

Unifocal, multifocal, or multicentric breast cancer distribution patterns on multiplanar breast MRI: a technical note

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ABSTRACT

The distribution patterns of breast cancer using multiplanar contrast-enhanced breast magnetic resonance imaging (B-MRI) have been insufficiently addressed. This technical note describes and schematizes the distribution pattern of breast cancer with multiplanar B-MRI from a radiologist's point of view. Multiplanar B-MRI can determine the distribution pattern of breast cancer in the three orthogonal axes (axial, sagittal, and coronal) and define the quadrant(s) of location. The distribution patterns are unifocal (UF), multifocal (MF), and multicentric (MC), which can be presented as multicentric uniuadrant (MCUQ) or multicentric multiquadrant (MCMQ). The radiologist must differentiate the distribution patterns of breast cancer and highlight the MC variants (MCUQ and MCMQ) to avoid confusing MF with MCUQ lesions. It is important to point out that each breast cancer pattern has a different prognosis and therapy recommendations. We present a digital template that can be used for reporting breast cancer distribution patterns as complementary information to the structured and standardized report of B-MRI, allowing a clear understanding and communication of findings for multidisciplinary teams and patients. The images and schematics in this technical note have been developed for educational purposes from a radiologist's perspective.

Keywords: Breast neoplasms. Distribution patterns. Magnetic resonance imaging. Diagnostic breast imaging.

INTRODUCTION

Breast cancer is the most commonly diagnosed malignancy, with an estimated 2.3 million new cases worldwide in 2020¹. The number of breast cancer-related deaths increases every year. It is the fifth most common cancer-related death and is reported more frequently in developing countries². Contrast-enhanced breast magnetic resonance imaging (B-MRI) detects breast cancer with a sensitivity of 75.2–100% and a specificity of 83–98.4% and determines its location, size, and local extent^{3–5}.

B-MRI resolves problematic cases that cannot be defined with other methods, such as mammography and ultrasound. The indications for performing B-MRI

are local cancer staging, response to neoadjuvant treatment, axillary lymph node carcinoma of unknown origin with suspected breast cancer, and screening young patients at high risk (BRCA mutation)⁵. Multiplanar B-MRI is useful in determining the distribution pattern of breast cancer in the three orthogonal axes (axial, sagittal, and coronal) and defining the quadrant(s) of location⁶. The importance of distinguishing the distribution patterns is based on the fact that each is associated with a different prognosis, neoadjuvant/adjuvant and surgical therapy⁷.

Distribution patterns are described in BI-RADS lexicon⁸. However, the description of breast cancer distribution patterns has been insufficiently addressed from

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Table 1. B-MRI distribution patterns and characteristics in 16 women with breast cancer

Case	Number of masses	KS	KS*	BI-RADS	Distribution pattern	Histologic diagnosis	Molecular subtype
1	1	7/11	10/11	6	UF	Invasive ductal carcinoma	Triple negative
2	2	10/11	-	6	MF	Invasive ductal carcinoma	Luminal B
3	2	11/11	-	6	MCUQ	Invasive ductal carcinoma	Luminal B
4	3	5/11	8/11	6	MCMQ	Invasive ductal carcinoma	Luminal B
5	1	7/11	10/11	6	UF	Invasive ductal carcinoma	Luminal B
6	4	11/11	-	6	MCMQ	Breast lymphoma	-
7	2	9/11	-	6	MCUQ	Invasive ductal carcinoma	Luminal B
8	4	10/11	-	6	MCUQ	Invasive ductal carcinoma	Luminal B
9	2	8/11	-	6	MCUQ	Invasive ductal carcinoma	Triple negative
10	2	8/11	-	6	MCUQ	Invasive ductal carcinoma	Triple negative
11	3	4/11	7/11	6	MF	Invasive ductal carcinoma	Triple negative
12	2	8/11	-	6	MCMQ	Primary neuroendocrine breast cancer	-
13	2	5/11	8/11	6	MF	Invasive ductal carcinoma	Luminal A
14	2	9/11	-	6	MCMQ	Invasive ductal carcinoma	Luminal B
15	3	6/11	9/11	6	MCMQ	Invasive ductal carcinoma	Luminal B
16	2	8/11	-	6	MCMQ	Invasive ductal carcinoma	Luminal B

