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T1-Weighted Dynamic Contrast-Enhanced Magnetic Resonance Imaging (DCE-MRI) to Distinguish Between Concurrent Cholesterol Granuloma and Invasive Ductal Carcinoma of the Breast: A Case Report

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
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Patient: Female, 52
Final Diagnosis: Cholesterol granuloma of the breast
Symptoms: Follow up
Medication: —
Clinical Procedure: Surgical excision
Specialty: Radiology

Objective: Rare disease

Background: Cholesterol granuloma is a benign condition that can be misdiagnosed as breast cancer on mammographic and ultrasound imaging. A case of concomitant cholesterol granuloma with invasive ductal carcinoma of the left breast was imaged with ultrasound elastography and magnetic resonance imaging (MRI) methods, including T1-weighted dynamic contrast-enhanced MRI (DCE-MRI), before biopsy and histopathology.

Case Report: A 52-year-old woman, with a previous history of intraduct papillomas in both breasts, underwent six-monthly follow-up breast imaging. The most recent breast mammogram showed a progressively enlarging oval mass in the upper inner quadrant (UIQ) of the left breast, and an adjacent irregular mass with microcalcifications. Virtual Touch IQ (VTIQ) shear wave elastography was used with ultrasound of the breast lesions. T1-weighted fat saturation (T1WFS) MRI, T2-weighted short-tau inversion recovery (STIR) MRI, and T1-weighted DCE-MRI were used to image the left breast. T1-weighted DCE-MRI showed that the oval lesion had a high T1-weighted signal and mild progressive enhancement, with a Type I (benign) time-signal intensity curve; the second, irregular, mass showed rapid, intense enhancement with a washout pattern or Type III (malignant) time-signal intensity curve. Histopathology confirmed that the oval mass was a cholesterol granuloma, and the irregular mass was an invasive ductal carcinoma.

Conclusions: A case of concomitant cholesterol granuloma with invasive ductal carcinoma of the left breast, showed that ultrasound with shear wave elastography and T1-weighted DCE-MRI could distinguish between cholesterol granuloma and invasive ductal carcinoma.

MeSH Keywords: Breast • Cholesterol • Elasticity Imaging Techniques • Granuloma, Foreign-Body • Magnetic Resonance Imaging

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Background

Cholesterol granuloma of the breast is a rare condition that can mimic breast cancer on radiological imaging. Cholesterol granuloma can be identified histologically by the presence of cholesterol clefts or crystals with a surrounding foreign-body giant cell inflammatory reaction. However, the radiological findings of cholesterol granuloma can be similar to those of breast cancer, and imaging alone may not be able to distinguish between the two conditions.

In previously published cases of isolated cholesterol granuloma of the breast, the imaging diagnosis has been described with the use of mammography and ultrasound [1–4]. However, the diagnosis of cholesterol granuloma of the breast has rarely been reported by ultrasound combined with shear wave elastography and magnetic resonance imaging (MRI), including dynamic contrast-enhanced MRI (DCE-MRI).

This report is of a case of concomitant cholesterol granuloma with an invasive ductal carcinoma of the left breast evaluated with Virtual Touch IQ (VTIQ) shear wave elastography used in the ultrasound assessment of the breast lesions and MRI, including T1-weighted DCE-MRI, before biopsy and histopathology of both lesions.

Case Report

A 52-year-old woman, with a previous history of intraduct papillomas in both breasts, underwent six-monthly follow-up breast imaging. Routine mammography showed nodular densities with benign-looking calcifications in both breasts, and the ultrasound showed some homogeneous bilateral hypoechoic breast nodules.

