Original Article

Sonographic and clinicopathologic features of metaplastic breast carcinoma and infiltrating ductal carcinoma: a comparative single-center cohort study

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Background: The rarity of metaplastic breast carcinoma (MBC) has resulted in limited sonographic data. Given the inferior prognosis of MBC compared to invasive ductal carcinoma (IDC), accurate preoperative differentiation between the two is imperative for effective treatment planning and prognostic prediction. The objective of this study was to assess the diagnostic accuracy of MBC and differentiate it from IDC by analyzing sonographic and clinicopathologic features.

Methods: In this retrospective cohort study, 197 women comprising 200 IDC lesions were enrolled between January 2012 and December 2021 and 20 women comprising 20 pure MBC lesions were enrolled between January 2019 and December 2019. A comparison was made between the sonographic and clinicopathologic characteristics of MBC and IDC.

Results: The results indicated that patients with MBC had a higher proportion of tumor grade 3 (95.0% *vs.* 32.5%; P<0.001), high Ki-67 expression (100.0% *vs.* 75.0%; P<0.001), and the triple-negative subtype (90.0% *vs.* 13.0%; P<0.001) as compared to those with IDC. On ultrasound (US) findings, MBC lesions tended to have a larger size (≥5 cm: 45.0% *vs.* 1.5%; P<0.001), regular shape (45.0% *vs.* 1.5%, P<0.001), circumscribed margin (40.0% *vs.* 0.5%, P<0.001), a complex cystic and solid echo pattern (50.0% *vs.* 3.5%; P<0.001), and posterior acoustic enhancement (95.0% *vs.* 14.5%; P<0.001). Additionally, MBC was more likely to be misinterpreted as a benign lesion by sonographers than was IDC (30.0% *vs.* 4.5%; P<0.001). Multilayer perceptron analysis revealed posterior acoustic enhancement, circumscribed margins, and size as distinguishing factors between these two tumor types. The estimated rates of local recurrence, distant metastasis, and 5-year overall survival in 19 cases with MBC were found to be 10.5%, 31.6%, and 65.0%, respectively.

Conclusions: MBC typically presents as a large breast mass with more benign US features in older women, findings which may facilitate its accurate diagnosis and differentiation from other breast masses.

Keywords: Metaplastic breast carcinoma (MBC); infiltrating ductal carcinoma (IDC); ultrasonography; clinicopathology

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Introduction

Metaplastic breast carcinoma (MBC), which is a diverse subset of invasive breast cancers, accounts for 0.2–1% of all cases of breast cancer, characterized by the presence of squamous epithelium or mesenchymal components, including spindle, squamous, chondroid, or bone-forming neoplastic cells (1). Histologically, MBC is associated with high tumor grade and triple-negative receptor status, defined by the absence of hormone receptors (HRs) and human epidermal receptor 2 (HER2) (2). Triple-negative breast cancer (TNBC) is a difficult-to-treat malignancy that responds poorly to conventional chemotherapy. Although researchers have investigated emerging chemoimmunotherapeutic approaches for the treatment of TNBC, these therapies are still in the exploratory phase, and the long-term survival outcomes need to be further validated (3-6). Compared to those of invasive ductal carcinoma (IDC), the pathologic features of MBC lead to a lower pathologic complete response (pCR) rate and a worse overall survival (OS) in patients after neoadjuvant chemotherapy (7-10). Hence, a preoperative differential diagnosis between IDC and MBC is important for treatment planning and prognosis prediction. Breast cancer is usually initially diagnosed by fine-needle aspiration, which extracts only a small amount of tissue from the tumor and does not allow for a thorough analysis of tumor features. Many MBCs contain an IDC component, and fine-needle aspiration of only the IDC component may thus mislead physician judgment. If certain imaging indicators of MBC can be identified, this could supplement fine-needle aspiration. However, few studies have detailed the imaging features of MBC (11-14).