UF: unifocal; MF: multifocal; MCUQ: multicentric uniuadrant; MCMQ: multicentric multiquadrant; KS: kaiser score; KS*: modified kaiser score; BI-RADS: Breast Imaging Report and Data System; B-MRI: breast magnetic resonance imaging.

a radiologist's point of view. This technical note is based on daily clinical radiological practice in the imaging assessment of patients treated by a multidisciplinary breast cancer committee. This technical note aims to describe and schematize the distribution patterns of breast cancer using multiplanar B-MRI for educational purposes from a radiologist's perspective. It provides a template that can be used for reporting distribution patterns of breast cancer as complementary information to the B-MRI report.

Distribution pattern definitions

Unifocal pattern (UF): a single lesion in a single breast regardless of its location^{9,10}.

Multifocal pattern (MF): ≥ 2 lesions in a single breast in a single quadrant with a distance < 5 cm^{9,10}.

Multicentric uniuadrant pattern (MCUQ): ≥ 2 lesions in a single breast in a single quadrant with a distance > 5 cm^{9,10}.

Multicentric multiquadrant pattern (MCMQ): ≥ 2 lesions in a single breast in ≥ 2 quadrants regardless of their distance^{9,10}.

Image acquisition and analysis protocol

A GE™ resonator (Discovery 750w, 3.0T, 2011; General Electric Healthcare, Milwaukee, WI, USA) with a dedicated Sentinelle™ breast antenna (Sentinelle Breast Coil Riser, 2019; In vivo Corp. Gainesville, FL, USA) was used. Multiplanar axial sequences in T1, T2 SPAIR (Spectral Attenuation Inversion Recovery), DWI (diffusion-weighted imaging), ADC (apparent diffusion coefficient), T1 volume imaging for breast assessment (VIBRANT) dynamic multiphase with contrast injection and subtractions were acquired for both mammary glands. Contrast injection for the dynamic T1 VIBRANT dynamic multiphase sequences was performed with a MEDRAD® injector (MEDRAD Spectris Solaris EP, 2019; Indianola, PA, USA) using gadolinium (*Gadovist*®) 0.1 mmol/kg at 3 mL/s with a consecutive push of normal saline (NaCl 0.9%) 20 mL at 4 mL/s.

Image analysis was performed on an AW™ workstation (Advanced Workstation 4.7, MRI BREAST, 2016, General Electric Healthcare, Milwaukee, WI, USA). Lesions were assessed according to the BI-RADS