The most recent breast ultrasound showed a progressively enlarging oval mass in the upper inner quadrant (UIQ) of the left breast, and an adjacent irregular mass showing

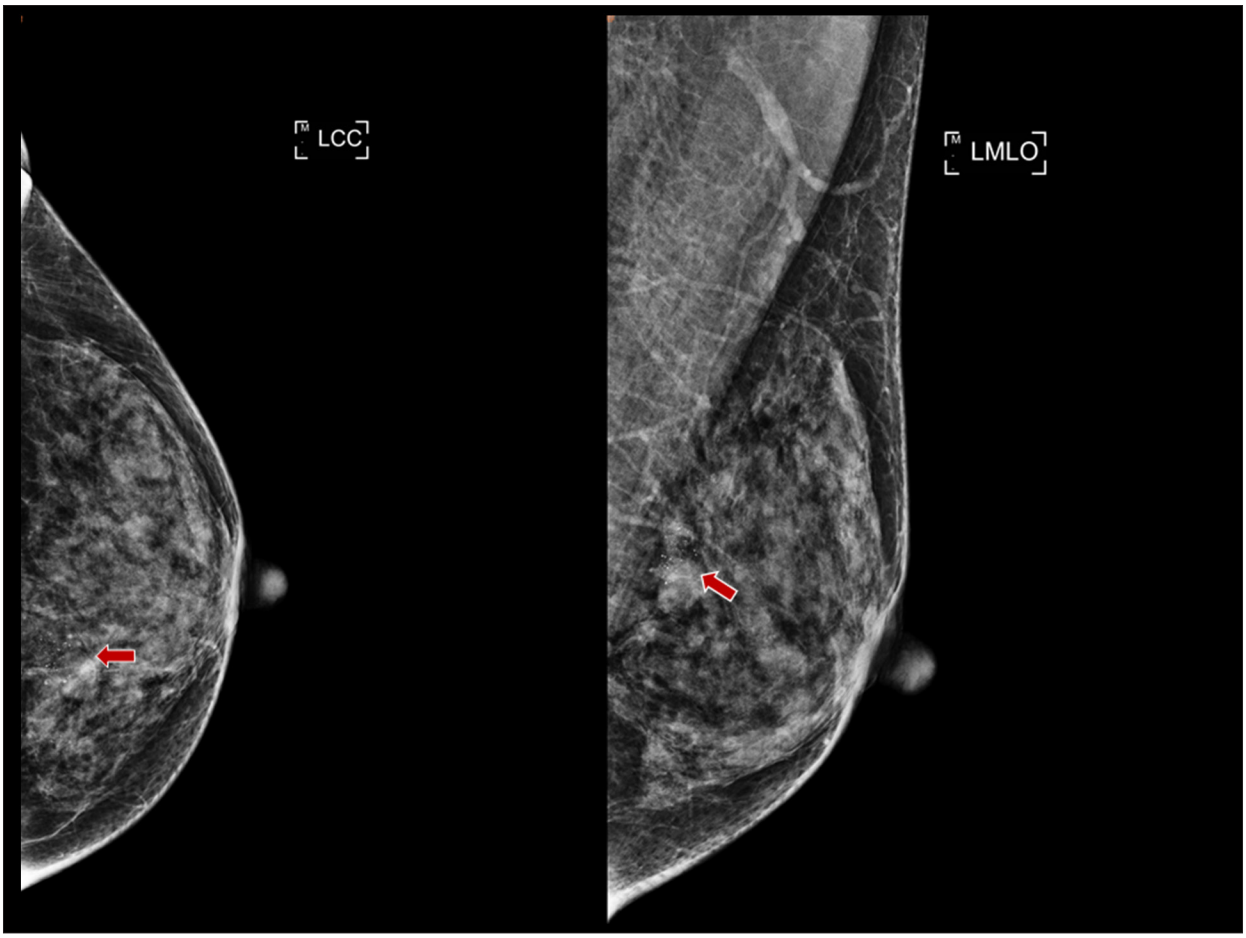

Figure 1. Mammographic imaging findings of the left breast. The left mammogram shows a cluster of amorphous microcalcifications in the upper inner quadrant (UIQ) of the left breast (arrow), classified using the breast imaging-reporting and data system (BI-RADS) as Category IVc. LCC – left-side craniocaudal view; LMLO – left-side mediolateral oblique view.

