Primary Breast Osteosarcoma: Dynamic Contrast-Enhanced Magnetic Resonance Imaging, Proton Spectroscopy and Diffusion Weighted Imaging Findings

Dear Editor,

Primary pure osteosarcoma of the breast is a rare malignant tumour and is histologically indistinguishable from conventional osteosarcoma of the bone and other extraskeletal sites. Being a rare entity that is briefly reported in the radiology literature, it has some interesting imaging features worthy of discussion. Here we report the novel findings of dynamic contrast-enhanced MRI (DCE-MRI), diffusion weighted imaging and MR spectroscopy of primary breast osteosarcoma which has never been previously reported.

Case Report

An 82-year-old woman presented with a 3-week history of a painless right breast lump. Physical examination revealed a hard and non-tender mass measuring 3 cm in the lower quadrant of the right breast. Mammogram showed a well-circumscribed high density mass in the lower medial quadrant of the right breast with no associated calcifications (Fig. 1). Breast ultrasound showed a well-circumscribed hypoechoic ovoid mass with peripheral vascularity at the 3 o'clock position of the right breast.

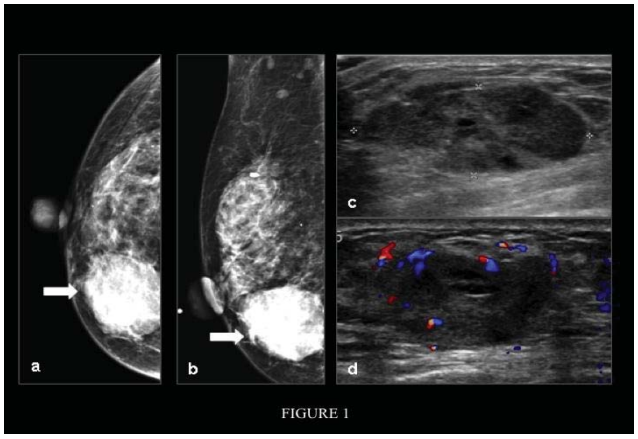


FIGURE 1

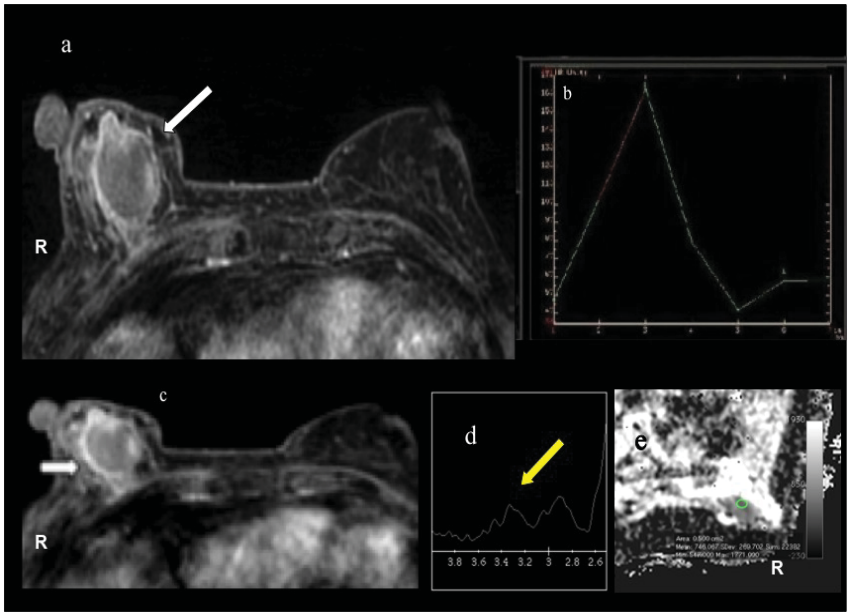
Figs. 1 (a, b) Two view mammogram (CC and MLO) showing a high-density lobulated mass (white arrow) in the right lower inner quadrant. (c) Ultrasound of the right breast demonstrating the well-circumscribed lobular hypoechoic mass which lies in close proximity but not infiltrating the chest wall. (d) Colour Doppler flow study showing peripheral vascularity within the lesion.