The preoperative assessment of the breast through ultrasound (US) is highly valuable due to its noninvasive, economical, and radiation-free features. US has emerged as the most efficient method for detecting breast masses, especially in women with dense breast parenchyma (15). Thus far, only one study has compared the US features of MBC with those of IDC. In this study, MBC exhibited more benign characteristics than did IDC, which could lead sonographer to misinterpret MBC as a benign lesion (11). Therefore, more research is required to assist sonographers in characterizing MBC and improve diagnostic accuracy. This study aimed to compare the sonographic and clinicopathologic features of MBC and IDC. We present this article in accordance with the STROBE reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1096/rc).

Methods

Study population

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The Ethics Committee of Guangdong Provincial People's Hospital granted approval for this retrospective study, for which informed consent was waived. A comparative single-center cohort study was conducted on a cohort of 197 women with 200 untreated IDC lesions between January 2012 and December 2021 and a cohort of 20 women with 20 untreated pure MBC lesions examined between January 2019 and December 2019. In this study, 3 of the 217 female patients had bilateral breast cancer. Inclusion criterion for this study was pathologically confirmed diagnosis of IDC or MBC from surgical specimens, and exclusion criterion was no pathologic findings. There were no excluded cases in this study. The review included the collection of basic clinicopathologic information from the electronic medical record, including patient age; body mass index; tumor type, grade, and size; HR and HER2 status; Ki-67 proliferation index; pathologic response (if neoadjuvant chemotherapy was administered); disease recurrence; survival; and preoperative US records.

Pathological findings

Based on the results of hematoxylin and eosin staining and immunohistochemistry, the breast cancers were categorized into four subtypes: HR^+ and $HER2^-$, HR^+ and $HER2^+$, HR^- and $HER2^+$, and TNBC (16). The updated fifth edition [2019] of the World Health Organization (WHO) classification of breast tumors distinguishes MBC into six subtypes: low-grade adenosquamous carcinoma, fibromatosis-like metaplastic carcinoma, spindle cell carcinoma, squamous cell carcinoma, metaplastic carcinoma accompanied by heterologous mesenchymal differentiation,

and mixed metaplastic carcinoma (1).

Ultrasonic image acquisition and interpretation

Breast US examinations were conducted with the Aplio 500 (probe frequency 14 MHz; Toshiba Medical Systems, Tokyo, Japan) and HI VISION Ascendus (probe frequency 13 MHz; Hitachi-Aloka Medical, Tokyo, Japan) devices. To ensure optimal breast exposure, patients were positioned in the supine position with their hands elevated above their head. The images of the masses were captured in at least two orthogonal planes, and the maximum diameter of the mass was measured. The static US images were retrieved from the electronic medical record were retrospectively evaluated by two radiologists with over five years of experience who were blinded to the pathology results. According to the Adler method and the fifth edition of the American College of Radiology breast imaging reporting and data system (ACR BI-RADS) atlas for breast US, breast cancers can be identified by their US characteristics, including shape, orientation, margin, echo pattern, posterior features, calcification, vascularity distribution, and vascularity grade (17,18). We considered the malignant lesion to be correctly diagnosed when the cases were classified as BI-RADS 4B, BI-RADS 4C, or BI-RADS 5. Otherwise, the malignant tumors were considered to have been incorrectly identified as benign. In instances of discordance between radiologists, a final consensus would be reached through discussion. Shape was classified as either regular or irregular, with regular shape indicating a round or oval mass. The interpretation of orientation pertained to whether the mass's long axis was parallel to the skin line. Margin was defined as the lesion's edge or border, categorized as either circumscribed or not circumscribed, with the latter further classified as indistinct, angular, microlobulated, spiculated margins, or any combination thereof. Echo pattern encompassed anechoic, isoechoic, hypoechoic, hyperechoic, complex cystic, and solid or heterogeneous echo. Posterior echo features included no posterior features, enhancements, shadows, or a combination of these. Calcification was categorized as either present or absent. Vascularity was classified into three categories: absent, internal, and rim vascularity. The Adler method involved grading vascularity on a four-point scale: grade I, grade II, grade III, and grade IV.

Statistical analysis

Data analysis was conducted using SPSS 25.0 software (IBM Corp., Chicago, IL, USA). Continuous and categorical variables were summarized as medians with ranges and as frequencies with percentages, respectively. Imaging and clinicopathologic characteristics were compared between groups using *t*-tests, Fisher exact tests, Chi-squared tests, or Mann-Whitney tests. The multilayer perceptron (MLP) was used to evaluate feature weights, while Kaplan-Meier was used to estimate 5-year survival probabilities. Statistical significance was determined by a two-tailed P value of less than 0.05.

