Magnetic Resonance Imaging Features of Breast Leukemia

Suk Jung Kim*

Department of Radiology, Haeundae Paik Hospital, Inje University College of Medicine
1435 Jwa-dong, Haeundae-gu, Busan 612–030, South Korea

(Received December 18, 2012; Accepted May 29, 2013; published online October 29, 2013)

Breast leukemia is extremely rare. Only 7 other reports describe its magnetic resonance (MR) imaging findings. This report describes a case of breast leukemia presenting as isolated intramammary leukemic relapse in the breasts after complete remission of acute myeloid leukemia. Dynamic contrast-enhanced MR imaging showed diffuse heterogeneous non-mass-like enhancement in one breast and a diffuse irregular heterogeneously enhancing mass in the other. Previous reports of MR imaging findings in breast leukemia have included only mass-like lesions; hence, the finding reported here is uncommon.

Keywords: breast, leukemia, magnetic resonance imaging (MRI)

Introduction

Breast leukemia is extremely rare. It can present as an isolated tumor before bone marrow infiltration or as an extramedullary manifestation of systemic leukemia.¹ This report describes a case of bilateral breast leukemia after complete remission of acute myelogenous leukemia and the accompanying ultrasonographic and magnetic resonance (MR) imaging findings.

Case Report

A 20-year-old woman presented in January 2012 with diffuse swelling and tenderness in both breasts of 3 months’ duration after complete remission of acute myelogenous leukemia. Physical examination revealed diffuse palpable thickening rather than a discrete mass in both breasts that was more pronounced in the left than the right breast. Neither breast demonstrated signs of inflammation, such as skin discoloration or heat sensation. Complete blood count revealed a hemoglobin level of 12.3 g/dL, white blood cell count of 5.01 × 10⁹/L, and platelet count of 264 × 10⁹/L. She had been diagnosed with acute myelogenous leukemia in January 2011 and achieved complete remission in February 2011. The patient had received 2 intensive courses of consolidation chemotherapy and undergone allogeneic peripheral blood stem cell transplantation from a sibling donor in June 2011.

An ultrasound showed a diffuse hypoechoic area with indistinct boundary in the right breast that exhibited multiple small island-like areas of low echo (i.e., mottled pattern) (Fig. 1a). These areas were noticeably distinct from normal glandular tissue but did not satisfy the criteria that define a mass. An ultrasound also showed an indistinct heterogeneously hypoechoic mass in the left breast (Fig. 1b). The posterior echo feature of both breast lesions was not changed, and several pathologic lymph nodes were observed in both axillae. The patient refused mammography because of fear of extreme pain.

Magnetic resonance (MR) images were acquired on a 3-tesla scanner (Achieva 3.0T Tx; Philips Healthcare, Best, the Netherlands) using a dedicated 7-channel surface breast coil. The imaging protocol consisted of axial T₁-weighted turbo spin-echo sequence (repetition time [TR]/echo time [TE], 583/10 ms; slice thickness, 3 mm), fat-suppressed T₂-weighted fast spin-echo sequence (TR/TE, 583/10 ms; slice thickness, 3 mm), diffusion-weighted sequence (TR/TE, 583/10 ms; slice thickness, 3 mm), and bilateral axial dynamic contrast-enhanced eTHRIVE sequence (TR/TE, 583/10 ms; slice thickness, 3 mm; flip angle, 12°). Diffusion-weighted sequence was performed for both breasts in the axial plane with the diffusion...
gradient applied in the orthogonal direction, with b-values of 0 and 1000 s/mm². Apparent diffusion coefficient maps were generated from the diffusion-weighted images. For dynamic contrast-enhanced images, contrast material was injected (0.5 mmol/L of meglumine gadoterate [Dotarem®; Guerbet, Roissy, France] per kilogram body weight at a rate of one mL/s) and followed by saline flush (25 mL at a rate of one mL/s). Dynamic images consisted of a total of 6 phases and were obtained once before and 5 times (103, 166, 229, 292, 355 s) after the administration of contrast material. Each phase required scanning time of 63 s, and there was no time delay between phases. Multiplanar reformatted images (MPR) were generated from dynamic images.

