Giant Cell Tumor of the Rib: Two Cases of F-18 FDG PET/CT Findings

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Abstract We report two cases of giant cell tumor arising from the rib and their F-18 FDG PET/CT findings. The two patients complained of chest wall pain, and large lobulated soft tissue masses with intense FDG uptake were seen on F-18 FDG PET/CT. A malignant tumor such as osteosarcoma or chondrosarcoma was suspected due to the large size of the mass, bony destruction, and intense FDG uptake. En bloc resection was performed and final pathologic results revealed giant cell tumor of the rib. Giant cell tumor of the rib is very rare, and larger lesions with high FDG uptake can be misdiagnosed as an intrathoracic malignancy arising from the rib, pleura, or chest wall.

Keywords FDG · Giant cell tumor of bone · PET/CT · Rib

Introduction

Giant cell tumor (GCT) of the bone is a rare primary bone tumor which accounts for 5 % of primary bone tumors and 20 % of benign bone tumors [1, 2]. GCT is categorized as a benign bone tumor, although it may show locally aggressive

features, and has a high recurrence rate (25–50 %) following after surgical resection [2]. Common sites of GCT are the bony end of long bones such as the distal femur, proximal tibia, and distal radius. Rib involvement is extremely rare [1, 2]. FDG uptake in GCT is relatively high compared to other benign bone tumors [3, 4]. It is difficult to differentiate benign from malignant bone tumors using only FDG-avidity. We report the F-18 FDG PET/CT findings of GCT arising from the rib with aggressive features mimicking osteosarcoma.

Case Reports

Case 1

A 39-year-old female complained of a palpable mass on the left anterior chest wall. Chest radiographs demonstrated a large, lobulated mass in the left upper thorax (Fig. 1a). On contrast-enhanced chest CT, a large, lobulated, enhancing mass with internal calcification was noted in the left anterior chest wall outgrowing from left 3rd rib (Fig. 1b). F-18 FDG PET/CT was performed. An intensely hypermetabolic lobulated mass was seen in the left anterior chest wall abutting the left upper lung parenchyma and mediastinum (Fig. 1c, d and e). On the basis of intense FDG-avidity, high contrast enhancement, and originated from the left 3rd rib, we suspected a malignant bone tumor such as osteosarcoma or chondrosarcoma, or an anterior mediastinal tumor such as a germ cell tumor or thymoma with unusual imaging findings and location. En bloc chest wall mass resection with reconstruction and wedge resection of the left upper lobe of lung was done. Final pathology revealed a giant cell tumor arising from the rib with lung and pleural invasion. Microscopic findings showed a high mitotic rate (20–25/10 high power field), necrosis, and osteoid formation. Based on these pathologic

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Fig. 1 Radiologic findings of case 1. **a** Plain chest radiograph shows large, lobulated mass in left upper thorax. **b** On contrast-enhanced chest CT, about 10 cm size of lobulated, heterogeneously enhancing mass is seen in left anterior chest wall. Mass is spreading from anterior arc of the

left third rib. **c** and **d** Heterogeneously, intense FDG uptake is noted in anterior chest wall mass (SUVmax 16.8). **e** There is no abnormal FDG uptake suggestive of metastasis

findings, the clinician recommended adjuvant treatment and the patient received systemic chemotherapy (mesna, doxorubicin, ifosfamide, and dacarbazine) followed by external radiation therapy.

Case 2

A 59-year-old female presented with a two-week history of back pain. Chest radiographs demonstrated a left superior

Fig. 2 Radiologic findings of case 2. **a** and **b** On contrast enhanced chest CT images, heterogeneously enhancing, expansile mass is seen in head and neck portion of left fourth rib. **c** and **d** The mass shows

heterogeneously, intense FDG uptake on F-18 FDG PET/CT (SUVmax 10.0). **e** On maximal intensity projection image of PET/CT, there is no evidence of metastasis

mediastinal mass. On chest CT, an exophytic mass with cortical break was seen in the posterior arc of the left 4th rib. The mass size was approximately $4.0 \times 6.0 \times 6.3$ cm and the mass appeared as a lobulated soft-tissue density with calcification and heterogeneous enhancement (Fig. 2a and b). Torso F-18 FDG PET/CT demonstrated intense FDG uptake without evidence of metastasis (Fig. 2c, d, and e). On MRI with enhancement, the mass showed low signal intensity on both T1 and T2 weighted images with heterogeneous enhancement. A focal cystic lesion connected to the main mass was seen adjacent to the posterior arc of the left 4th rib. En bloc tumor resection with chest wall reconstruction was performed, and the final pathology revealed a bone giant cell tumor with infrequent mitotic figures (2/10 high power field). Adjuvant treatment was considered because of the relatively large size of the tumor and aggressive imaging findings of bony expansion with cortical break and some mitotic activity, but the patient refused further treatment.