Results

Clinicopathologic features of MBC and IDC

This single-center cohort research included 197 women comprising 200 IDC lesions and 20 women comprising 20 MBC lesions. *Table 1* provides a summary of their clinicopathological characteristics. The results indicated no significant difference between the two groups in terms of age (P=0.400) or body mass index (P=0.625). Compared to patients with IDC, those with MBC exhibited higher tumor grade (P<0.001) and Ki-67 (P=0.027) levels. In contrast to IDC cases, the majority of MBC cases were negative for estrogen receptor (ER) and progesterone receptor (PR) (P<0.001). However, no significant difference was observed in the HER-2 level between the two groups (P=0.085). Notably, the molecular subtype of most patients with MBC was TNBC (90.0% *vs.* 13.0%; P<0.001), which differed from that of those with IDC. Furthermore, no significant distinction was found in the rate of pCR between MBC and IDC cases that received neoadjuvant chemotherapy (18.2% *vs.* 22.2%; P=0.1895). We also compared the clinicopathological characteristics of the triple-negative MBC and triple-negative IDC subgroups. There were no significant differences in histological grade (P=0.451), Ki-67 (P>0.99), or pCR rates (P=0.057) between the two subgroups.

Comparison of sonographic findings between MBC and IDC

Table 2 presents the sonographic features of MBC and IDC, as well as their subgroups. Ultrasonic indicators for suspicious MBC included big size, regular shape, circumscribed margin, complex cystic and solid echo, and posterior echo enhancement (*Figure 1*). Conversely, IDC was characterized by small or medium size, irregular shape, angular or spiculated margin, the absence of posterior features or posterior shadows, and hypoecho (*Figure 2*).

Table 1 Clinicopathological characteristics of patients in MBC and IDC

Characteristic	MBC (n=20)	IDC (n=200)	P	TN-MBC (n=18)	TN-IDC (n=26)	P
Age (years)	51 [31–62]	52 [27–79]	0.400	50 [37–62]	52 [27–74]	0.462
BMI			0.625			0.662
<25 kg/m^2	14 (70.0)	148 (74.0)		14 (77.8)	22 (84.6)	
25–29 kg/m^2	4 (20.0)	42 (21.0)		3 (16.7)	4 (15.4)	
≥30 kg/m^2	2 (10.0)	10 (5.0)		1 (5.5)	0 (0.0)	
Tumor grade			<0.001			0.451
Grade 1	1 (5.0)	22 (11.0)		1 (5.5)	2 (7.7%)	
Grade 2	0 (0.0)	113 (56.5)		0 (0.0)	3 (11.5)	
Grade 3	19 (95.0)	65 (32.5)		17 (94.5)	21 (80.8)	
Ki-67			0.027			>0.99
<20	0 (0.0)	48 (24.0)		18 (100.0)	25 (96.2)	
≥20	20 (100.0)	150 (75.0)		0 (0.0)	1 (3.8)	
Unknown	0 (0.0)	2 (1.0)		0 (0.0)	0 (0.0)	
ER			<0.001			
Positive	1 (5.0)	152 (76.0)				
Negative	19 (95.0)	48 (24.0)				
PR			<0.001			
Positive	1 (5.0)	129 (64.5)				
Negative	19 (95.0)	71 (35.5)				
HER2			0.085			
Positive	1 (5.0)	49 (24.5)				
Negative	19 (95.0)	149 (74.5)				
Unknown	0 (0.0)	2 (1.0)				
Subtype			<0.001			
Triple negative	18 (90.0)	26 (13.0)				
Non-triple negative						
HER2$^+$ and HR$^+$	0 (0)	32 (16.0)				
HER2$^+$ and HR$^-$	1 (5.0)	19 (9.5)				
HER2$^-$ and HR$^+$	1 (5.0)	123 (61.5)				
Neoadjuvant chemotherapy						
No	9 (45.0)	110 (55.0)		8 (44.4)	15 (57.7)	
Yes	11 (55.0)	90 (45.0)	0.1895	10 (55.6)	11 (42.3)	0.057
pCR$^+$	2 (18.2)	20 (22.2)		1 (10.0)	6 (54.5)	
pCR$^-$	9 (81.8)	63 (70.0)		9 (90.0)	4 (36.4)	
Unknown	0 (0.0)	7 (7.8)		0 (0.0)	1 (9.1)	

