The Complimentary Role of Methoxy-Isobutyl-Isonitrile and Hand-Held Gamma Probe in Adamantinoma

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Abstract

Adamantinoma is a rare locally aggressive osteolytic tumor that is found 90% of the time in the diaphysis of the tibia with the remaining lesions found in the fibula and long tubular bones. A case of adamantinoma of the tibia is presented. The added value of nuclear medicine investigations in the workup of this patient is described. A three-phase whole body ^{99m}Tc-methylene diphosphonate bone and a whole body ^{99m}Tc-methoxy-isobutyl-isonitrile scans were complimentary in the demarcation of viable bone tumor and the assessment of the remainder of the bone and soft tissue to exclude other sites. Intra-operative assistance with a hand-held gamma probe, guided the biopsy of the most metabolically active tumor tissue. Histology revealed a biphasic tumor composed of epithelial and fibrous components, in keeping with an adamantinoma.

Keywords: Adamantinoma, bone scan, gamma probe, methoxy-isobutyl-isonitrile, tumor

Interesting Image

A 28-year-old male patient presented with 3 months history of pain and swelling over the anterior aspect of the left tibia.

Planar X-rays revealed at least one section of confluent lytic areas with an associated pathological fracture, surrounded by cortical thickening and demarcated superiorly by an area of irregular sclerosis [Figure 1a-c].

Magnetic resonance imaging demonstrated a lobulated lesion involving the midshaft of the left tibia, measuring ± 9 cm in total length. Cartilaginous features in the proximal aspect of the lesion were confirmed by areas of irregular hyperintensity. An irregular hyperintense component in relation to the lytic area and the pathological fracture was observed suggesting extraosseous extension of tumor tissue causing overlying displacement of soft tissue. The radiological features were that of an aggressive Adamantinoma.

The patient was referred to nuclear medicine to further evaluate the extent of the primary lesion and to determine other sites of possible metastases. ^{99m}Tc-methylene diphosphonate (^{99m}Tc-MDP) whole body blood pool and 3 h delayed whole body [Figure 2a] bone scan were done. There was a localized area of increased vascularity and inhomogeneous concentration of radiopharmaceutical in the left proximal tibia. Intense localized osteoblastic activity was seen in the superolateral and anterior aspect of the lesion corresponding to the fracture site, a relatively photopenic defect was seen medial and adjacent to this area with a rim of low-grade increased osteoblastic activity. The remainder of the bone scan was normal. A ^{99m}Tc-methoxy-isobutyl-isonitrile (^{99m}Tc-MIBI) whole body scan [Figure 2b] was performed 2 days after the bone scan to determine the extent of the metabolically active component of the tumor. It showed avid uptake corresponding to the photopenic area on the bone scan. The rest of the scan was normal.

Directly after the MIBI study the patient was transferred to theater for intraoperative localization, biopsy of the metabolically active tumor tissue and excision

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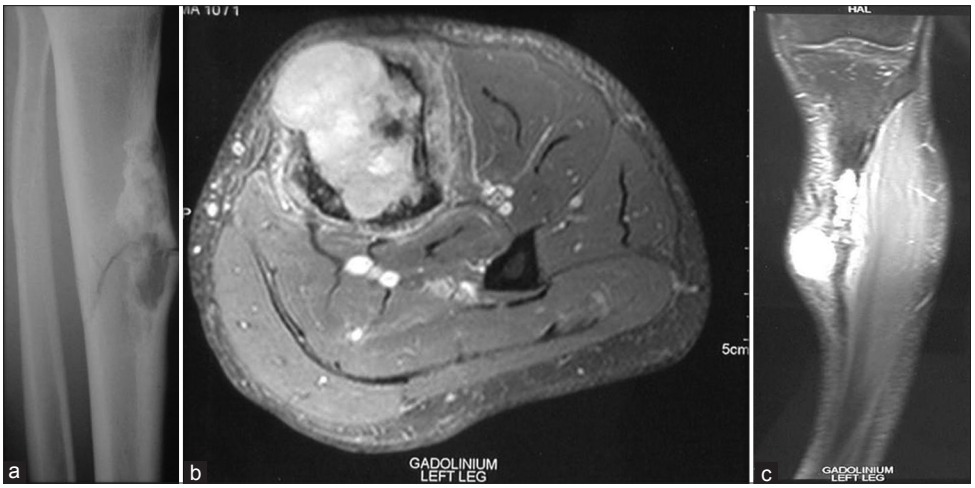

