

Assessment of imaging characteristics and value of 1.5 TESLA MRI in breast conservation surgery

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ABSTRACT

Background: Tumour assessment by magnetic resonance imaging (MRI) helps to accurately measure and estimate tumours before breast-conserving surgery.

Objective: The study aims to describe the imaging characteristics of 1.5 Tesla MRI in breast cancer diagnosis and evaluate the value of MRI in breast-conserving surgery.

Methods: A cross-sectional descriptive study was conducted on 99 patients newly diagnosed with breast cancer who were indicated for breast-conserving surgery at Tan Trieu K Hospital from July 2020 to August 2021. All participants underwent assessing characteristics of breast tumours by 1.5 Tesla MRI. The data were analysed using SPSS version 20.0, with descriptive statistics applied to summarize the study variables.

Results: The study showed that the characteristics of breast tumours determined by 1.5 Tesla MRI, most patients had low (33.4%) and moderate (31.3%) contrast enhancement, and the group of tumours with multiple spread locations had the highest rate of histological grade III (71.4%). The majority of tumours had irregular shapes and margins (53.6% and 60.7%), and most tumours demonstrated early enhancement (88.9%). In addition, based on MRI results, 12 (12.1%) patients had their surgical options changed, and 6 cases benefited from these decisions.

Conclusion: 1.5 Tesla MRI images help to accurately diagnose the morphology, tumour location, and contrast agent absorption level of breast cancer, thereby resulting a modification of the surgical plan for 12 patients. Therefore, 1.5 Tesla MRI needs to be performed on a large scale with patients indicated for conservative surgery in order to design the most appropriate and effective treatment regimen.

Keywords: 1.5 Tesla, Breast cancer, Conservative surgery, Magnetic resonance imaging (MRI)

1. Introduction

According to the World Health Organization in 2022, 2.3 million women were diagnosed with breast cancer and there were 670,000 deaths globally. Breast cancer occurs in women of all ages, but the incidence increases with age [1]. In Vietnam, there are 21,555 new cases of breast cancer and breast cancer accounts for 25.8% of all cancer cases in women [2].

Breast-conserving surgery involves removing the tumour along with a portion of the surrounding breast tissue. The goal is to ensure preserving the breast's appearance. In recent years, breast-conserving surgery is increasingly indicated as an alternative to total mastectomy, as it removes the tumour while still achieving favourable cosmetic outcomes. However, an accurate assessment of the tumour's size and characteristics is essential before conservative treatment [3].

There are several methods to measure the size of breast tumours, including clinical examination and imaging techniques such as mammography, ultrasound, and magnetic resonance imaging (MRI) [4]. Recently, international studies have evaluated the value of breast MRI in patients with breast cancer but studies specifically assessing its role in candidates for breast-conserving surgery,

especially in Vietnam, remain limited. Specifically, a preliminary Vietnamese oncoplastic surgery showed a breast-conservation rate below 20%, and local challenges, such as smaller breast size, limited screening programs, and low surgeon awareness [5]. Other study of breast-conserving surgery illustrates the use of MRI images in pre- and post-operative evaluation, but it lacks comprehensive analysis of MRI's diagnostic accuracy or its impact on surgical planning [6]. This suggests the need for studies to assess the precise role of MRI in the decision to choose conservative surgery in Vietnam. Therefore, this study aimed to describe the magnetic resonance imaging features in the diagnosis of breast cancer using a 1.5 Tesla MRI scanner; and evaluate the value of 1.5 Tesla MRI in breast-conserving surgery.

2. Methods

2.1 Study Design

A cross-sectional study was conducted in the Diagnostic Imaging Centre, Vietnam National Cancer Hospital (Tan Trieu establishment) from July 2020 to August 2021. This study was in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist (<https://www.strobe-statement.org/>).