Data are presented as median [range] or number (percentage). MBC, metaplastic breast carcinoma; IDC, invasive ductal carcinoma; TN-MBC, triple-negative metaplastic breast carcinoma; TN-IDC, triple-negative invasive ductal carcinoma; BMI, body mass index; ER, estrogen receptor; PR, progesterone receptor; HER-2, human epidermal growth factor receptor 2; Ki-67, Ki-67 proliferation index; HR, hormone receptor; pCR, pathologic complete response.

Table 2 Sonographic characteristics of patients in MBC and IDC

Characteristic	MBC (n=20)	IDC (n=200)	P	TN-MBC (n=18)	TN-IDC (n=26)	P
Size			<0.001			0.005
<2 cm	3 (15.0)	85 (42.5)		3 (16.7)	8 (30.8)	
2–4 cm	8 (40.0)	112 (56.0)		7 (38.9)	17 (65.4)	
≥5 cm	9 (45.0)	3 (1.5)		8 (44.4)	1 (3.8)	
Shape			<0.001			<0.001
Regular	9 (45.0)	3 (1.5)		8 (44.4)	0 (0.0)	
Irregular	11 (55.0)	197 (98.5)		10 (55.6)	26 (100.0)	
Orientation			0.176			0.884
Parallel	20 (100.0)	174 (87.0)		17 (94.4)	23 (88.5)	
Unparallel	0 (0.0)	26 (13.0)		1 (5.6)	3 (11.5)	
Margin						
Circumscribed	8 (40.0)	1 (0.5)	<0.001	8 (44.4)	0 (0.0)	<0.001
Indistinct	3 (15.0)	43 (21.5)	0.694	1 (5.6)	7 (26.9)	0.159
Spiculated	0 (0.0)	67 (33.5)	<0.001	0 (0.0)	7 (26.9)	0.048
Angular	1 (5.0)	133 (66.5)	<0.001	1 (5.6)	15 (57.7)	<0.001
Microlobulated	9 (45.0)	75 (37.5)	0.510	9 (50.0)	14 (53.9)	0.802
Calcification			0.932			0.447
In mass	10 (50.0)	98 (49.0)		9 (50.0)	10 (38.5)	
None	10 (50.0)	102 (51.0)		9 (50.0)	16 (61.5)	
Echo pattern						
Complex cystic and solid	10 (50.0)	7 (3.5)	<0.001	10 (55.6)	1 (3.8)	<0.001
Hypoechoic	10 (50.0)	192 (96.0)	<0.001	8 (44.4)	25 (96.2)	<0.001
Isoechoic	0(0.0)	1 (0.5)	1.000			
Posterior features						
No posterior features	1 (5.0)	102 (51.0)	<0.001	1 (5.6)	15 (57.7)	<0.001
Enhancement	19 (95.0)	29 (14.5)	<0.001	17 (94.4)	8 (30.8)	<0.001
Shadowing	0 (0.0)	68 (34.0)	0.002	0 (0.00)	2 (7.7)	0.505
Combined pattern	0 (0.0)	1 (0.5)	1.000	0 (0.00)	1 (3.8)	1.000
Vascularity distribution						
Absent	4 (20.0)	18 (9.0)	0.241	3 (16.7)	2 (7.7)	0.661
Internal vascularity	14 (70.0)	158 (79.0)	0.519	13 (72.2)	21 (80.8)	0.765
Vessels in rim	2 (10.0)	24 (12.0)	1.000	2 (11.1)	3 (11.5)	>0.99
Vascularity grade			0.981			0.300
Grade 0	4 (20.0)	18 (9.0)		3 (16.7)	2 (7.7)	
Grade I	2 (10.0)	38 (19.0)		1 (5.6)	7 (26.9)	
Grade II	3 (15.0)	44 (22.0)		3 (16.6)	3 (11.5)	
Grade III	11 (55.0)	100 (50.0)		11 (61.1)	14 (53.9)	
Diagnosis by BI-RADS-US			<0.001			0.027
Correct	14 (70.0)	190 (95.0)		12 (66.7)	25 (96.2)	
Incorrect	6 (30.0)	10 (5.0)		6 (33.3)	1 (3.8)	

