Research Article

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The effect of dynamic contrast magnetic resonance imaging (DCE-MRI) in the diagnosis of breast cancer cases

Meme kanseri olgularının tanısında dinamik kontrastlı manyetik rezonans görüntüleme (DCE-MRI) yönteminin etkisi

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Abstract

Purpose: The aim of this study is to investigate the effect of dynamic contrast magnetic resonance imaging (DCE-MRI) in the diagnosis of breast cancer (BC) and to compare it with ultrasonography (USG).

Materials and methods: In our study, 78 patients who underwent preoperative DCE-MRI and USG in our diagnosis center in TRNC between 2009 and 2022 and were diagnosed with BC histopathologically were investigated retrospectively.Findings obtained according to the BI-RADS classification in both methods, detection of BC, detection of tumor foci (TF) in multiple tumors (multicentric and multifocal tumors) (MT), correct diagnosis rates (CDR)s in invasive lobular cancers (ILC) and invasive ductal cancers (IDC) were compared and the results were evaluated statistically.

Results: The mean age of the ILC and MT cases was found to be significantly lower than the IDC and unifocal tumor(UF) cases ($p<0.05$). CDRs in BC cases; 94.8% of DCE-MRI, 78.2% of USG ($p<0.05$), in the detection of TFs; 94.5% of DCE-MRI, 73.6% of USG ($p<0.05$), in detecting ILC cases; DCE-MRI 87.5%, USG 37.5% ($p>0.05$) in detecting IDC cases; it was determined as 95.7% in DCE-MRI and 80.2% in USG ($p<0.05$).

Conclusion: DCE-MRI is a more effective diagnostic method than USG in the diagnosis of BC cases and TFs in MT cases.

Key words: Magnetic resonance with dynamic contrast, breast cancer, multiple tumors, ultrasonography.

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Öz

Amaç: Bu çalışmanın amacı meme kanseri (MK) tanısında; dinamik kontrastlı manyetik rezonans görüntülemenin (DCE-MRI) etkisini araştırmak ve ultrasonografi (USG) ile karşılaştırmaktır.

Gereç ve yöntem: Çalışmamızda 2009 ve 2022 yılları arasında KKTC deki tanı merkezimizde preoperative olarak DCE-MRI ve USG yapılan ve histopatolojik olarak MK tanısı konulan 78 olgu retrospektif olarak araştırılmıştır.

Olgularda her iki yöntemde Bİ-RADS sınıflamasına göre elde edilen bulgular; MK tespiti, multipl tümörlerde (multisentrik ve multifocal tümör) (MT) tümör odaklarının (TO) tespitinde, invaziv lobüler kanserlerde (İLK) ve invaziv duktal kanserlerde (İDK) doğru tanı oranları karşılaştırılmış, sonuçlar istatistiksel olarak değerlendirilmiştir.

Bulgular: İLK ve MT olgularının yaş ortalaması, İDK ve tek odaklı tümör (TOT) olgularına göre anlamlı ölçüde küçük bulunmuştur ($p<0,05$). DTO ları MK olgularında; DCE-MRI'ın %94,8, USG'nin %78,2 ($p<0,05$), TO larının tespitinde; DCE-MRI'ın %94,5, USG'nin %73,6 ($p<0,05$), İLK olgularını saptamada; DCE-MRI'ın %87,5, USG'nin %37,5 ($p>0,05$), İDK olgularını saptamada; DCE-MRI'ın %95,7, USG'nin%80,2 ($p<0,05$) olarak tespit edilmiştir.

Sonuç: DCE-MRI, MK olgularının ve MT olgularında TO'ların tanısında USG'ye göre daha etkili bir tanı yöntemidir.

Anahtar kelimeler: Dinamik kontrastlı manyetik rezonans, meme kanseri, multipl tümör, ultrasonografi.

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Introduction

According to the global cancer statistics of 2020, BCs are the most common type of cancer in women in many countries around the world and the most common cause of death from cancer [1]. According to the data of The International Agency for Research on Cancer (IARC), there is a 66% increase in cancer-related death rates compared to 1960 [2]. Every year, 685,000 deaths are seen in the world due to BC [1].

Early diagnosis is of great importance to reduce mortality rates in cancer cases. Although studies with serum molecular markers have opened a new era in the early diagnosis of BC, as in many cancer types, the most widely used diagnostic tests are still USG and mammography (MG) [3]. Despite this, there are publications reporting that the absolute diagnosis rates of USG and MG in MTs are quite low, especially in BC types such as ILC [4, 5]. Some studies have reported that other advanced diagnostic tests such as DCE-MRI are more effective in these cases [6, 7]. The DCE-MRI imaging method is based on the quantitative measurement of enhancement. The number of studies investigating the effect of DCE-MRI in BCs, MTs and subtypes of BC and comparing it with conventional USG is not very large.