2.2 Sample size

The number of participants was calculated based on the formula for estimating a population proportion with relative precision:

$$n = Z_{1-\alpha/2}^2 \cdot \frac{p(1-p)}{(p\varepsilon)^2}$$

In which:

n: required sample size

p: expected sensitivity of 1.5 Tesla MRI in detecting breast tumours (from prior studies, $p=0.378$) [7].

α : Statistical significance level with $\alpha = 5\%$ then coefficient $Z_{1-\alpha/2} = 1.96$

ε : relative error between the experimental study and the population proportion (ranges from 0.1 - 0.5). The study took $\varepsilon = 0.1$. A 10% relative error was chosen to balance precision with feasibility, as smaller errors would require a larger, impractical sample size, while still ensuring adequate power for detecting moderate effects.

Applying those results, the sample size was 90. The final sample size was 99.

2.3 Sampling

All woman hospitalized at the Diagnostic Imaging Centre, Vietnam National Cancer Hospital (Tan Trieu establishment) with newly diagnosed breast cancer; and were selected to

participate in the study using a convenience sampling method.

Inclusion criteria: patients were diagnosed with breast cancer by pathology; had no contraindications to general MRI and underwent breast MRI; were indicated for breast-conserving surgery; and agreed to participate in the study.

Exclusion criteria include women patients who have been treated for breast cancer; patients who have received adjuvant chemotherapy before surgery.

2.3 Data collection process and methods

- **Equipment:** 1.5 Tesla Echelon MRI (Hitachi Medical Corporation, Tokyo, Japan), Ingenia (Philips Healthcare, Best, Netherlands) and 1.5 Tesla GE SIGNA Pioneer (GE Healthcare, Chicago, IL, USA), using breast coil.

- **MRI procedure:** patients underwent pre-operative 1.5 Tesla breast MRI with conventional and diffusion-weighted pulse sequences. The patient was placed in the prone position, positioned in the same position as on the conventional MRI scan. Coil: head coil.

- **Data collection method:** patients were selected according to the sampling criteria and underwent MRI scan with a 1.5 Tesla

machine. The images were coded and blinded to the patient's information, then two experienced specialists read the results.

2.4. Data Analysis

Data were processed using SPSS 20.0 software. Descriptive statistics were used to analyse the data.

3. Results

3.1 Participants' characteristic

Of the 99 patients participating in the study, an average age of participants was 46.0±10.4, while most were between 40 and 60 years old (65.7%). 54.5% were still menstruating, and 72 (72.7%) of the patients had no clinically palpable tumours (Table 1).

Table 1: Characteristic of breast cancer women (n=99).

Contents	Number (n)	Percentage (%)
Age range		
20 – 40	26	26.3
40 – 60	65	65.7
> 60	8	8.0
Mean (SD)	46.0(±10.4)	
Min: Max	20:80	
Menstrual status		
Menstruation	54	54.5
Pre-menopause	26	26.3
Menopause	19	19.2
Clinical features of tumours		
Palpable	27	27.3
Not palpable	72	72.7

3.2 Imaging characteristics of breast tumours using 1.5 Tesla MRI

The results of Table 2 showed that most patients had low (33.4%) and moderate (31.3%) drug absorption, while patients with

menstruation mainly had moderate and significant drug absorption, accounting for 44.4% and 31.0% (Table 2).

Table 2: Degree of contrast enhancement of the parenchymal background (n=99).

Degree	Menstruation (n; %)	Premenopausal (n; %)	Menopause (n; %)	Total (n; %)
Minimum	1 (1.9)	4 (16.7)	8 (38.1)	13 (13.1)
Low	9 (16.7)	11 (45.8)	13 (61.9)	33 (33.4)
Moderate	24 (44.4)	7 (29.2)	0 (0.0)	31 (31.3)
Significant	20 (31.0)	2 (8.3)	0 (0.0)	22 (22.2)
Total	54 (54.5)	24 (24.2)	21 (21.3)	99 (100)

Table 3 showed that the group of tumours that spread to multiple locations had the highest rate of histological grade 3, accounting for 71.4%. When the tumour was localized to one location, the upper outer quadrant group

had the lowest rate of histological grade 3, while the lower outer quadrant and lower inner quadrant groups had the highest rates (17.2%, 38.5%, and 42.9%, respectively) (Table 3).