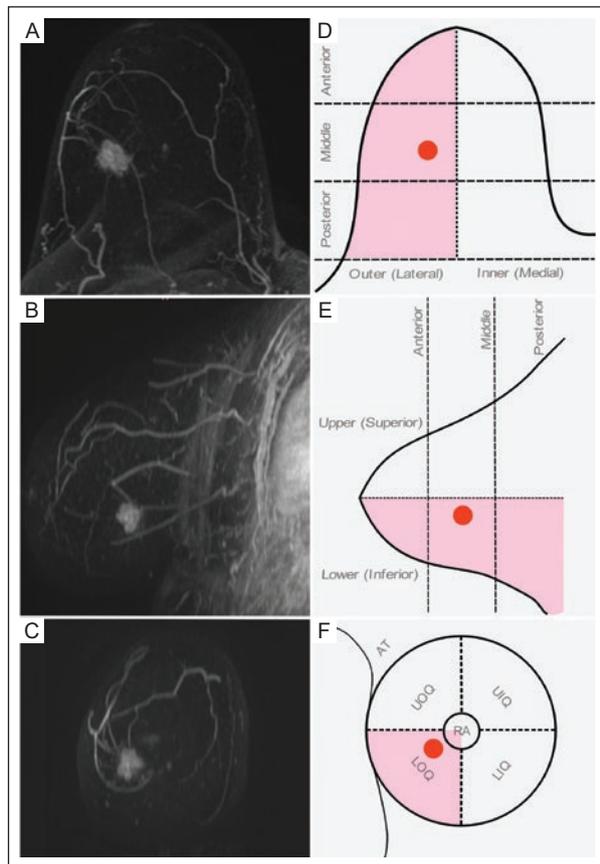


Figure 1. B-MRI of a 49-year-old woman with triple-negative molecular subtype IDC in the right breast with a unifocal distribution pattern. **A:** axial plane, **B:** sagittal plane, **C:** coronal plane showing an irregular spiculated mass with heterogeneous enhancement and AVS (KS 7/11, KS* 10/11) in the T1+C sequence (Sub Ph2, MIP) toward LOQ in the middle third. **D, E,** and **F:** schematic representation of the unifocal pattern. The lesion (red circle) is located in only one quadrant (pink). The unifocal pattern is only a single lesion in a single breast, regardless of its location (UOQ, UIQ, LOQ, LIQ, and RA).

AT: axillary tail; AVS: adjacent vessel sign; B-MRI: breast magnetic resonance imaging; IDC: invasive ductal carcinoma; KS: Kaiser score; KS*: modified Kaiser score; LIQ: lower inner quadrant; LOQ: lower outer quadrant; MIP: maximum intensity projection; RA: retroareolar; Sub Ph2: subtraction of the second contrast phase; T1+C: T1 sequence with multiphase contrast; UIQ: upper inner quadrant; UOQ: upper outer quadrant.

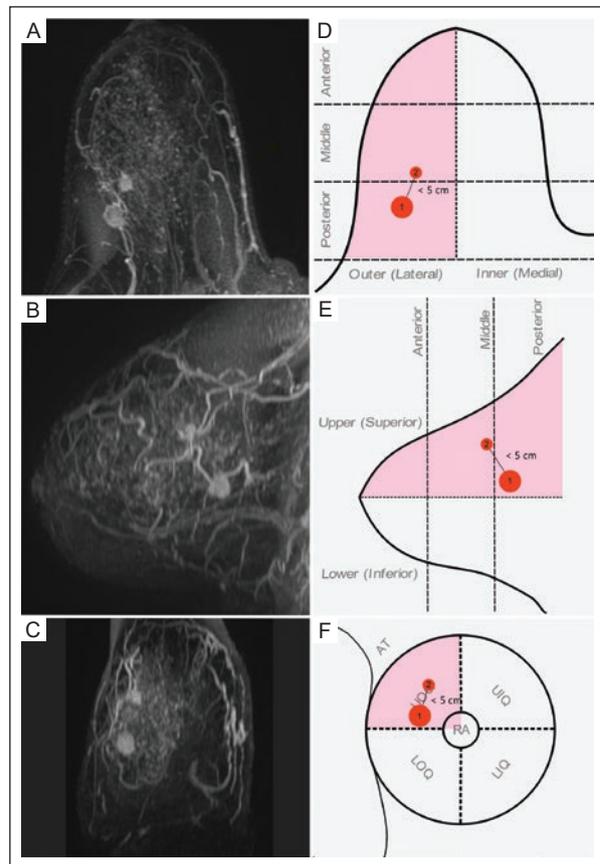


Figure 2. B-MRI of a 56-year-old woman with luminal molecular subtype B IDC in the right breast with a multifocal distribution pattern. **A:** axial plane, **B:** sagittal plane, **C:** coronal plane showing two irregular spiculated masses with heterogeneous enhancement and AVS (KS 10/11) in the T1+C sequence (Sub Ph2, MIP) toward the UOQ in its middle/posterior third. **D, E,** and **F:** schematic representation of the multifocal pattern. Note that the lesions (red circles) are located in a single quadrant (pink color) at a distance of < 5 cm from each other. The term multifocal pattern is ≥ 2 lesions in a single breast in a single quadrant (UOQ, UIQ, LOQ, and LIQ) with a distance < 5 cm. The masses were numbered for multiplanar identification.