MBC, metaplastic breast carcinoma; IDC, invasive ductal carcinoma; TN-MBC, triple-negative metaplastic breast carcinoma; TN-IDC, triple-negative invasive ductal carcinoma; BI-RADS-US, breast imaging reporting and data system for ultrasound.

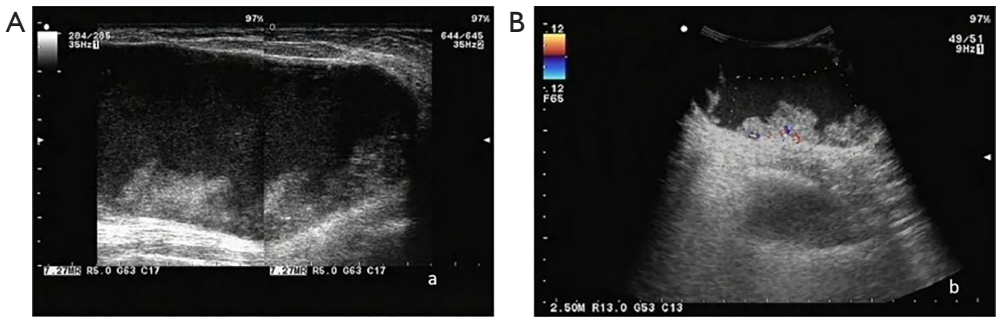

Figure 1 Ultrasound results from a 42-year-old patient with MBC. (A) The two-dimensional ultrasonic performance of MBC included big size, regular shape, circumscribed margin, cystic and solid echo pattern, and posterior acoustic enhancement; (B) the vascularity grade of MBC was grade II. MBC, metaplastic breast carcinoma.

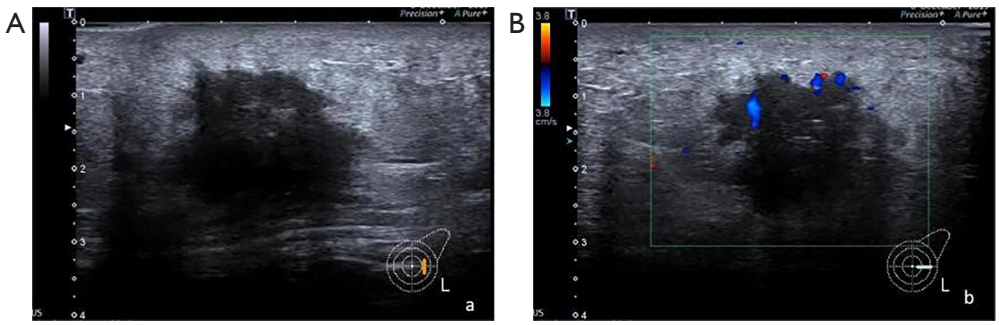

Figure 2 Ultrasound results from a 57-year-old patient with IDC. (A) Two-dimensional ultrasound showed the lesion with irregular shape, spiculated, and angular margin, hypoechoic pattern, and posterior shadows; (B) the vascularity grade of IDC was grade II. IDC, invasive ductal carcinoma.

Orientation, calcifications, vascularity distribution, and grade did not exhibit significant differences between these two groups. There were significant differences in size (P=0.005), shape (P<0.001), circumscribed margin (P<0.001), angular margin (P<0.001), spiculated margin (P=0.048), a complex cystic and solid echoic component (P<0.001), a hypoechoic (P<0.001), the absence of posterior features (P<0.001), and posterior echo enhancement (P<0.001) for the triple-negative MBC and IDC subgroups. In terms of diagnostic accuracy, MBC and triple-negative MBCs were more likely to be misdiagnosed as benign lesions than were IDCs (P<0.001) and triple-negative IDCs (P=0.027), respectively.