Table 3: Tumour location by histological grade (n=99).

Grade	1/4 above outside (n; %)	1/4 top inside (n; %)	1/4 bottom outside (n; %)	1/4 bottom inside (n; %)	Centre (n; %)	Multiple locations (n; %)	Total (n; %)
I	2 (6.9)	1 (3.6)	0 (0.0)	1 (14.3)	2 (14.3)	0 (0.0)	6 (6.1)
II	18 (62.1)	15 (53.5)	6 (46.2)	2 (28.6)	7 (50.0)	2 (25.0)	50 (50.5)
III	5 (17.2)	7 (25.0)	5 (38.5)	3 (42.9)	3 (21.4)	5 (62.5)	28 (28.3)
Missing information	4 (13.8)	5 (17.9)	2 (15.3)	1 (14.2)	2 (14.3)	1 (12.5)	15 (15.2)
Total	29	28	13	7	14	8	99 (100)

According to pathology, Table 4 showed that the majority of mass-forming tumours have irregular shapes, accounting for 53.6%. The

majority of tumours have irregular borders, accounting for 60.7%. 100% of mixed tumours have thorny tassel edge (Table 4).

Table 4: Morphological characteristics of Mass-forming tumour according to pathological anatomy (n=84).

Contents	Pathology (n)						Total
	DCIS	IDC	ILC	Mixed	Mucus	Other	
Mass-forming tumour							
Shape							
Oval	2	12	0	1	1	1	17
Round	1	15	0	1	2	3	22
Irregular	2	36	2	1	0	4	45
Edge							
Even	0	7	0	0	1	1	9
Uneven	4	38	2	0	2	5	51
Thorny tassel	1	18	0	3	0	2	24
Total	5	63	2	3	3	8	84

DCIS = Ductal Carcinoma in Situ; IDC = Invasive Ductal Carcinoma; ILC = Invasive Lobular Carcinoma

The non-mass forming group, tumours are mainly distributed in lobular ad multi-regional patterns, accounting for 46.7% and

26.7%, and the IDC group accounts for the majority (71.7%) (Table 5).

Table 5: Morphological characteristics of non-mass-forming lesion according to pathological anatomy (n=15).

Contents	Pathology (n)						Total
	DCIS	IDC	ILC	Mixed	Mucus	Other	
Location							
Localized	0	1	0	0	0	0	1
Strip	1	0	0	1	0	0	2
Lobular	1	4	1	0	0	1	7
Regional	1	0	0	0	0	0	1
Multiregional	0	3	0	1	0	0	4
Total	3	8	1	2	0	1	15

DCIS = Ductal Carcinoma in Situ; IDC = Invasive Ductal Carcinoma; ILC = Invasive Lobular Carcinoma

Table 6 showed that most tumours exhibited rapid contrast enhancement (88.9%). Only 13.1% of tumours demonstrated a progressive enhancement pattern, while 86.9%

showed plateau or washout patterns. None of the slow-enhancing cases exhibited washout (Table 6).

Table 6: Tumour enhancement graph according to histological grade (n=99).

Grade	Accumulate (n; %)	Plateau (n; %)	Drug disposal (n; %)	Total (n; %)
I	2 (15.4)	1 (2.2)	3 (7.5)	6 (6.1)
II	4 (30.8)	24 (52.1)	22 (55.0)	50 (50.5)
III	4 (30.8)	13 (28.3)	11 (27.5)	28 (28.3)
Missing information	3 (23.0)	8 (17.4)	4 (10.0)	15 (15.1)
Total	13	46	40	99 (100)

3.3 The 1.5 Tesla MRI Value in Breast-Conserving Surgery

Among 99 patients indicated for preoperative breast-conserving surgery MRI, 12 patients (12.1%) had their surgical plan changed. Of

these, 6 patients were confirmed to have multifocal lesions on postoperative histopathology, while the other 6 had additional lesions detected that were proven to be benign (Table 7).