Therefore, in this study, we investigated the effect of DCE-MRI in the diagnosis of BC, MT cases and some BC subtypes (ILC and IDC) and compared it with USG.

Materials and methods

Study type and ethical approval

This study was a retrospective observational study and approval was obtained from The Girne American University Health Sciences Ethics Committee.

Patients and data collection

In our study, breast DCE-MRI and USG examinations of 359 patients who admitted to our diagnosis center in Cyprus between 2009 and 2022 were evaluated retrospectively.

Inclusion criteria of these cases in our study:

1.Cases in which DCE-MRI and USG were performed together preoperatively,

2.Cases biopsied after imaging tests,

3.Cases with malignant histopathological results as a result of biopsy.

Exclusion criteria of the cases in our study:

1.Cases who underwent secondary operation,

2.Recurrent cases,

3.Cases in which USG was not performed together with DCE-MRI,

4.Cases without biopsy,

5.Cases with benign histopathological results.

Cases were evaluated according to the American College of Radiology (ACR) Breast Imaging Reporting and Data System (BI-RADS) classification.

BI-RADS I, II, III cases, low probability of malignancy,

BI-RADS IV, V cases were considered as cases with a high probability of malignancy (correct diagnosis).

Imaging techniques

DCE-MRI images were obtained with a 1.5 Tesla MRI device (Signa HDx, 1.5 T, GE Healthcare) using a double-stranded breast coil. Precontrast T2 FSE axial, T2 FSE fatsat axial, T2 fatsat sagittal, diffusion sequences were obtained. Postcontrast images were obtained in the dynamic phase. Following the images taken without contrast, 0.1 mmol/kg IV contrast material (gadolinium) was injected at a rate of 3 ml per second in the dynamic examination and 6 consecutive multiphase images were taken in the same region. Added axial and sagittal vibrant sequences. After the examination, subtraction images and enhancement curves of early and late contrast sections were obtained in all patients. It was examined whether the lesions had contrast enhancement pattern, dynamic curve types, diffusion restriction. Nonmass enhancement lesions were investigated without background parenchymal enhancement. The time-intensity curve (TIC) was classified as persistent (type I), plateau (type II), and wash-out (rapid contrast loss) (type III).

USG examinations were performed using GE Logiq 730 pro, GE Logiq 9, GE Logiq S7 expert devices and 4-15MHz, 5-13MHz linear transducers. Both breasts and axilla were examined in different planes. PI and RI values were measured. Contour features, spicular extension, aspect ratio, echopattern, posterior acoustic shadowing and presence of calcification were investigated for benign-solid differentiation.

Statistical analysis

In our study, whether the data were suitable for normal distribution was examined using the Shapiro Wilk test. Descriptive statistics for continuous variables are given as (mean±standard deviation) in those that fit the normal distribution. Descriptive statistics for categorical variables are given as frequency and percentage (n (%)). In the independent group comparisons of continuous variables, the t-test was used for those showing conformity with the normal distribution. Pearson chi-square test and Yates Correction test were used to compare categorical variables between groups. Statistical analysis was made in IBM SPSS v.21 package program. The significance level was taken as α=0.05.

Results

All of our patients are women. Age range of our cases; 25-82, mean age; 48. The mean age of our ILC cases (n=6) was 37.6, our IDC cases (n=66); 48.5, the difference was statistically significant ($p<0.05$).MT (11.5%) was detected in 9 of our patients (n=78), and UF tumor was detected in 69 of them (88.4%). The mean age of our UF cases (n=69) was 49.1, the mean age of our MT cases (n=9) was 37.3, the difference was statistically significant ($p<0.05$).

The distribution of our BC cases according to the age variable is shown in (Table 1).

The histopathological distribution of TFs (n=91) in our cases (n=78) is as follows: IDC in 71 cases (78.0%), ILC in 16 cases (17.6%), mucinous in 2 cases (2.1%), tubular carcinoma in 1 case (1.1%), comedocarcinoma in 1 case (1.1%) (Table 2).