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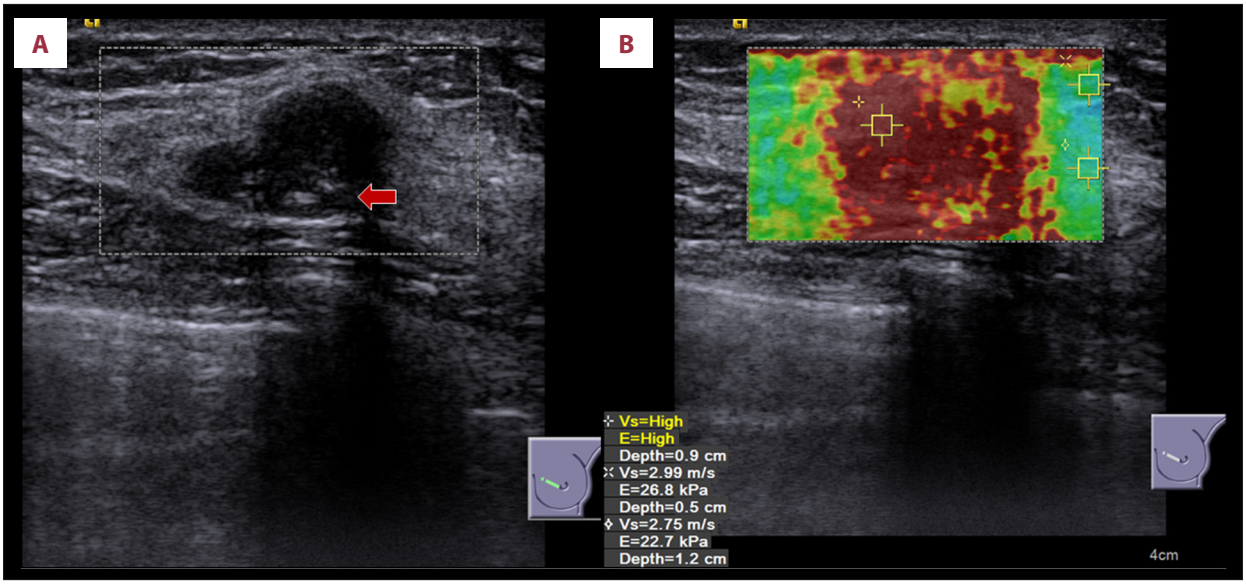

Figure 2. Ultrasound, including shear-wave elastography, imaging findings of the left breast. (**A**) Gray-scale ultrasound shows an irregular hypoechoic tumor with microcalcifications in the lower area of the lesion (arrow), classified using the breast imaging-reporting and data system (BI-RADS) as Category IVc. (**B**) Virtual Touch IQ (VTIQ) shear wave elastography, used in the ultrasound assessment of the lesion (arrow), shows higher velocities in the mass compared with the surrounding breast tissue, indicating marked stiffness of the mass.

microcalcifications on mammography. The patient had no family history of breast cancer or recent breast trauma, and she had no history of disorders of metabolic lipid disorders. Therefore, at our hospital, she underwent a series of breast imaging tests for the two suspicious breast masses of the left.

Mammographic imaging was performed using the diagnostic categories of the breast imaging-reporting and data system (BI-RADS) classification from the American College of Radiology (ACR), as follows: Category I: negative; Category II: benign; Category III: probably benign, short interval follow-up suggested; Category IV: suspicious abnormality; Category IVa: low level of suspicion for malignancy; Category IVb: intermediate suspicion of malignancy; Category IVc: moderate suspicion for malignancy; Category V: highly suggestive of malignancy, action should be taken; Category VI: biopsy-proven malignancy.

Mammography showed a recent cluster of amorphous microcalcifications in the upper inner quadrant (UIQ) of the left breast, classified as BI-RADS Category IVc (Figure 1). Breast ultrasound showed an enlarging and irregular hypoechoic mass with suspicious areas of calcification in the lower portion of this lesion, which was categorized as BI-RADS IVc (Figure 2A). Virtual Touch IQ (VTIQ) (Siemens) shear wave elastography was used in the ultrasound assessment, which showed that the mass showed marked stiffness and considerably increased ultrasound velocities in the mass compared with the surrounding breast tissue (Figure 2B). A further nodule with similar sonographic and elastographic imaging results was observed in her right breast. Because of the presence of multicentric lesions in both breasts, she was counseled to undergo breast magnetic resonance imaging (MRI) before biopsy.