Following the implementation of multicollinearity tests to identify statistically significant variables, a total of 11 US and pathological features were selected and subjected to analysis using MLP. The weights of each feature are visually presented in *Figure 3*, with posterior acoustic enhancement, circumscribed margin, and size emerging as the most crucial characteristics for diagnosing MBC and distinguishing it from IDC.

Survival analysis

One patient with MBC was lost to follow-up. The median follow-up time was 39.0 (7.0–110.0) months, and the 5-year OS was 65.0% (95% CI: 51.3–78.7%) for 19 patients with MBC. Notably, there were 2 cases (10.5%) of local recurrence, 6 cases (31.6%) of distant metastasis, and 5 cases (26.3%) of death due to MBC (*Table 3*). The 5-year OS curve for MBC is displayed in *Figure 4*.

Discussion

MBC is characterized by a notable degree of histological and molecular diversity and propensity for aggressiveness and chemoresistance, which are linked to epithelial–mesenchymal transition and cancer stem cell traits

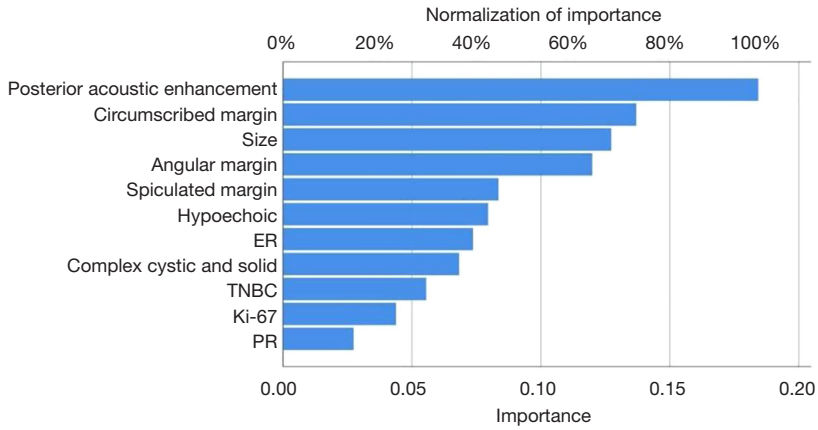

Figure 3 An illustration of the significance of features in MLP for predicting MBC and IDC. Each bar represents the weight of a feature, and the longer the bar is, the greater its importance. According to the map, the top three features were posterior acoustic enhancement, circumscribed margin, and size. ER, estrogen receptor; TNBC, triple-negative breast cancer; PR, progesterone receptor; MLP, multilayer perceptron; MBC, metaplastic breast carcinoma; IDC, invasive ductal carcinoma.

Table 3 Follow-up of MBC

Category	MBC (n=19)
Local recurrence, n (%)	2 (10.5)
Distant metastasis, n (%)	6 (31.6)
Death, n (%)	5 (26.3)
Follow-up time (month), median (IQR)	39.0 (7.0–110.0)
5-year OS rate (95% CI), %	65.0 (51.3–78.7)

MBC, metaplastic breast carcinoma; IQR, interquartile range; OS, overall survival; CI, confidence interval.

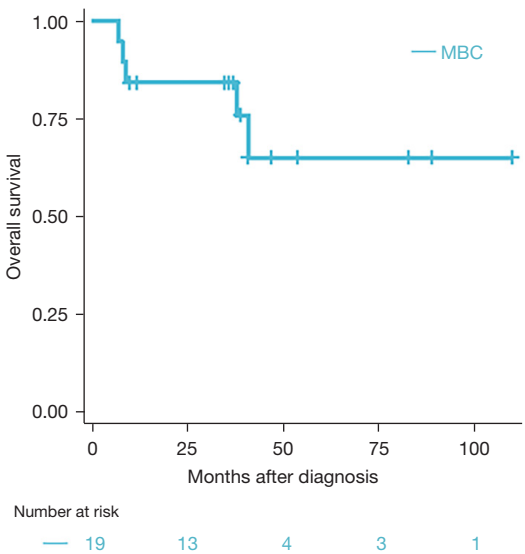

Figure 4 Kaplan-Meier survival curve of 19 cases with MBC. MBC, metaplastic breast carcinoma.