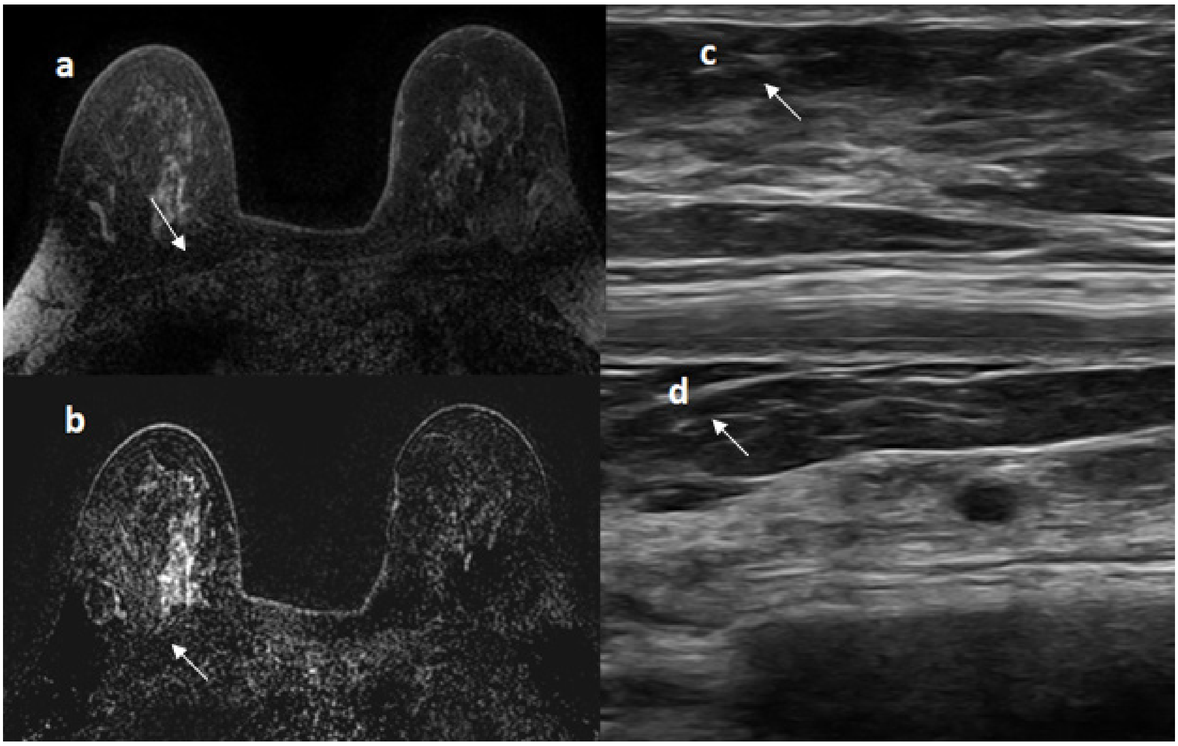
It was reported as BI-RADS III (n=13), BI-RADS IV (n=29) and BI-RADS V (n=29) in 71 foci with histopathological diagnosis of IDC. DCE-MRI results of the same cases were BI-RADS III (n=3), BI-RADS IV (n=19), BI-RADS V (n=49). It was reported as BI-RADS III (n=11), BI-RADS IV (n=3) and BI-RADS V (n=2) in 16 foci with histopathological diagnosis of ILC. DCE-MRI results of the same cases are BI-RADS III (n=2), BI-RAD 80.2%S IV (n=1), BI-RADS V (n=13) (Picture1, 2).