Using breast MRI, two distinct masses adjacent to each other were identified in the deep upper inner quadrant (UIQ) of the left breast. The oval mass (size, 7.3×5.3 mm) exhibited homogeneous high signal intensity on T1-weighted fat saturation (T1WFS) MRI (Figure 3A) and mixed intermediate signal intensities on T2-weighted short-tau inversion recovery (STIR) MRI (Figure 3B). The oval mass exhibited high signal intensity on diffusion-weighted images (DWIs) (Figure 3C) and signal void on the apparent diffusion coefficient (ADC) map (Figure 3D).

Using T1-weighted imaging dynamic contrast-enhanced MRI (DCE-MRI), the oval lesion also exhibited mild enhancement and a Type I (benign) curve (Figure 4A). The other irregular mass (size, 11.0×6.0 mm) showed an iso-intense T1 signal and a high T2 signal on fat-saturation imaging with a mild signal drop on the ADC map and a Type III (malignant) enhancing curve on the T1-weighted DCE-MRI (Figure 4B).

Initially, both lesions in the left breast were suspicious for malignancy, on imaging alone. However, ultrasound-guided biopsy of the oval mass showed cholesterol clefts with a foreign-body inflammatory reaction. Because this benign histology was unexpected, the patient was advised to have a mammography-guided needle localization and surgical excision of the irregular mass showing microcalcifications. The histopathologic

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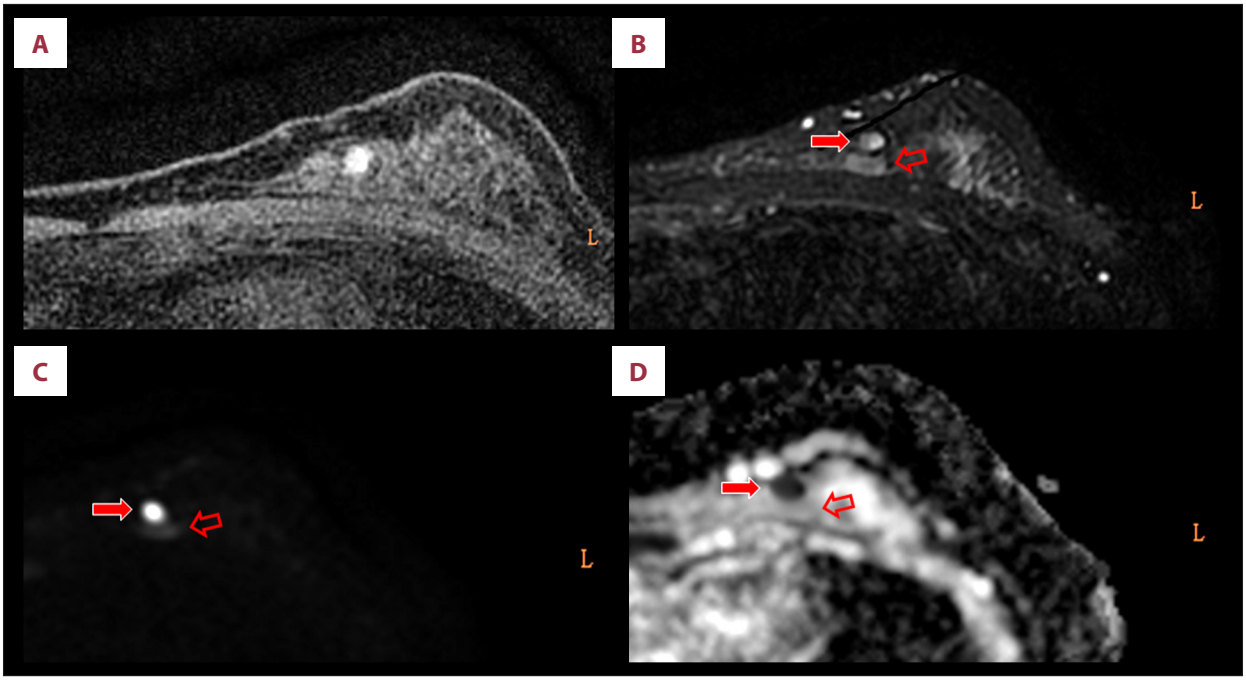