(2,8,10,19). MBC warrants further investigation due to its high mortality rate, but little research has been conducted regarding its imaging features. In this study, we aimed to assess the clinical utility of conventional US and clinicopathology in diagnosing MBC and differentiating it from IDC.

In our study, only 11 (55%) of the patients with MBC were aged over 50 years, which is in contrast to prior research that indicated a majority of patients with MBC were above 50 years of age (10,12,13,20). This discrepancy may be attributed to the limited sample size of patients with MBC in our single-center study. Li *et al.* previously demonstrated that patients aged above 58 years exhibit unfavorable survival outcomes, with poor OS and cancer-specific survival (21). Furthermore, older patients with MBC are typically diagnosed with higher-risk histological subtypes, which consequently leads to lower survival rates (22). As demonstrated in our investigation and other research, patients diagnosed with MBC exhibit elevated tumor grade, a high Ki-67 expression, HR negativity, and a higher likelihood of TNBC, while HER2 expression remains comparable to that of IDC (10,20,23,24). Elimimian *et al.* (25) conducted a comparative analysis of various rare TNBC subtypes, reporting that triple-negative MBC had the lowest expression of ER and PR at 19.0% and 14.1%, respectively, but the highest expression of HER2 at

4.4%. The elevated expression of the HER2 oncogene may account for the increased risk of lung and bone metastasis associated with MBC. In a study (19) comprising 75 patients diagnosed with MBC revealed, the majority of patients exhibited basal markers, epidermal growth factor receptor, epithelial–mesenchymal transition marker vimentin, and the stem cell marker CD44. The expression of basal-like markers was significantly associated with disease-free survival. The underlying mechanisms underlying the aggressive nature and unfavorable outcomes of MBC remains unclear, but these clinicopathologic features may be a key to revealing them.

Numerous studies have demonstrated that MBC is associated with a worse prognosis, including poor response to neoadjuvant chemotherapy, higher recurrence rates, and lower OS rates (2,7-10). In our study, the pCR rate among the cases with MBC was found to be 18.2%, which is inconsistent with an estimate of 11% in the literature (7). We examined a cohort of 19 patients with MBC over the course of a decade, during which 2 cases experienced postoperative local recurrence, 6 cases developed distant metastases, and 5 cases died due to MBC. The 5-year OS rate was determined to be 65%, which aligns with the 63.1% reported by Elimimian *et al.* (25). Furthermore, Moreno *et al.* reported that the 5-year OS rates for MBC were consistently lower than those for TNBC and other breast cancer types across all clinical stages, with stage I disease exhibiting rates of 85%, 87%, and 91%, stage II disease exhibiting rates of 73%, 77%, and 87%, and stage III disease exhibiting rates of 43%, 53%, and 75%, respectively (8). Elimimian *et al.* (25) concluded that the unfavorable prognosis of MBC may be linked to advanced stage, lung metastasis, older age, and lack of chemotherapy or radiation therapy.

MBC exhibits no distinct imaging characteristics, rendering it indistinguishable from malignant tumors and potentially even benign masses. In one study, the results of multimodal imaging of five MBC cases, encompassing US, mammography, magnetic resonance imaging (MRI), and positron emission tomography–computed tomography, revealed that MBC displayed more benign imaging features, such as round or oval shapes, circumscribed margins, and fewer axillary lymph node metastases in comparison to IDC (26). A study involving 19 patients with MBC revealed that mammography and US exhibited benign imaging characteristics, whereas MRI with T2-weighted imaging included distinct signal intensity features based on the analysis of apparent diffusion coefficient and time–intensity curves (27). Another study comprising 65 patients with MBC reported comparable findings, indicating that imaging techniques can reveal benign or moderately malignant features of MBC, with MRI potentially offering better characterization of malignant features than other imaging modalities (28). T2-weighted MRI can facilitate the diagnosis of MBC by detecting high signal intensity resulting from cystic or necrotic components. However, it is imperative to differentiate MBC from mucinous carcinoma and, to a lesser extent, necrotic IDC (26,29). Mammographically, MBC typically presents as round or oval-shaped high-density masses, with calcifications being a less frequent finding. However, MBC with osseous differentiation may present as a densely calcified lesion on mammography (20,30). Günhan-Bilgen *et al.* (12) analyzed eight patients with MBC, in whom the tumor exhibited high density and lacked prominent spiculations, microcalcifications, and architectural distortion on mammography. Another study of 67 women with MBC revealed that the most frequently observed mammographic characteristics were oval or round shape (52.5%), non-circumscribed margins (71.6%), and absence of calcification (68.7%) (31). However, in cases where MBC has an IDC component, masses may exhibit an irregular or spiculated margin (32).