Discussion

GCT of the rib is very rare, especially in the anterior arc. The most common malignant condition of the rib is metastatic, followed by primary malignant bone tumors such as chondrosarcoma, plasmacytoma or lymphoma. Common benign tumors of the rib include fibrous dysplasia, osteochondroma, enchondroma, and aneurysmal bone cyst [5, 6]. Of particular note, tumors of the anterior ribs often appear as an anterior mediastinal mass. Therefore, when a tumor originating from the rib is detected, the above-mentioned primary bone tumors or mediastinal tumors are considered rather than GCT. A small number of cases with GCT of the rib were reported [7–10]. Reported cases showed aggressive radiologic and pathologic features as our cases and they were treated with surgical resection. However, cases with F-18 FDG PET/CT findings are rare.

On plain radiographs, GCT shows a well-defined, purely lytic lesion with a non-sclerotic margin and eccentric location. GCT can also show aggressive radiologic features including cortical thinning, expansile bone lesions, cortical bone destruction, and soft tissue mass formation. Air-fluid level is also seen when an aneurysmal bone cyst coexists with GCT [1]. Diffusely increased radiotracer uptake or peripheral uptake with decreased activity in the center is a well-known finding on bone scintigraphy. Three-phase bone scintigraphy images typically show increased uptake in blood flow and blood pool [1, 9, 11]. F-18 FDG PET/CT is useful in differentiating benign from malignant tumors, although not always for bone tumors, a positive correlation between FDG uptake intensity and tumor grade has been noted. However, some benign tumors such as giant cell tumors,

chondroblastomas, sarcoidosis, Langerhans cell histiocytosis, non-ossifying fibromas, and fibrous dysplasia show high FDG uptake. Benign bone tumors containing histiocytic cells or giant cells usually show high FDG uptake [4, 9]. GCT contains multinucleated osteoclast-type giant cells with background mononuclear stromal cells. These cells have a high glucose metabolism due to their role in response to injury and infection [4]. Therefore, GCT shows high FDG uptake and the intensity of FDG uptake alone cannot be used to differentiate benign and malignant bone tumors. However, the high metabolic activity seen on FDG PET/CT reflects high cellular proliferation. Case 1 shows greater FDG uptake than case 2 on PET/CT. On microscopic examination, case 1 shows higher cellularity and more frequent mitotic rate than case 2 (Fig. 3).

Fig. 3 Microscopic images of case 1 and case 2. The tumors consist of numerous multinucleated giant cells (white stars) and mononuclear stromal cells (black arrowheads) on both cases. The giant cells resemble osteoclasts of bone. The nuclei of stromal cells are morphologically similar to the nuclei within the giant cells. **a** Frequent mitotic activity (black arrows) (20–25/10 high power field) and high cellularity are seen in case 1. **b** Case 2 shows infrequent mitotic activity and low cellularity

Bone GCT is a benign bone tumor with locally aggressive features and a high recurrence rate of 40 %. Malignant transformation has also been reported in 1–2 % of bone GCT and is common after radiation [9]. Primary malignant GCTs are rare. GCTs as a secondary malignancy following radiation treatment are more common than primary malignant GCTs [12]. The classic GCT consists of spindle mononuclear stromal cells and multinuclear giant cells. Some mitotic figures can be seen without atypical mitosis. However, malignant GCTs have hyperchromatic nuclei, mitotic activity, and atypical mitosis. Osteosarcoma-like osteoid production and fibrosarcoma-like spindle cells can also be observed [12, 13]. When GCT has aggressive features such as invasion of adjacent tissue, large soft tissue formation, cortical destruction and malignant pathologic features, adjuvant treatment such as external radiation or chemotherapy is needed following complete resection with a wide surgical margin.

In summary, the two cases described herein exhibited large GCTs of the rib with aggressive features. Large GCT of the rib with high FDG uptake on PET/CT can mimic an intrathoracic malignancy.

Compliance with Ethical Standards

Conflicts of interest The authors Hye Lim Park, Ie Ryung Yoo, Yeongjoo Lee, Sonya Youngju Park, and Chan Kwon Jung declare that they have no conflict of interest.

Ethical statement This study was performed in accordance with the regulations of our hospital's Institutional Review Board, which approved the retrospective design and waived the requirement for informed consent. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

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