Figure 3. T1-weighted fat saturation (T1WFS) and T2-weighted short-tau inversion recovery (STIR) magnetic resonance imaging (MRI), diffusion-weighted images (DWIs) and the apparent diffusion coefficient (ADC) map of the left breast. (**A**) T1-weighted fat saturation (T1WFS) magnetic resonance imaging (MRI) shows an oval tumor with a homogeneous high signal intensity. (**B**) T2-weighted short-tau inversion recovery (STIR) MRI shows a tumor (arrow) with heterogeneous signal intensities with an outer low-signal rim. An irregular tumor with heterogeneous high signals is shown below the tumor (open arrow). (**C, D**) The oval tumor (arrow) shows a high signal intensity on the diffusion-weighted images (DWI) (**C**) and a signal void on the apparent diffusion coefficient (ADC) map (**D**). The irregular tumor exhibits a mild signal drop on the ADC map, but this is not as low as for oval tumor (open arrow).

diagnosis showed that the oval lesion was a cholesterol granuloma and that the irregular lesion containing microcalcifications was a Grade 2 invasive ductal carcinoma of the breast (Figure 5). The nodule in the right breast was histologically diagnosed as an area of benign fibrocystic change following ultrasound-guided core needle biopsy.

Discussion

Cholesterol granulomas are unusual benign lesions that can occur at various sites in the human body, most commonly in the middle ear and mastoid process but are rarely found in the breast tissue. Cholesterol granulomas arising in the breast are believed to result from mammary duct ectasia. Mammary duct ectasia is a benign process that is associated with periductal inflammation, including plasma cell mastitis and mastitis obliterans, which may result in rupture of the dilated duct with the release of lipid-rich intraluminal material that forms cholesterol clefts or crystals in the surrounding granulation tissue. The lipids released into the breast tissue also result in a foreign body giant cell reaction [5,6].

In previously published studies, cholesterol granulomas have been shown to result in nonspecific mammographic findings, but microcalcifications have also been observed in several cases [2,6]. The reported ultrasound findings in cholesterol granuloma of the breast have included lobular hypoechoic masses or intracystic masses [4].

In this case report, ultrasound findings showed that there were clusters of amorphous microcalcifications that were mainly associated with invasive ductal carcinoma. In previously published cases, both mammography and ultrasonography alone have been unable to distinguish between benign cholesterol granuloma and breast cancer [1–4]. Shear wave elastography can be used in the ultrasound assessment of the breast lesions, and the findings of this method in cases of invasive ductal carcinoma have been well described in the previously published literature [7,8], but the use of elastography in imaging cholesterol granuloma has not been reported previously. In this present case, the elastographic findings for cholesterol granuloma were considered to be similar to those of invasive ductal carcinoma, although artifacts in the method and its interpretation might be generated due to the coexistence of these two tumors and their proximity in the same breast.