Table 7: The value of 1.5 Tesla MRI in breast-conserving surgery (n=99).

Surgery	Malignancy on histopathology	Benign on histopathology	Total (n; %)
Conservative Surgery	7	0	7 (7.1)
Mastectomy	6	6	12 (12.1)
Total	13	6	19 (19.2)

4. Discussion

The determination of morphology, location, and degree of contrast enhancement of breast tumours is a prerequisite for selecting an effective treatment method and significantly reducing mortality rates in patients. The levels of endogenous hormones influence the degree of contrast enhancement in the parenchymal background, with the lowest enhancement observed on days 7-20 and the

highest on days 21-8, as well as 1-6 of the menstrual cycle [8]. In our study, a small proportion of patients (13.1%) showed minimal contrast enhancement in the parenchymal background. The majority of this group were postmenopausal women (61.5%). This is consistent with the characteristics of our study population, with 92% of patients under 60 years of age and 54.5% still menstruating, corresponding to high levels of endogenous hormones, leading to a higher degree of

contrast enhancement. However, unlike other studies the proportion of patients with minimal contrast enhancement in our study was much lower (13.1% vs. 41%) [8-9]. This difference is likely due to the timing of imaging. The studies mentioned typically performed breast MRI between days 7-10 of the menstrual cycle, while in our study, due to various factors, many patients underwent imaging at the beginning or end of their cycle, resulting in significantly higher levels of contrast enhancement. The exact timing of MRI relative to the menstrual phase was not systematically recorded or controlled for, this limitation may have contributed to increased background enhancement and potentially influenced image interpretation.

Regarding tumour location, the MRI results in our study showed that tumours were most commonly found in the upper outer quadrant and upper inner quadrant (29.3% vs. 28.3%). In contrast, in many other studies, the upper outer quadrant has a significantly higher rate, ranging from 67-78% [10-13]. This difference is due to the fact that in most of these studies, tumour location was determined through clinical examination in sitting or supine positions. While those studies often relied on clinical examination or imaging in the sitting or supine position, our study used MRI

in the prone position. This posture can lead to downward displacement of breast tissue due to gravity and parenchymal laxity, altering the apparent location of tumours. Additionally, variations in breast density, anatomy, and tumour biology across populations may also contribute to the observed differences in tumour distribution.

In our study, the majority of cancerous lesions had irregular borders. This finding is similar to the research by *Gutierrez et al.*, where 74.4% of malignant lesions had lobulated or irregular borders [14], and the study by *Grimm et al.*, where 78.2% had lobulated or irregular borders [15]. Additionally, compared to these studies, the rate of malignant tumours with irregular borders in our study was lower, possibly because our patients were primarily those with indications for breast-conserving surgery, which typically involves smaller tumours and earlier stages. Subjectively, small tumours pose challenges for radiologists in assessing tumour shape, while objectively, low-stage tumours have not yet exhibited aggressive invasive morphology, and their shapes remain relatively intermediate. Furthermore, the lobulated and multifocal patterns were the most common in non-mass-forming breast cancer (46.7% and 33.3%). These results are consistent with

studies worldwide [16-19]. In contrast, breast cancer rarely presents with a diffuse distribution. In our study, as well as in studies by *Gity et al.* [16], *Yabuuchi et al.* [19], no cases of diffuse distribution were found. In *Rosen et al.*'s study, only 6% of patients had this distribution pattern [17].

Comparing the rates of contrast enhancement patterns between histological groups is necessary to answer the question of whether high histological grade is associated with changes in the enhancement curves. In our study, the differences in these rates were not statistically significant, similar to *Leong et al.*'s findings [20]. Additionally, this study observed that the rates of plateau enhancement and washout in the groups were not significantly different, at 46.5% and 40.4%, respectively. This result differs from other studies [18, 20-21]. This discrepancy may be attributed to differences in imaging techniques and film interpretation. This study used two imaging times (early late) with intervals of 2 and 4 minutes, whereas *Leong et al.* used 90 seconds and 180 seconds [20], and *Tozaki et al.* used 60 seconds and 4 minutes [22].