Table 1. Distribution of our breast cancer cases according to age variable

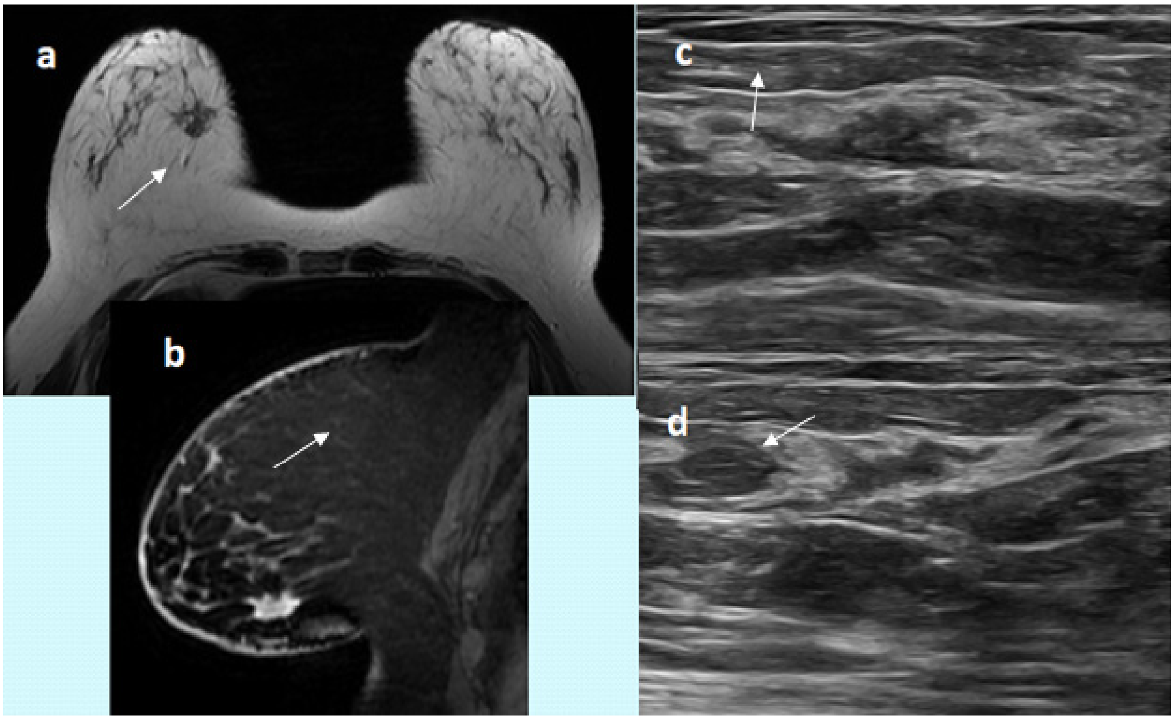
Breast cancer (n=78)		*p*
ILC (n=6) 37.6±3.0	IDC (n=66) 48.5±10.9	**<0.05**
Unifocal (n=69) 49.1±11.0	Multiple (n=9) 37.3±3.0	**<0.05**

Table 2. Histopathological findings in tumor foci (n=91) in our breast cancer cases (n=78)

Breast cancer	Number of cases	%
Invasive ductal carcinoma	71	78.0
Invasive lobular carcinoma	16	17.6
Mucinous carcinoma	2	2.1
Tubular carcinoma	2	1.1
Comedo carcinoma	1	1.1



Picture 1. DCE-MRI and USG images in an ILC case (DCE-MRG BI-RADS IV, USG BI-RADS II)
a and b- Segmental pathological contrast enhancement that does not form a mass in the right breast inner quadrant in postcontrast series in DCE-MRI
c and d- No fibrocystic changes and no solid mass were detected on USG



Picture 2. DCE-MRI and USG images in an ILC case (DCE-MRI BI-RADS V, USG BI-RADS IV)
a- Irregular contoured lesion in precontrast MRI examination
b- The same lesion showing significant contrast enhancement in the postcontrast image in DCE-MRI
c and d- No mass form on USG. Suspected hypoechoic field partially distributed in different sections

USG examination of 2 foci diagnosed with mucinous carcinoma detected BI-RADS IV (n=1) and BI-RADS V (n=1). DCE-MRI results of the same cases were BI-RADS IV (n=1), BI-RADS V (n=1). In 1 focus diagnosed with comedocarcinoma, it was BI-RADS IV in USG and BI-RADS V in DCE-MRI. In 1 focus diagnosed with tubular carcinoma, both modality results were BI-RADS V (Table 3).

CDRs (BI-RADS IV+V); 78.2% in BC (n=78) (61/78) on USG, 73.6% in TFs (n=91) (67/91), ILCs (n=16) (6/16) 37.5%, IDCs (n=71) (57/71) 80.2%, DCE-MRI in BC (n=78) (74/78) 94.8%, TFs (n=91) (86/91) 94.5%, ILCs (n=16) (14/16) 87.5%, IDCs (n=71) (68/71) 95.7% (Table 3).

Table 3. BI-RADS IV+V (Absolute diagnosis) findings in DCE-MRI and USG in breast cancer cases

	DCE-MRI (BIRADS IV+V)	USG (BIRADS IV+V)	*p*
Breast cancer (n=78)	74 (94.8%)	61 (78.2%)	**<0.05**
Tumor focus (n=91)	86 (94.5%)	67 (73.6%)	**<0.05**
Invasive lobular cancer (n=16)	14 (87.5%)	6 (37.5%)	1.00
Invasive ductal cancer (n=71)	68 (95.7%)	57 (80.2%)	**<0.05**