AT: axillary tail; AVS: adjacent vessel sign; B-MRI: breast magnetic resonance imaging; IDC: invasive ductal carcinoma; KS: Kaiser score; LIQ: lower inner quadrant; LOQ: lower outer quadrant; MIP: maximum intensity projection; RA: retroareolar; Sub Ph2: subtraction of the second contrast phase; T1+C: T1 sequence with multiphase contrast; UIQ: upper inner quadrant; UOQ: upper outer quadrant.

categories, the Kaiser score, and the modified Kaiser¹¹ by a breast imaging radiologist (RDC) with 25 years of experience.

Description of the clinical cases

The characteristics and distribution patterns of lesions by B-MRI in 16 women with breast cancer are shown in Table 1. The number of masses, Kaiser score, modified

Kaiser score, BI-RADS, distribution pattern, histological diagnosis, and the molecular subtype were recorded. The breast cancer quadrant location was determined by multiplanar B-MRI (axial, sagittal, and coronal) using Sub Ph2 sequences in maximum intensity projection (MIP). Then, the type of distribution pattern was defined. A representative case of each distribution pattern was selected to develop the diagrams depicting each breast cancer distribution pattern in a multiplanar B-MRI view.

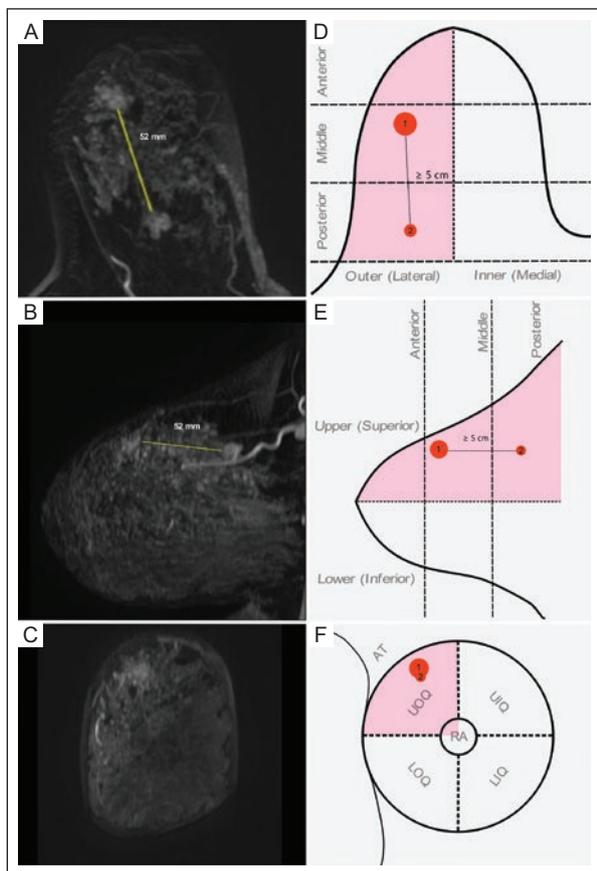


Figure 3. B-MRI of a 41-year-old woman with luminal B molecular subtype IDC in the right breast with a multicentric uniquadrant distribution pattern. **A:** axial plane, **B:** sagittal plane, **C:** coronal plane showing two spiculated masses with heterogeneous enhancement (KS 11/11) and a distance of 52 mm (yellow line) in the T1+C sequence (Sub Ph2, MIP) toward the UOQ in the middle and posterior third. **D, E, and F:** schematic representation of the multicentric uniquadrant pattern. Note how the lesions (red circles) lie in a single quadrant (pink color) but are separated by ≥ 5 cm. This pattern is ≥ 2 lesions in a single quadrant of a single breast (UOQ, UIQ, LOQ, and LIQ) separated by ≥ 5 cm. The masses were numbered for multiplanar identification.