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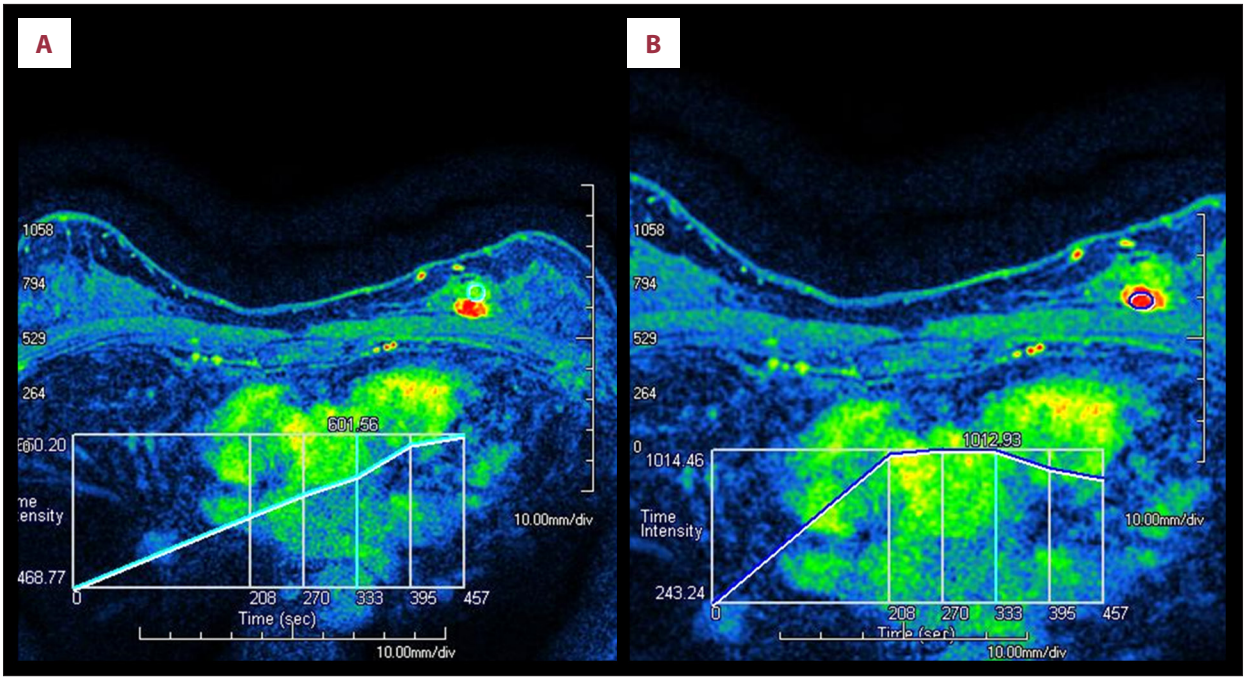

Figure 4. T1-weighted dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) of the left breast. (**A**) T1-weighted dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) of the oval tumor in the left breast shows mild progressive image enhancement (Type I curve). (**B**) T1-weighted DCE-MRI of the irregular mass in the left breast shows a rapid enhancement and washout pattern (Type III curve). The histopathology reports of the core needle biopsies of the two lesions showed that the oval mass was a benign cholesterol granuloma, whereas the irregular mass was a Grade 2 (moderate grade) invasive ductal carcinoma of the breast.