Contrast-enhanced MRI at 3.0T (GE Signa, GE Medical Systems, Milwaukee, USA) showed an irregularly shaped rim enhancing mass measuring 3.0 cm x 2.6 cm in the right breast. On dynamic imaging, the lesion displayed rapid contrast uptake in the early phase and rapid washout in the delayed phase consistent with type 3 kinetic curve (Fig. 2). There was enhancement of adjacent breast parenchyma extending towards the pectoralis muscle consistent with chest wall involvement. There was no nipple, skin or axillary involvement. The contralateral breast and axilla were normal. Diffusion weighted imaging showed reduced diffusion with corresponding mean apparent diffusion coefficient (ADC) value of 0.75 $x10^3$. Choline peak was also present on the single voxel proton spectroscopy sequence at 3.2 ppm. Ultrasound guided trucut biopsy was performed and the histopathology showed neoplastic spindle cells with abundant osteoid formation (Fig. 3). Further immunohistochemistry with Vimentin stain turned out strongly positive for mesenchymal tissues in keeping with sarcomatous neoplasm. The final diagnosis of an osteogenic sarcoma of either primary or secondary nature was made and further investigation to exclude skeletal sarcoma was suggested. There was no previous history of trauma or local irradiation to the chest or breast. Whole body 99mTc-methylene diphosphonate bone scintigraphy showed faint radiotracer uptake in the right breast without abnormal uptake in the bony skeleton. Serum alkaline phosphatase was not raised.

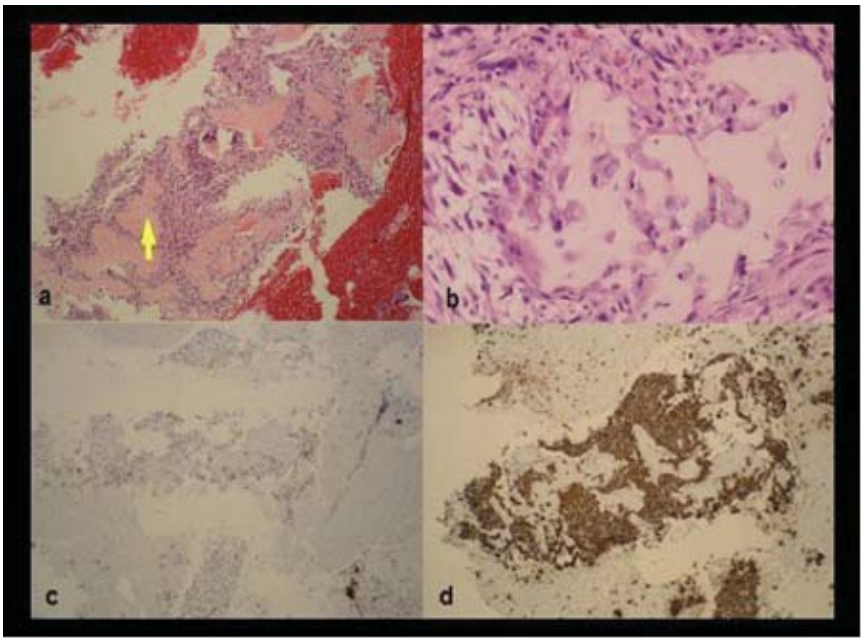
As the patient refused further treatment, palliative care was offered. The mass quickly ulcerated within the next 3 months and she passed away at her home 6 months later.

Discussion

Primary breast osteosarcoma is commonly found in women with mean age of 52 to 64 years and may be clinically indistinguishable from primary carcinoma of the breast.[1] The criteria required for the diagnosis of a primary osteosarcoma of the breast include (i) demonstration of neoplastic osteoid and neoplastic osteoblasts, (ii) the exclusion of primary bony origin, and (iii) the absence of neoplastic epithelial component that may undergo metaplasia.[2] Appearances on mammography are variable but most presented as well circumscribed dense masses with lobulated borders usually containing prominent calcifications.[3]



Figs. 2. Axial post contrast-enhanced MRI (a) showing a lobulated heterogeneously enhancing lesion (white arrow) in the right breast which showed delayed rim enhancement (c). (b) Dynamic imaging analysis demonstrated rapid early contrast uptake with delayed washout (type 3 kinetic curve). (d) There was a choline peak detected 3.2 to 3.3 ppm on MR proton spectroscopy (yellow arrow). (e) The mass showed restriction in diffusion on DWI /ADC map (b = 1000) with a mean ADC value of 0.75 x10^{-3} mm^2/s.



Figs. 3. Histopathology with H&E stain in (a) low power field (10x), and (b) high power field (20x) showing malignant osteoid (yellow arrow) and sarcomatous cells. (c) Epithelial Membrane Antigen stain (EMA stain) was negative for neoplastic features of ductal epithelial tumours. (d) VIMENTIN stain was positive consistent with sarcoma.

