Extra-articular Knee Lesion with High Fluorodeoxyglucose-Uptake on Positron Emission Tomography

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Abstract

Pigmented villonodular synovitis (PVNS) is an uncommon musculoskeletal tumor that is typically benign and often diagnosed radiologically by magnetic resonance imaging (MRI). Fluorodeoxyglucose (FDG)-uptake positron emission tomography (PET) is an imaging tool primarily used in oncology to evaluate malignancy. FDG measures metabolic activity with standardized uptake value (SUV). A high SUV is suggestive of malignancy. We report a case of PVNS detected incidentally by FDG-PET as an extracapsular mass adherent to vastus medialis tendon with a high SUV of 15.1. Given the patient’s history of cancer and the high SUV, the lesion was initially considered a malignancy. The objective of this case report is to illustrate that even a high-SUV mass detected with PET imaging does not necessarily indicate malignancy, and thus a benign lesion can also demonstrate such elevated signal.

A 62-year-old woman with a history of stage I chronic lymphocytic leukemia (CLL), hyperlipidemia, osteopenia, and a basal cell carcinoma of the eyelid was referred to her gynecologist for workup of recent abdominal pain with a 20-pound weight loss and early satiety. Her family history was remarkable for CLL, brain cancer, and prostate cancer. Her uterus was surgically removed for suspicion of leiomyosarcoma, but 2 weeks later she experienced excruciating generalized musculoskeletal pain.

She was referred to our clinic with an atypical distribution of pain over the temporomandibular joints, biceps, lower back, palms, and bilateral lower legs. She denied fever, rash, or mucosal lesions to suggest a systemic connective-tissue disease. Rheumatologic workup was negative for polymyalgia rheumatica, rheumatoid arthritis, and polymyalgias. Physical examination revealed palpable swelling of the affected knee without warmth, tenderness, or erythema, although she denied recent trauma or knee pain proportionally greater than her other complaints.

Imaging Interpretation

Given the significant personal and family history of cancer, a whole body PET was performed demonstrating a hypermetabolic area in the left knee. A 3.8 x 1.4 cm homogeneous well-circumscribed soft tissue radio-dense structure (37 Hounsfield Units) just deep to the distal left vastus medialis tendon, medial to the inferior patella was noted to be hypermetabolic with an SUV of 15.1 (Fig. 1).

MRI of the left knee showed a diffusely contrast-enhancing solid lesion measuring 5.4 x 4.3 x 1.2 cm in the anteromedial joint capsule adjacent to and contacting the medial pole of the patella and the anteromedial surface of the medial femoral condyle. It was heterogeneous with amorphous low-signal foci (Fig. 2).

These findings suggest several possible differential diagnoses: soft tissue sarcoma, metastatic lesion, pigmented villonodular synovitis, infection, and myositis.

Histology Interpretation

Because of the high SUV, malignant lesion could not be excluded. An excisional biopsy was therefore performed to obtain tissue diagnosis. Intraoperatively, a dark, brown-colored tumor was observed outside the joint capsule fixed...
and adherent to the vastus medialis tendon. The tumor was excised, and a soft tissue specimen measuring 1.3 x 1.0 x 0.4 cm was sent for final diagnosis. The histologic examination revealed sheets of proliferating cells creating fronds protruding the synovial lining, which is compatible with pigmented villonodular synovitis (PVNS) (Fig. 3). There was no evidence of infection or sarcoma.

Discussion and Treatment

PVNS is a benign, slow growing, but locally aggressive intra-articular lesion known to arise from a polyclonal population of cells in synovial joints, tendon sheaths, and bursae. The increased synovial proliferation typically results in monoarticular disease most commonly affecting the knee. PVNS is typically diagnosed by history, physical examination, and MRI. Pathologic examination of tissue biopsy is required for definitive diagnosis, and histologic appearance is characterized by hemosiderin deposition, histiocytic infiltrate, and giant cells. Hemosiderin causes the distinctive brownish color and manifests as either patchy or continuous low foci signal by MRI on T1- and T2-weighted sequences. However, early inflammatory lesions with less hemosiderin can produce large amounts of bright signal on T2 sequences.

The tumor’s growth pattern can result in either a localized nodular mass or a diffuse process affecting the entire synovium. The former is managed effectively with synovectomy and has a low recurrence rate, while the latter is more common and has a high recurrence rate of up to 46%. The lesion can be aggressive and extend outside the articular space, and the condition can raise the risk of secondary osteoarthritis.

There are reported cases of malignant synovial tumors, but generally PVNS has low potential for metastasis. While radiotracer scintigraphy has previously been useful in initial detection of PVNS and other tumors, fluorodeoxyglucose-positron imaging tomography (FDG-PET) can serve as a clinically useful noninvasive assessment of the degree of malignancy, although it is primarily used to monitor tumors with an established diagnosis.

