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Original Article

Magnetic resonance imaging findings of intramammary metastases

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ABSTRACT

The purpose of this study was to identify magnetic resonance imaging (MRI) findings of intramammary metastases (IM). We identified 8 cases with IM, which were investigated by breast MRI (1.5 T). In every case, the diagnosis of IM was proven histopathologically on breast biopsy specimens. Overall, 187 IM were identified. IM had inconsistent MRI features, which cannot be clearly classify as benign or malignant. IM should be taken into consideration in the differential diagnosis of breast lesions to avoid possible misinterpretations.

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1. Introduction

According to the literature, intramammary metastases (IM) from solid nonbreast malignancies are very rare [1–4]. Furthermore, the frequency of IM varies significantly in different studies. For example, it ranged from 0.11% to 6.3% in histopathological series and from 0.019% to 1.76% in radiological investigations [1–5]. As reported previously, IM occurred most frequently in malignant melanoma, ovarian cancer, and gastric cancer in decreased order of frequency [5]. Other malignancies metastasized rarely into the breast [5] (Table 1). However, in children and adolescents, IM arose from rhabdomyosarcoma have been described as frequent [7].

Clinically, about half of IM have been reported to be asymptomatic and were identified incidentally on whole body staging investigations, such as computed tomography or positron emission tomography [5–7]. Furthermore, as reported previously, approximately 30% of the patients with IM presented with painless breast lumps [5].

Mammographic and sonographic features of IM have been well described previously [5–7]. It has been reported that, on mammography, most IM manifested as breast masses were round or oval in shape with circumscribed margins [5,6]. In addition, lobular lesions occurred in 12%. Calcifications were seen in 10% [5].

On ultrasound, most reported lesions were homogenously hypoechoic with posterior acoustic enhancement and microlobulated margins [5].

Magnetic resonance imaging (MRI) findings of IM have been reported only sporadically. There were predominantly isolated case reports [8–16]. Furthermore, the publications described MRI features of IM provided findings on old investigation technique, such as 0.5 or 1.0 T magnet [5,10–12].

The purpose of this study was to identify MRI features of IM in a multicenter sample.

2. Materials and methods

This study has been approved by the Institutional Ethics Committees.

2.1. Patients

A retrospective search in the databases of 15 radiological departments from 2000 to 2012 revealed 92 cases of IM. All images in digital format were accumulated in the department of radiology of Martin Luther University. In 8 cases (4 radiological departments), breast MRI was performed. All patients were female with a mean age of 59.5 years (Table 2). Overall, in the 8 patients, 187 IM were identified (Table 2).

In every patient, the diagnosis of IM was proven histopathologically on breast biopsy specimens of one or two lesions.

2.2. MRI

MRI was performed on 4 different 1.5 devices: Siemens Sonata, Siemens Symphony, Siemens Espree, and Siemens Avanto (Siemens, Erlangen, Germany).

There are no conflicts of interest.

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Table 1
Reported frequency of IM in several malignancies [5]

Malignant diseases	Frequency of IM, %
Malignant melanoma	4.92
Ovarian cancer	4.43
Gastric cancer	1.47
Renal cell carcinoma	1.17
Sarcoma	1.13
Lung cancer	0.89
Laryngeal cancer	0.77
Uterine cervical cancer	0.76
Testicular seminoma	0.52
Prostatic cancer	0.24
Thyroid cancer	0.22
Colorectal cancer	0.12

The acquired images were transferred to a workstation Leonardo (Siemens, Erlangen, Germany) with dedicated software, such as image subtraction and functional tool.

In all patients, both breasts were imaged in the transversal plane with 3 mm slice thickness using a T1-weighted (T1w) 2D sequence The technical parameters were as follows: TR: 106–285 ms; TE: 4.6–4.8 ms; acquisition matrix: 307–282 by 384–512 pixels. Measurement time varied from 60 to 80 s, once before and six or seven times after intravenous bolus injection of gadolinium-based contrast medium.