Upon sonographic examination, the most distinctive indications of MBC have been reported to be the presence of masses exhibiting a complex cystic and solid echo pattern, as well as posterior acoustic enhancement (31-35). Our research revealed that 50.0% of MBC lesions exhibited complex cystic and solid components, while 95.0% of MBCs were characterized by posterior acoustic enhancement, which aligns with prior research (33). The cystic areas might be caused by necrosis, hemorrhage, or cystic degeneration (13). Notably, in our cohort, 45.0% of MBCs exceeded 5 cm in diameter, whereas only 1.5% of the IDCs were of similar size. This discrepancy may suggest that the growth rate of MBC is significantly greater than that of IDC. Unlike the IDCs, which were mostly irregular in shape (98.5%), 45.0% of MBCs had a regular shape and were typically oval or round. The most common margin characteristics of MBCs were circumscribed margin (40.0%) or microlobulated margin (45.0%), with none presenting with spiculated or angular margin, which are typically observed in IDCs (33.5% and 66.5%, respectively). The present findings are largely in agreement with previous research, indicating that MBC may exhibit an oval, round, or infrequently irregular shape, and may possess either circumscribed or

microlobulated margins (27,35). To differentiate MBC from IDC, we employed MLP to assess the significance of various sonographic and clinicopathologic characteristics. Our analysis revealed that masses exhibiting posterior acoustic enhancement, circumscribed margins, and larger size were more likely to be MBC, whereas those with spiculated or angular margins and hypoechoic features may potentially be indicative of IDC.

Since many MBCs are mixed with IDC components, pathological puncture may only puncture IDC tissue, resulting in an initial diagnosis of IDC instead of MBC, which eventually influences the clinician's therapeutic strategy. Imaging may be helpful for examining MBC features as a whole. When imaging suggests MBC features, then the lesion can be repunctured to obtain new pathological findings. Therefore, the aim of our study was to provide additional information for pathology puncture to help improve the accuracy of preoperative MBC diagnosis. However, there is currently no large sample imaging analysis of MBC due to its rarity. In addition, MBC is classified into six subtypes, including those with benign characteristics, such as spindle cell carcinoma and fibromatosis-like carcinoma, and those with some malignant characteristics, such as squamous cell carcinoma. Each of the subtypes should be investigated further in a sufficiently large sample size. Therefore, future MBC research should focus on collecting a large sample of data and exploring the features from multiple imaging modalities. We found that in addition to US, mammography and MRI may indicate specific distinguishing traits, and thus the combination of multimodal imaging features may allow for precise MBC diagnosis.

The main limitation of this retrospective, single-center, case series study is the small sample size, which is due to the rarity of MBC. The study comprised 20 patients, and thus external validation with a larger sample size in future analysis is required. Furthermore, differentiating MBC from IDC is difficult to achieve through the sole use of radiographic imaging. Pathologic diagnosis with extensive sampling remains critical to arriving at a definitive diagnosis.

Conclusions

MBC, which is mostly classified as TNBC, is an extremely rare and aggressive breast cancer with a 5-year overall survival rate of only 65.0%. Compared to IDC, MBC typically presents with a relatively large size, a regular shape, a circumscribed margin, a complex cystic and solid echo pattern, and posterior acoustic enhancement on sonography. Although these sonographic features may not be universally present in patients with MBC and are not entirely unique, MBC should be considered in the diagnosis of breast malignant tumors when these US manifestations are observed.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of Guangdong Provincial People's Hospital. Individual consent for this retrospective analysis was waived.

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