Dynamic contrast-enhanced MR images showed diffuse heterogeneous non-mass-like enhancement in the right breast and a diffuse irregular heterogeneously enhancing mass in the left breast (Fig. 2a). MPR images more clearly delineated the non-mass nature of the right breast lesion, in which areas of fat were dispersed (Fig. 2b, c), and the mass nature of the left breast lesion (Fig. 2b, d). Analysis of the enhancement kinetics showed that the initial signal increase in the right breast was weak in the right breast and medium in the left breast; post-initial contrast enhancement in both breasts demonstrated a persistent pattern (Fig. 2e). On T₁-weighted images, both breast lesions showed homogeneous low signal intensity compared to that of residual mammary glands (Fig. 2f). High signal intensities in the right breast lesion on T₁-weighted image represented fat tissue interspersed in the involved breast tissue (Fig. 2f). On T₂-weighted images, the right breast lesion showed relatively iso-signal intensity and the left breast lesion showed relatively low- or iso-signal intensity (Fig. 2g). Both breasts lesions showed high signal intensity on the diffusion-weighted image (Fig. 2h) and low apparent diffusion coefficient value on the apparent diffusion coefficient map (Fig. 2i), which were more pronounced in the left than right.

Ultrasoundography-guided core needle biopsy of both breasts confirmed leukemic infiltration (Fig. 3). At that time, the differential white blood cell count and results of bone marrow aspiration were normal, and no other signs of relapse were observed.

Discussion

Breast leukemia is rare; only 141 cases are reported in the literature. In terms of its temporal relationship with systemic leukemia, breast leukemia can occur in 3 situations. First, the tumor can represent the first sign of relapse or failure of treatment of systemic leukemia after therapy or stem cell transplantation. This is the most common manifestation of the tumor in the breast. Second, the tumor can occur simultaneously with systemic (marrow or blood) leukemia, either at the time of or subsequent to diagnosis of leukemia. Third, the tumor can occur prior to systemic leukemia as an isolated primary breast tumor. Such cases herald the progression to full-blown disease, and systemic leukemia generally develops within one to 2 years.

Radiologic features of breast leukemia have been reported only sporadically through case reports and have been nonspecific. Mammography shows 2 patterns-masses and architectural distortions. Ultrasonographic findings mainly include hypoechoic, microlobulated, or indistinct masses.

MR imaging findings of leukemia of the breast have been described in 7 cases (Table). These findings have included hyperintense masses on T₂-weighted images that showed marked inhomogeneous enhancement after administration of contrast. In Case 7, the text described MR imaging findings as a mass without further details or actual images. In the remaining 6 cases, MR imaging findings were
Fig. 2. Contrast-enhanced axial T1-weighted magnetic resonance images acquired during second post-contrast phase (a) show diffuse heterogeneous non-mass-like enhancement in the right breast and a diffuse irregular heterogeneously enhancing mass in the left breast. The multiplanar reformatted images more clearly depict lesion characteristics as non-mass-like enhancement in the right breast and a mass in the left breast (b: coronal bilateral breasts, c: sagittal right breast, d: sagittal left breast). Note that the non-mass-like enhancements have multiple areas of fat interspersed between the abnormally enhancing components. The enhancement kinetics curve shows a weak initial rise and persistent post-initial enhancement pattern in the right breast (L1 in e) and medium initial rise and persistent post-initial enhancement in the left breast (L2 in e). On the T1-weighted images, both breast lesions show homogeneous low signal intensities compared to residual mammary glands (f). The high signal intensities in the right breast lesion on the T1-weighted image (f) represent fat tissue interspersed in the involved breast tissue. On the T2-weighted images, the right breast lesion shows relatively iso signal intensity and the left breast lesion shows relatively low or iso signal intensity (g). Both breasts lesions are shown with high signal intensity on the diffusion weighted image (h) and low apparent diffusion coefficient value on the apparent diffusion coefficient map (i), which are more pronounced in the left than right.

provided in both the text and figures. Cases 3 and 4 appear to be identical when comparing the clinical course and findings presented on imaging. Therefore, to date, MR imaging findings of breast leukemia have actually been presented in only 6 other cases. In the present case, ultrasonography showed a lesion that was not a discrete mass, but a hypoechoic area distinct from the normal glandular tissue, and MR imaging also showed non-mass-like enhancement in the right breast that was analogous to the sonographic findings.