Figure 1: (a) Planar X-ray of left tibia, (b) Magnetic resonance imaging transaxial cut of proximal left tibia, (c) Magnetic resonance imaging left tibia

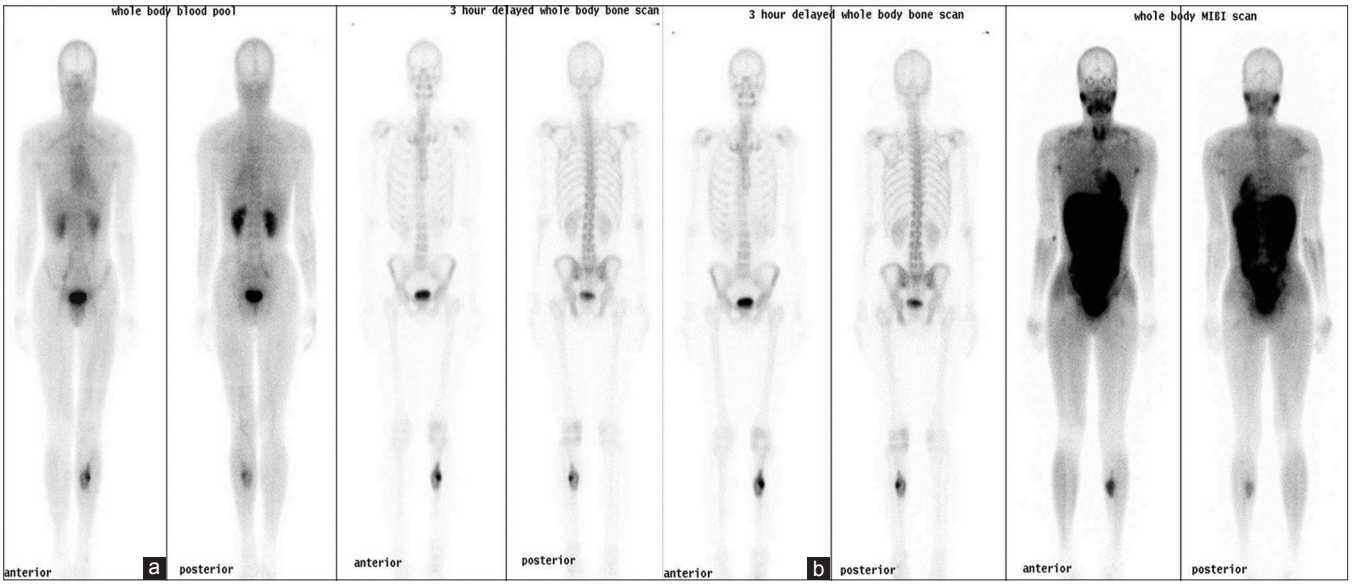

Figure 2: (a) Whole body blood pool and whole body delayed images, (b) Whole body bone scan versus whole body methoxy-isobutyl-isonitrile scan

of the lesion. This was aided by a hand-held gamma probe (World of Medicine Gamma Finder) [Figure 3]. Multiple fragments of tissue were taken for histology; the largest was 17 × 15 × 5 mm. Counts of more than 20% of background activity were considered as significant. The patient underwent *en block* excision of the proximal tibia with preservation of the growth plate. The defect was filled by use of a bone transplant technique and an external fixation was applied.

Histology revealed a biphasic tumor with epithelial and fibrous components. The epithelial component displayed three different patterns, basaloid [Figure 4a], fascicular [Figure 4b], and tubular [Figure 4c]. The fibrous component did not contain features of fibro-osseous dysplasia or osteofibrous dysplasia-like areas. Immunohistochemistry for pancytokeratin [MNF 116] [Figure 4d] revealed a strong expression in the epithelial component and negative in stromal component.

A week post total excision of the tumor a repeat MIBI whole body scan was performed to evaluate for residual active tumor. This scan showed no abnormal uptake [Figure 5]. It was confirmed on histology that the tumor was removed with a clear margin. Postoperatively, the patient did well and long-term follow-up has been planned.