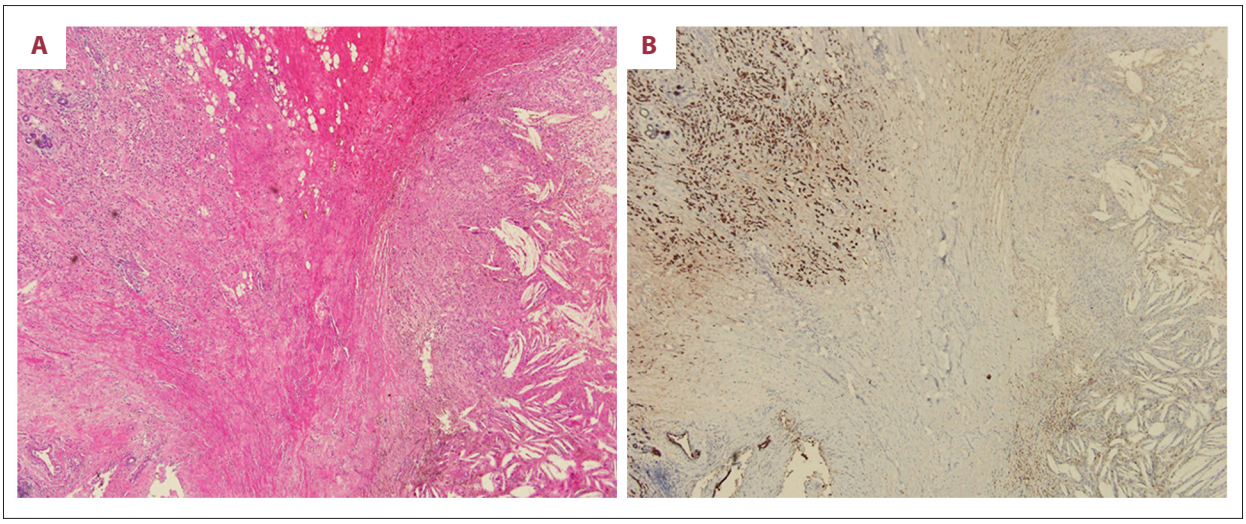

Figure 5. Photomicrographs of the histology of the breast lesions. (**A**) Hematoxylin and eosin stain (H&E) of the excisional biopsy showing cholesterol clefts (right) and another area of infiltrative cancer cells (left). A thin septum of tissue is present between the two breast lesions. (×40 objective magnification). (**B**) Immunohistochemical positive staining for cytokeratin shows positively stained (brown) proliferating malignant cells consistent with invasive ductal carcinoma of the breast. (×40 objective magnification).

Using T1-weighted dynamic contrast-enhanced MRI (DCE-MRI), the imaging characteristics of the cholesterol granuloma were related to the varied components of the lesion. Cholesterol clefts showed both a high signal intensity on T1-weighted and T2-weighted images, and low-signal intensity on T1-weighted fat saturation (T1WFS) images were suggestive of a fatty

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component. The outer hypointense rim on the T2-weighted images was most likely due to hemosiderin deposition.

Cholesterol granuloma that arises in the petrosal bone and mastoid antrum has been shown to be a less-enhancing lesion on MRI [9]. However, cholesterol granuloma of the breast has been previously shown to be an enhancing lesion by dynamic contrast-enhanced computed tomography (CT) imaging, and with masses showing mild fluorodeoxyglucose (FDG)-uptake in combined positron emission tomography (PET)-CT imaging [10,11]. The MRI findings in this case are consistent with those of previously published cases but also, this case report has highlighted the value of the use of T1-weighted DCE-MRI which exhibited a typical benign enhancing curve (Type I) for the cholesterol granuloma. The diffusion-restricted characteristics identified on the diffusion-weighted images (DWIs) and the apparent diffusion coefficient (ADC) map of the left breast were also supportive for the diagnosis of cholesterol and fat deposition. Therefore, this case supports the importance of using MRI of the breast to distinguish between cholesterol granuloma from breast cancer.

The presentation of this case is important because cholesterol granuloma and invasive ductal carcinoma are difficult to distinguish when they exist together [12]. In this patient, the initial diagnosis was made of a solitary breast tumor when ultrasound, mammography, and shear-wave elastography were used. However, T1-weighted DCE-MRI identified two distinct tumors through their different patterns of contrast-enhancement and their diffusion-restricted characteristics [13]. Also, although the presence of microcalcifications in a breast lesion on imaging is an association with malignancy, it can occur in benign lesions associated with chronic inflammation [14]. Therefore, in this case, biopsy followed by mammographic guided surgical excision was used for both breast masses. In this present case, breast T1-weighted DCE-MRI was shown to be particularly helpful in clinical decision-making, especially when multifocal lesions or bilateral breast lesions are present. From the findings of this case report, breast T1-weighted DCE-MRI may be considered by clinicians should surgical excision not be feasible for the patient.

Conclusions

Although cholesterol granuloma can be indistinguishable from breast cancer on mammography, ultrasonography, and shear-wave elastography, this case report has shown that it can be diagnosed using T1-weighted dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI), which uses a time-signal intensity curve, or kinetic curve. Following repeated DCE-MRI scans, three types of time-signal intensity curves may be produced: persistent enhancing (Type 1); plateau (Type 2); or washout (Type 3). The Type 1 DCE-MRI persistent enhancing curve shows a persistent increase in the intensity of the MRI signal and correlates with benign lesions, including cholesterol granuloma.

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Conflict of interest

None.

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