pigmented villonodular synovitis. The T2-weighted image demonstrates very low signal intensity, compatible with hemosiderin. Knee MRI studies performed without a T2 weighted sequence may be misleading in this assessment, since the signal is not very low on the proton density images. Correlation with scout gradient echo images is sometimes helpful in confirming low signal.
Fig. 20: Quadriceps fat pad impingement. 52 year-old male with knee pain and swelling. T1-weighted sagittal demonstrates an edematous quadriceps fat pad (yellow arrow), most likely from fat pad impingement.
**Fig. 21:** Quadriceps fat pad impingement. 52 year-old male with knee pain and swelling. Fat-suppressed proton density axial image demonstrates an edematous quadriceps fat pad (yellow arrow), most likely from fat pad impingement. It is difficult to distinguish whether the edematous fatty tissue is only in the fat pad, or if there may be fatty synovial hyperplasia projecting into the joint.
Fig. 22: Intraarticular lipoma. A large rounded fatty mass (yellow arrows) is found in the medial portion of the suprapatellar recess on this T1-weighted image. Unlike lipoma arborescens, it is not comprised of small lobules or villi. A lipoma had been resected from this site many years earlier and this lesion was recurrent. Mild fibrosis at the upper margin is from prior surgery.
**Fig. 23:** Liposarcoma of the knee. Sagittal T1 weighted image demonstrates hypointense eccentric mass in the suprapatellar bursa containing small amount of fat at its upper pole.
Fig. 24: Liposarcoma of the knee. Axial PD FS weighted image showing hyperintense mass in the supra patellar bursae containing hypointense stranding with signs of cortical femoral medial condyle invasion.
Fig. 25: Liposarcoma of the knee. Coronal FS with contrast shows intense contrast uptake within the supra patellar mass deliniating hypointense non enhancing fatty components. Note extension to the medial femoral condyle.
Conclusion

Villous subsynovial lipomatous proliferation is an uncommon response to chronic synovial irritation, whether mechanical or inflammatory in nature. It is typically found in chronically arthritic joints, most often in the suprapatellar recess of the knee, but also in other joints, bursae, and even tendon sheaths. Occasionally this process becomes mass-like and more deserving of the term lipoma arborescens. Features on MRI are distinctive. Many radiologists, rheumatologists, and orthopedic surgeons will encounter this in their practice and should not mistake it for neoplasm or other pathology.

Personal information

References