Discussion

Adamantinoma is a rare locally aggressive osteolytic tumor, found 90% of the time in the diaphysis of the tibia with remaining lesions found in the fibula and long

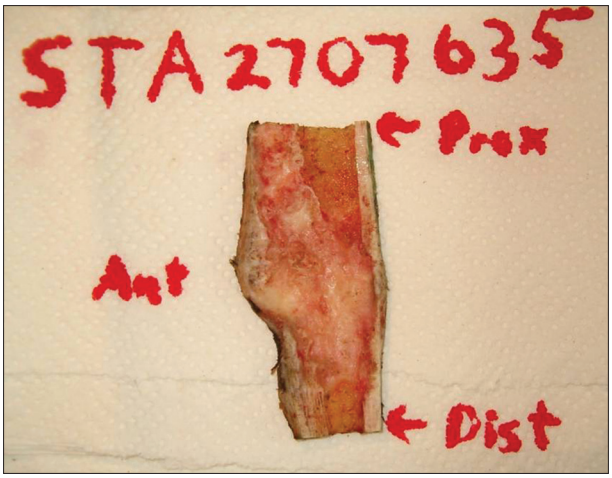

Figure 3: Largest tissue fragment taken

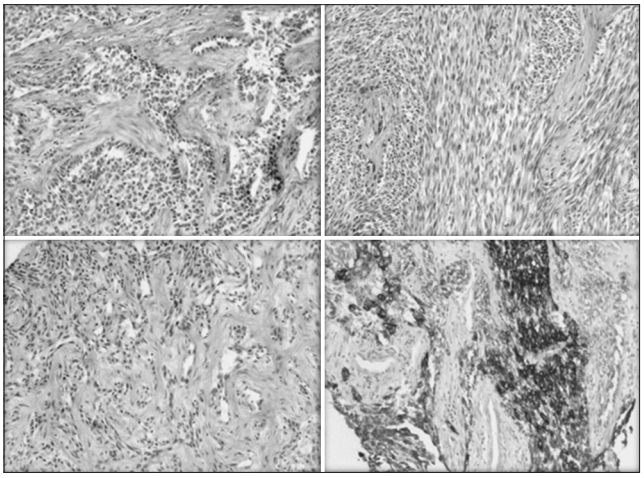

Figure 4: Histology revealed biphasic tumor

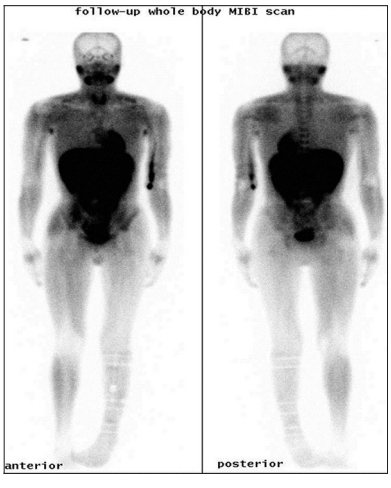

Figure 5: Whole body methoxy-isobutyl-isonitrile scan postsurgery

tubular bones. Adamantinoma typically ranges from 3 to 15 cm in size, and metastases occur in approximately 15-20% of patients. Diagnosis is histological. The tumor is known to have a dominant lytic component. This tumor is insensitive to radiation and chemotherapy.[1,2]

The accurate assessment of musculoskeletal tumors may be unreliable due to pathological fractures, hemorrhage, calcification, and inflammation on a bone scan. In 1990, Delmon-Moingeon *et al.*, described Sestamibi as an *in vivo* tumor imaging agent.[3] Better delineation of tumor outlines and cellular activity is an advantage of MIBI scintigraphy, which is helpful in the evaluation of musculoskeletal tumors. No relationship could be found between tumor MIBI uptake and ^{99m}Tc-MDP osteoblastic activity in musculoskeletal tumor's.[4] Although the exact uptake mechanisms of MIBI into the myocardial and tumor cells are not well-understood, it is postulated to be related to blood flow, blood residence time, and the cellular uptake due to passive influx of the lipophilic cation, driven by the plasma and mitochondrial membrane potentials generated in living cells. Elevated potentials are directly related to metabolic state.[5] MIBI is physiologically taken up by the salivary glands, thyroid, heart, liver, spleen, and skeletal muscle. There is physiological hepatobiliary and renal clearance. MIBI has the advantage of being readily available, easy to prepare and cost-effective.

Conclusion

As demonstrated in this case report, molecular imaging techniques can provide complementary information to anatomical imaging techniques in staging, therapeutic monitoring and surveillance as well as additional applications that include the localization of a malignant lesion using a hand held gamma probe. The best test will be defined by local cost, availability, and expertise within a given modality, in addition to patient specific circumstances.

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