Discussion

Today, the most commonly used methods for BC screening and diagnosis are mammography (MG) and USG. In a national study conducted by the Japanese strategic anticancer randomized trial (J-START) organization in Japan, in the scans performed on 72,998 women with MG and USG between 2007 and 2011; it has been reported that MG is still the most important screening test in the diagnosis of BC, but the sensitivity decreases as the breast density increases, and its effectiveness increases more when USG is performed together [8]. In a study by Freer, it was reported that the sensitivity of MG decreased to 62-68% in women with dense breasts [9]. It has been reported that BC develops at a rate of 1/156 or 1/312 depending on the number and dose of MG in patients who underwent MG in BC scans [10]. Despite its advantages such as being cost-effective and portable, no radiation risk, and being able to be performed in a short time, USG in the diagnosis of BC is insufficient in the diagnosis of microcalcifications, MTs and ILCs [3, 4]. Therefore, more advanced diagnostic tests are needed. In a meta-analysis by Mann et al. [11], the sensitivity rates of DCE-MRI in BC were found to be between 81-100%. A meta-analysis of the effectiveness of USG in the diagnosis of BC by Sood et al. [12] found an overall sensitivity and specificity of 80.1%.

In our study, the ADR of USG in the diagnosis of BC was 78.1%, and DCE-MRI 94.8%, the difference was statistically significant (p<0.05) (Table 3).

In a study by Partridge et al. [13], it has been reported that diffusion-weighted imaging (DWI) and apparent diffusion coefficients (ADC) values in DCE-MRI, morphological criteria, and dynamic contrast enhancement curves of lesions are different in malignant lesions as reasons for the superiority of DCE-MRI method over USG in the diagnosis of BC cases who underwent DCE-MRI. Some other studies have also reported that DCE-MRI shows significant diffusion restriction and low ADC values in malignant lesions compared to benign ones [14, 15]. Zhang et al. [16], in the models they developed for the diagnosis of BC, demonstrated that ADC mean values and delayed enhancement are independent and significant factors in the diagnosis of BC [16]. In the study conducted by the same researchers, high AUC values such as 0.952 were obtained with DCE-MRI to differentiate malignant tumors in 188 cases.

ILC is the second most common (5-15%) malignancy of the breast [17]. ILC is often undetectable by MG because it is of equal or lower density to fibroglandular tissue, and microcalcifications are often undetectable in contrast to IDC or carcinoma in situ [18]. In addition, ILC cases that do not form a mass in USG and present only as structural distortion may be overlooked [19]. In a study by Wilson et al. [17], it was reported that the sensitivity was 93% with DCE-MRI, 57-81% with MG, and 68-98% with USG in ILCs. However, in the same study, it was found that false-positive diagnosis rates with USG in ILC cases could increase up to 29.9%.

In our study, the CDR of DCE-MRI (14/16) was 87.5% and USG (6/14) was 37.5% in ILC cases, and the difference was statistically insignificant (*p*>0.05) (Table 3). The reason why the difference is statistically insignificant may be the small number of our cases. In a meta-analysis conducted by Vera Badillo et al. [20] in 67,557 women, it was reported that 4-50% of BCs are multicentric or multifocal, ILC cases are more common, and their prognosis is worse. In a retrospective study conducted by Neri et al. [21] in 1158 BC women, it was reported that the mean age of MT cases was significantly lower than that of UF cases, and the prognosis was worse.

In our study, the mean age of MF cases was found to be significantly lower than that of UF and BC cases, and the mean age of ILC cases was significantly lower than that of IDC cases (Table 1). For these reasons, early diagnosis is more important in MT cases, especially at young ages, and more advanced diagnostic methods with high sensitivity and specificity are needed. In a study by Acar et al. [4], the sensitivity of DCE-MRI, which is one of the advanced diagnostic methods in MT cases, was found to be high, reaching 98.6%. In a study by Song et al. [7], it was reported that the sensitivity and specificity of DCE-MRI in MTs is high, tumor foci smaller than 1 cm can be detected more easily, and unnecessary biopsies can be prevented.

In our study, CDR was found to be 94.5% (86/91) in tumor foci with DCE-MRI, 73.6% (67/91) with USG, and the difference was found to be significant (*p*<0.05) (Table 3).

The limitation of our study is that it was not a prospective randomized study. The different aspect of our study is the limited number of studies in the literature comparing the effects of DCE-MRI and USD in BC cases.

In conclusion, DCE-MRI imaging method is more effective in detecting tumor foci than USG, and it is recommended to be applied together with USG, especially in risk group cases (genetics, young age, obesity, fibrocystic disease, bilateral mass).

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Ethics committee approval: Permission was obtained from Girne American University Health Sciences Ethic Committee for the study of with a number 2022-23/001 and the date October 03.2022.

Authors' contributions to the article

Both authors equally contributed to the study conception and design. Both authors read and approved the final manuscript.