The results showed that 1.5 Tesla MRI detection of multifocal lesions led to changes in surgical plans for 12.1% of patients. Of these, 7.0% experienced clearly beneficial changes,

such as appropriate conversion to wider resection or mastectomy based on confirmed malignancy. However, in another 5.1% of patients, treatment plans shifted from breast-conserving surgery to total mastectomy based on MRI findings that were later proven to be benign on postoperative histopathology. This raises concerns about potential overtreatment. In such cases, additional imaging or preoperative biopsy might have helped confirm the nature of the suspicious lesions and potentially prevented unnecessary mastectomies. Comparatively, *Bilimoria et al.* (2023) reported a 35% rate of surgical plan changes, with nearly half of the patients benefiting from those changes [23]. Similarly, *Pop et al.* observed plan modifications in 8.6% of cases, with 6.9% showing clinical benefit [24]. These findings highlight both the potential value and the risks of preoperative MRI in detecting occult disease and influencing surgical decisions, underscoring the need for careful interpretation and confirmatory diagnostics.

This study found some limitations. First, the use of convenience sampling and data collection from a hospital may limit the generalizability of the findings to other settings or broader populations. Future studies should consider multicentre designs and randomized

sampling to enhance external validity. Second, the absence of a control group (e.g., patients without MRI or with alternative imaging modalities) restricts our ability to directly compare diagnostic or treatment outcomes. Including a control arm in future research would allow for more rigorous evaluation of MRI's added value. Third, MRI timing relative to the menstrual cycle was not standardized or systematically recorded. Hormonal fluctuations may have influenced background parenchymal enhancement and lesion visibility. Future studies should control for cycle phase ideally scheduling imaging between days 7-10 or at least document menstrual timing to allow for adjustment in analysis. Finally, some patients underwent total mastectomy based on MRI-detected lesions that were later confirmed to be benign, raising concerns about potential overtreatment. Incorporating additional diagnostic steps, such as second-look ultrasound or image-guided biopsy before surgical decision-making, may help minimize unnecessary mastectomies and improve clinical outcomes.

5. Conclusion

The morphological characteristics, location, and degree of contrast enhancement of tumours in this study are consistent with the newly diagnosed breast cancer condition and

the patient's breast-conserving treatment approach. Moreover, additional lesions detected on 1.5 Tesla MRI led to changes in the treatment plan for cases, benefiting patients from these decisions. Therefore, using the 1.5 Tesla MRI machine should be considered by doctors to perform on a large scale with patients indicated for conservative surgery in order to design the most appropriate and effective treatment regimen. This change could ultimately improve the quality of life for patients in the future. Additionally, this study offers valuable insight into the use of 1.5 Tesla MRI in a real-world clinical setting in Vietnam, where 3.0 Tesla machines may not be widely available.

Acknowledgment

We would like to express our sincere thanks to the study participants for their enthusiastic cooperation.

Author contributions

NDL contributed to the study conception and design, data collection, data analysis, and manuscript drafting. PQL contributed to data analysis, critical revision of the manuscript, and approved the final version for publication.

Declaration**Ethics approval and consent to participate**

The study was conducted after approval by the Institutional Review Board of K Hospital Tan Trieu, according to Decision No. 35/QD-HDDDYSH dated June 25, 2020. All participants were made aware of the study's objectives and details, and those who agreed to participate were required to sign a consent form before filling out the questionnaire.

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Participants had the right to withdraw from the study at any point without facing any negative repercussions. The study was carefully designed to avoid any impact on the participants' health or well-being.

Competing interests

There are no conflicts of interest in this study.

Funding

Not applicable.

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Received 23/04/2025

Received in revised form 25/06/2025

Accepted 27/06/2025



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