AT: axillary tail; B-MRI: breast magnetic resonance imaging; IDC: invasive ductal carcinoma; KS: Kaiser score; LIQ: lower inner quadrant; LOQ: lower outer quadrant; MIP: maximum intensity projection; RA: retroareolar; Sub Ph2: subtraction of the second contrast phase; T1+C: T1 sequence with multiphase contrast; UIQ: upper inner quadrant; UOQ: upper outer quadrant.

Unifocal (UF) pattern

Case 1 is a 49-year-old woman with invasive ductal carcinoma (IDC), with a molecular subtype triple-negative. B-MRI showed an irregular spiculated mass with heterogeneous enhancement in the lower outer quadrant of the right breast, middle third (Figure 1A, B, and C). Multiplanar diagrams illustrate the characteristics of the UF distribution pattern (Figures 1D, E, and F). The unifocal pattern is only a single lesion in a single breast, regardless of its location.

Multifocal (MF) pattern

Case 2 is a 56-year-old woman with an IDC, with a molecular subtype luminal B. B-MRI showed two irregular spiculated masses with heterogeneous enhancement in the right breast toward the upper outer quadrant, middle third (Figures 2A, B, and C). Multiplanar diagrams illustrate the characteristics of the MF distribution pattern (Figures 2D, E, and F). A multifocal pattern is ≥ 2 lesions in a single breast in a single quadrant with a distance of < 5 cm. Masses were numbered for multiplanar identification.

Multicentric uniquadrant (MCUQ) pattern

Case 3 is a 41-year-old woman with an IDC, with a molecular subtype luminal B. B-MRI showed two irregular spiculated masses with heterogeneous enhancement in the right breast extending toward the upper outer quadrant in the middle and posterior third, separated by 52 mm from each other (Figures 3A, B, and C). The multiplanar diagrams illustrate the characteristics of the MCUQ distribution pattern (Figures 3D, E, and F). The multicentric uniquadrant pattern is ≥ 2 lesions located in a single quadrant of a single breast, separated by ≥ 5 cm. Masses were numbered for multiplanar identification.

Multicentric multiquadrant (MCMQ) pattern

Case 4 is a 35-year-old woman with an IDC, with a molecular subtype luminal B. B-MRI showed three irregular masses with heterogeneous enhancement in the right breast in the upper outer, upper inner, and lower outer quadrants (Figure 4A, B, and C). The multiplanar diagrams illustrate the characteristics of the MCMQ distribution pattern (Figure 4D, E, and F). A multicentric multiquadrant pattern is ≥ 2 lesions in ≥ 2 quadrants of a single breast. Masses were numbered for multiplanar identification.

Template of breast cancer distribution patterns

We provide a digital template (supplementary material) that can be downloaded and used for reporting breast cancer distribution patterns as complementary information to the structured and standardized report of the B-MRI to allow clear communication of findings to the multidisciplinary team who can offer the patient the best available therapy.