The differential diagnosis of diffuse infiltrative
Table. Summary of published reports that include magnetic resonance (MR) imaging findings of breast leukemia\(^{3–9}\)

| Case | Authors | Age, years | Sex | Location | Historical course | MR imaging findings |
|------|---------|------------|-----|----------|------------------|--------------------|
| 1    | Guermazi(4) | 43 | F | Left | Intramammary relapse after complete remission of AML | strongly enhancing mass with spiculation |
| 2    | Fitoz(3) | 13 | F | Left | Intramammary relapse after complete remission of AML | huge markedly enhancing mass with smooth margin |
| 3    | Kinoshita(5) | 53 | F | Bilateral | Intramammary relapse after complete remission of AML | multiple markedly enhancing masses with smooth margin and washout kinetics |
| 4    | Nishida(6) | 53 | F | Bilateral | Intramammary relapse after complete remission of AML | multiple markedly enhancing masses with smooth margin and washout kinetics |
| 5    | Azim(8) | 52 | F | Left | Isolated primary breast myeloid sarcoma without systemic involvement | irregular enhancing mass |
| 6    | Todo(7) | 20 | F | Left | Intramammary relapse after complete remission of ALL | strongly enhancing mass |
| 7    | Farkash(9) | 45 | F | Left | Isolated primary breast hairy cell leukemia without systemic involvement | 2.5 cm mass |

ALL, acute lymphoblastic leukemia; AML, acute myelogenous leukemia

**Fig. 3.** Histologic examination shows diffuse infiltration of blast cells. The blasts vary in size, appearance, amount of cytoplasm, and prominence of nucleoli (hematoxylin and eosin stain, ×400).

Breast lesions include both benign and malignant entities.\(^{10}\) Benign entities include physiologic changes during lactation, breast edema, inflammatory and infectious disease, such as mastitis, abscess, and granulomatous mastitis, and benign tumors, such as pseudoangiomatous stromal hyperplasia, and hemangioma. Malignant entities include inflammatory breast carcinoma, invasive lobular carcinoma, and metastasis.

As noted, the presence of isolated primary breast leukemia may herald bone marrow relapse, a major cause of morbidity and mortality.\(^5\) In most cases, mean survival is 10 months. Therefore, it is important to detect relapse promptly and initiate treatment as soon as possible.

In conclusion, in our patient, MR imaging of breast leukemia showed diffuse, heterogeneous, non-mass-like enhancement in one breast and a diffuse irregular heterogeneously enhancing mass in the other. This MR imaging finding differs from those previously reported for breast leukemia-mass lesions. Whatever the radiologic findings, it is the clinical background and situation that probably make us consider the possibility of breast leukemia. From this perspective, radiologic findings do not play a major role in diagnosis. However, familiarity with the various imaging findings can increase confidence in clinical diagnosis.

**References**

1. Surov A, Wienke A, Abbas J. Breast leukemia: an update. Acta Radiol 2012; 53:261–266.
2. Dutta Roy S, Stafford JS, Scally J, Selvachandran SN. Granulocytic sarcoma of the breast antedating acute myelogenous leukemia. Breast 2004; 13:242–246.
3. Fitoz S, Atasoy C, Yavuz K, Gozdasoglu S, Erden I, Akyar S. Granulocytic sarcoma. Cranial and breast involvement. Clin Imaging 2002; 26:166–169.
4. Guermazi A, Quoc SN, Socie G, et al. Myeloblastoma (chloroma) in leukemia: case 1. Granulocytic sarcoma (chloroma) of the breast. J Clin Oncol 2000; 18:3993–3996.
5. Kinoshita T, Yokokawa M, Yashiro N. Multicentric granulocytic sarcoma of the breast: mammographic, sonographic, and MR findings. Clin Imaging 2006; 30:271–274.
6. Nishida H, Kinoshita T, Yashiro N, Ikeda Y, O’Uchi T. MR findings of granulocytic sarcoma of the breasts. Br J Radiol 2006; 79:e112–e115.
7. Todo K, Morimoto A, Osone S, et al. Isolated relapse of acute lymphoblastic leukemia in the breast of a young female. Pediatr Hematol Oncol 2008; 25:607–613.
8. Azim HA Jr, Gigli F, Pruneri G, Martinelli G, Travaini LL, Petralia G, Peccatori FA. Extramedullary myeloid sarcoma of the breast. J Clin Oncol 2008; 26:4041–4043.
9. Farkash EA, Ferry JA, Harris NL, et al. Rare lymphoid malignancies of the breast: a report of two cases illustrating potential diagnostic pitfalls. J Hematop 2009; 2:237–244.
10. An YY, Kim SH, Cha ES, et al. Diffuse infiltrative lesion of the breast: clinical and radiologic features. Korean J Radiol 2011; 12:113–121.