Kinetic analysis of contrast enhancement was performed additionally in 7 patients (183 lesions). Time–signal intensity curves were drawn using operator defined region of interest (ROI). The ROI was smaller than the lesion size. The initial signal increase (Initial SI) from the precontrast value (SI_p) to the maximum peak within the first 3 min after the administration of contrast medium ($SI_{1-3\ min}$) was calculated as reported previously [17–19]:

$$\text{Initial SI}\ (\%) = \left(SI_{1-3\,min} - SI_p\right)/SI_p \times 100\%$$

In addition, the postinitial behavior of the signal curve (Postinitial SI) from the maximum peak (SI_{peak}) to the end of the examination (SI_{end}) was also analyzed [17–19]:

$$\text{Postinitial SI}\ (\%) = \left(SI_{peak} - SI_{end}\right)/SI_{peak} \times 100\%$$

Furthermore, IM were evaluated according to the Göttingen score (GS) including dynamic as well as morphologic features of breast lesions (Table 3) [19,20].

All available images were interpreted by one radiologist (SB with 11 and 4 years of experience on the field of general radiology and breast imaging, respectively). Lesion size was determined by measuring the maximum diameter. Magnetic resonance findings were classified according to the Breast Imaging Reporting and Data Systems (BI-RADS 5th Edition) of the American College of Radiology [21].

Table 2
Patients, primary tumors, and localizations of IM

Case	Sex	Age	Primary tumor	Number of IM	Localization of IM
1	f	47	Uterine cervical cancer	1	Right breast
2	f	63	Melanoma	2	Left breast
3	f	24	Melanoma	3	Bilateral
4	f	74	Lung cancer	46	Bilateral
5	f	58	Lung cancer	126	Bilateral
6	f	64	Neck squamous cell carcinoma	3	Left breast
7	f	48	Melanoma	2	Left breast
8	f	61	Melanoma	4	Bilateral

f, female.

Table 3
GS: morphological and functional parameters [20]

Features	Points
Shape	
Round, oval, lobular	0
Linear, dendritic, stellate	1
Margins	
Well defined	0
Ill defined	1
Enhancement kinetic	
Centrifugal	0
Homogeneous	0
Inhomogeneous	1
Centripetal (ring sign)	2
Initial peak of signal intensity increase (SI increase)	
<50%	0
50–100%	1
>100%	2
SI increase at 3–8 min after contrast media administration	
Continuous signal intensity increase	0
Plateau	1
Washout	2

Evaluation: <**3 points**, benign lesion; **3 points**, unclear dignity; >**3 points**, suspicious/malignant lesion.

2.3. Statistics

For statistical analysis, the SPSS statistical software package was used. Collected data were evaluated by means of descriptive statistics (absolute and relative frequencies). Continuous variables were expressed as mean ± standard deviation (S.D.), and categorical variables were expressed as percentages.

3. Results

All detected IM manifested as breast masses (Figs. 1 and 2). The mean size of IM was 7.0 ± 5.0 mm, median size, 6.0 mm, range, 3.0–36.2 mm. In the precontrast T1w images, all metastatic masses were isointense to normal breast tissue (Fig. 2). After intravenous administration of contrast medium, they had different features (Figs. 1 and 2). Most lesions were oval or round in shape with smooth margins and rim enhancement (Table 4). Kinetic analysis of contrast enhancement showed that 58% of the masses had slow initial rise (<50%), 9.8% had a moderate signal increase, and 32.2% of the lesions demonstrated rapid signal increase (Table 4). Furthermore, most of IM had plateau or washout delayed phase (Table 4).

The calculated GS of the breast masses showed that most lesions had 3 (19.7%) or 4 points (49.2%), 16.4% of the masses had 1 or 2 points, and the remaining 14.7% of the lesions had 5 or 6 points (Table 4).

Magnetic resonance findings were categorized as BI-RADS 3 in two patients, BI-RADS 4 in four patients, and BI-RADS 5 in two patients.

4. Discussion

Our analysis provided MRI features of IM presented as breast masses. In previous publications, breast masses were reported as major pattern of IM [5,6,8–10,22]. In addition, according to the literature, diffuse intramammary infiltration can also occur in metastatic breast disease [5,12].

According to the previous reports, most metastatic masses presented with “benign” morphological features on MRI [5]. For example, in a series of 24 patients with IM investigated on 1.0 T MRI, over 90% of IM had round or oval shape with smooth margins and marked homogenous contrast enhancement. Inhomogeneous and rim enhancement were rarely present, namely in 8% and 12%, respectively [5,9]. However, most of the reported IM had suspicious enhancement kinetic. It has been showed that 89% of metastases manifested with a rapid initial

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