Skeletal scintigraphy with administration of Tc-99m methylene diphosphonate (MDP) may show intense concentration of activity in the primary osteosarcoma breast tumour.[4] In contrast, the tumour in our patient demonstrated faint radiotracer intensity while no abnormal soft tissue uptake was observed in their case by Dragoumis et al.[5] We postulate that the composition of predominant cell subtypes, either chondroblastic, osteoblastic or osteoclastic within the tumour determine the appearance on scintigraphy.

The mammographic and sonographic features of the breast mass in our patient were suspicious for malignancy. However, when the histopathology was confirmed to be osteosarcoma, the possibility of breast metastases from a skeletal sarcoma had to be excluded. On skeletal scintigraphy, the isolated radiotracer uptake in the right breast with absence of skeletal uptake supported the diagnosis of primary breast osteosarcoma.

There is a suggestion that primary breast osteosarcoma

may arise from metaplasia of pre-existing breast lesions i.e. fibroadenoma, intraductal papilloma or phyllodes tumour.[1] This is the result of extensive osseous metaplasia due to the totipotent characteristic of the mesenchymal cells of the breast stroma. In our patient, the Epithelial Membrane Antigen (EMA) was negative suggesting that the sarcoma did not arise from metaplastic transformation of a primary carcinoma of the breast.[6]

Magnetic resonance imaging (MRI) was performed on our patient as part of the ongoing breast MRI research study to investigate the quantification of choline metabolites in breast tumours on MR spectroscopy. Contrast-enhanced MRI is increasingly being used in breast cancer management to assess extent of disease, detect mutifocality as well as determine skin or chest wall involvement. The features of breast carcinoma on MRI include irregular mass enhancement, spiculated margin, rim enhancement and lymphadenopathy. Three enhancement patterns can be identified by plotting the signal intensity values in breast tissue intensity time – curve after contrast material injection on dynamic study. Type 1 curve is a progressive enhancement pattern usually associated with a benign finding. Malignant masses usually display type 2 and type 3 curves with type 3 being the most suspicious pattern for breast malignancy.[7]

Type 2 curve is plateau pattern showing initial increase in signal intensity followed by flattening of the enhancement curve. In Type 3 curve, there is washout pattern after an initial increase.

On diffusion weighted (DWI) breast MRI, studies have shown that malignant breast tumours demonstrate lower ADC value ($[0.97 \pm 0.20] \times 10^{-3}$ mm^2/s) than benign breast lesions ($[1.57 \pm 0.23] \times 10^{-3}$ mm^2/s).[8]

On proton MR spectroscopy, malignant lesions usually display elevated choline resonance peak.[9] The features of malignant morphology, delayed rim enhancement and early rapid and washout dynamic pattern (type 3 curve) are indistinguishable from that of invasive breast carcinoma. Of interest is also the presence of choline metabolites on the MR proton spectroscopy and the low ADC value usually observed in malignant breast tumours. Overall, we conclude that the findings on advanced MRI of breast osteosarcoma in our case were consistent with malignant tumour.

The definitive management of primary breast osteosarcoma is complete tumour resection or mastectomy to ensure a wide excision with clear margins. Axillary dissection is usually not required as haematogenous is more common than lymphatic spread. The role of adjuvant chemotherapy, although proven to be effective in osteosarcoma of the bone, is unclear in primary osteosarcoma of the breast because of the scarcity of data. Prognosis is believed to be poor and the lungs are the most frequent target for metastases.

Mastectomy was initially planned in view of the tumour size and chest wall involvement demonstrated on MRI, however the patient refused surgery and died 6 months after diagnosis.

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Joo Siong Ho, [1]*MBBS, MRad, FRCR*, Kartini Rahmat,[2] *MBBS, MRad(Mal), FRCR(UK)*, Kasumawati Alli, [2]*MBBS, MRad*, Kum Thong Wong,[3] *MBBS, MPath, MD*, Cheng Har Yip, [4]*MBBS,FRCS*

[1]Radiology, Bintulu Medical Centre, Kemena, Bintulu, Sarawak,
[2]Department of Biomedical Imaging ,University Malaya Research Imaging Centre, University of Malaya.
[3]Department of Pathology, Faculty of Medicine, University of Malaya
[4]Department of Surgery, Faculty of Medicine, University of Malaya.

Address for Correspondence: Dr Kartini Rahmat, University Malaya Research Imaging Centre, Department of Biomedical Imaging, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia.
Email: katt_xr2000@yahoo.com