Fluorodeoxyglucose (FDG) is a glucose analog used as a tracer to detect the hypermetabolic activity of tumors. FDG-PET demonstrated a region of increased uptake at the medial aspect of the left knee. Coronal (A) and transaxial (B) three-dimensionally reconstructed FDG-PET imaging of both knees demonstrates a hypermetabolic mass (SUVmax = 15.1 g/mL) in the left knee. Coronal (A) and transaxial CT (C) shows the mass is a homogeneous well-circumscribed soft tissue density (arrows). Coronal (E) and transaxial (F) views of merged CT and PET imaging localizes the structure as deep to the distal left vastus medialis tendon and medial to the inferior patella.
PET uses a standardized uptake value (SUV), an estimate used to quantify the uptake of the tracer in the region of interest. This approximates the local metabolic activity in order to monitor tumor size during cancer therapy. Studies have shown that PET is also effective in detection of malignancy in the extremities, identifying sarcoma with a sensitivity of 0.91 and specificity of 0.85.13

We present a case of PVNS of the knee with an SUV of 15.1 detected by FDG-PET, in order to demonstrate to clinicians that even a remarkable elevation of FDG-uptake by PET can still represent a benign lesion. In addition, the high SUV suggests a high level of metabolic activity in PVNS. In this case, whole-body FDG-PET imaging was performed because of the patient’s constitutional symptoms in the setting of leukemia. The high metabolic activity enhanced suspicion for malignancy.

High metabolic activity has been demonstrated to correlate with aggressive activity and high tumor grade in lung cancer, colorectal cancer, breast cancer, melanoma, and malignant lymphoma.14 Specifically in non-small cell lung cancer, SUVs ranging from 2.5 to 20 have been used as a prognostic cutoff,15 and one study showed overall survival was significantly longer in patients with SUV < 15.16

To date, four case reports of PVNS with a high-SUV provide insight into the use of FDG-PET for this disease (Table 1). Kitapci and coworkers reported detection of PVNS lesion at the acetabulum with an SUV of 11.3, which was thought to be metastasis.17 The other case reports do not specify the SUV but reported a similar diagnostic dilemma and concern for a malignant lesion.18-20 All four cases indicated suspicion for sarcoma or metastasis based on a personal or family history of malignancy.
As imaging is critical to the management of musculoskeletal tumors, studies have reported the potential and promise for FDG-PET to distinguish a malignant lesion from a benign soft tissue mass or bone tumor. In one series, 10 malignant soft tissue tumors were distinguished from 10 benign lesions using a cutoff SUV of 1.90. Similar cutoff values were used to differentiate benign and malignant primary intraosseous lesions. However, initial reports supporting the use of FDG-PET as a diagnostic tool were challenged by a number of studies which were not able to distinguish benign from malignant bone tumors. Results were often complicated by high-uptake aggressive benign tumors or inflammatory lesions, which often are highly vascular, with elevated cell turnover.

False-positive detection of locally aggressive benign lesions that do not metastasize, therefore, limits the use of FDG-PET as a tool for differential diagnosis. Given the considerable frequency of high-uptake benign lesions, it has been suggested that FDG-PET use be confined to grading and monitoring of soft-tissue sarcoma.

Interestingly, our patient had constitutional symptoms including complex myalgias and arthralgias (with notable exception of the knee). Though the symptoms are more likely coincidental with the lesion, there has been a report of diffuse back pain and paresthesias in the extremities in the setting of PVNS of the zygapophyseal joint. Results were often complicated by high-uptake aggressive benign tumors or inflammatory lesions, which often are highly vascular, with elevated cell turnover.

After tumor excision at the knee, the generalized pain was improved, but she continued complaining of residual pain in the jaw and hip joints. A paraneoplastic panel was sent, which was negative for all autoantibodies with the exception of striational paraneoplastic autoantibody, which is compatible with neurologic dysfunction. But, further neurologic workup revealed mild sensory neuropathy of no apparent cause.

At 6 months postoperative follow-up, the patient’s status was substantially improved, and she reported resolution of her musculoskeletal pain and was progressing well with physical therapy. Although the constitutional symptoms improved with excision of the mass, the exact mechanism by which PVNS relates to these phenomena cannot be determined.

In summary, while a high SUV on PET is most consistent with a malignancy, some benign-aggressive lesions, such as the one presented in this case, can also show high signal. The biology and prognosis of this subset of tumor are not well elucidated, and this high metabolic activity may have implications for the risk of recurrence. A prospective study on SUV and rate of recurrence of PVNS might help answer this question. Nevertheless, it is important to manage a high-SUV lesion as malignant until proven otherwise.

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