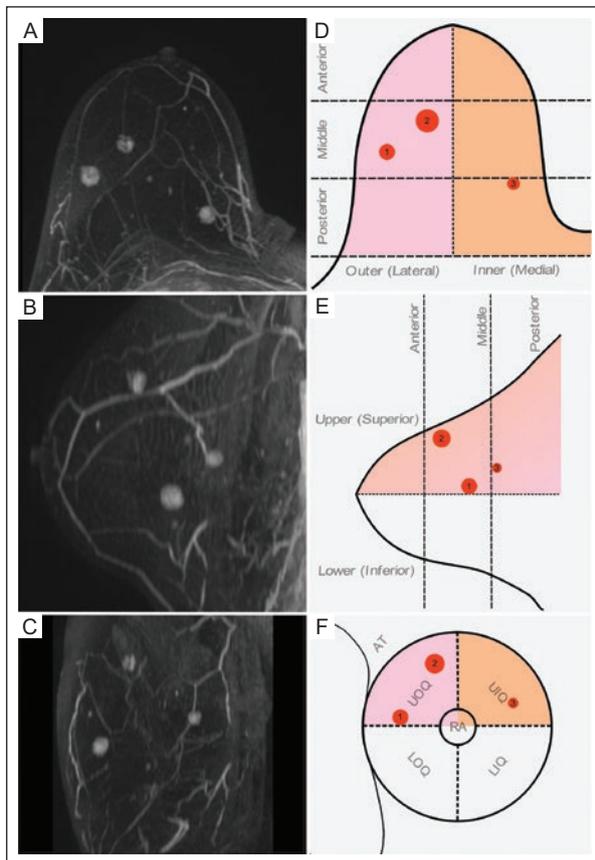


Figure 4. PB-MRI of a 35-year-old woman with luminal molecular subtype B IDC in the right breast with a multicentric multiquadrant distribution pattern. **A:** axial plane, **B:** sagittal plane, **C:** coronal plane showing three irregular masses with heterogeneous enhancement and AVS (KS 5/11, KS* 8/11) in the T1+C sequence (Sub Ph2, MIP) toward UOQ and UIQ in the middle/posterior third. **D, E, and F:** schematic representation of the multicentric multiquadrant pattern showing how the lesions (red circles) are localized in more than one quadrant (pink and orange). A multicentric multiquadrant distribution pattern is ≥ 2 lesions located in ≥ 2 quadrants of a single breast. The masses were numbered for multiplanar identification.

AT: axillary tail; AVS: adjacent vessel sign; B-MRI: breast magnetic resonance imaging; IDC: invasive ductal carcinoma; KS: Kaiser score; KS*: modified Kaiser score; LIQ: lower inner quadrant; LOQ: lower outer quadrant; MIP: maximum intensity projection; RA: retroareolar; Sub Ph2: subtraction of the second contrast phase; T1+C: T1 sequence with multiphase contrast; UIQ: upper inner quadrant; UOQ: upper outer quadrant.

DISCUSSION

The B-MRI images and template in this technical note facilitate recognizing breast cancer distribution patterns from a radiologist's point of view and allow correct identification by multidisciplinary teams and patients. The radiologist must differentiate the distribution patterns of breast cancer, emphasizing the two presentations of the MC pattern (MCUQ and MCMQ) to avoid confusion of the MF pattern with an MCUQ pattern.

According to Bendifallah et al.¹², the description of distribution patterns dated back to 1977 when Lagios, a pathologist specializing in breast pathology, described the MF distribution pattern as tumor foci in the same quadrant of the same breast and the MC distribution pattern as tumor foci in different quadrants or more than 5 cm in the same breast. Most MF and MC distribution pattern publications can be found in pathology, oncology, and surgical oncology journals, from the perspective of these specialties⁹. In a recently published systematic review and meta-analysis, Zhang et al.⁹ selected 31 studies published in oncology and/or oncosurgery journals. Of these, only 5 studies included imaging and pathology methods for detecting tumor foci and determining lesion distribution patterns, but none addressed the radiologist's perspective in determining the type of distribution pattern⁹. Thus, this technical note provides graphical representations of breast cancer distribution patterns on B-MRI as a standardized and complete description for radiologist that optimizes the radiological report using a template. The radiologist's point of view in reporting breast cancer distribution patterns is critical for therapeutic decisions that impact prognosis. In countries where resources are limited, conservative surgery should be avoided in MC breast cancer¹³.

MF and MC pattern descriptions vary considerably in the literature, particularly in relation to the distance between foci¹⁴. The ACR BI-RADS fifth edition only cites the MF and MC patterns in the MRI section but does not list specific schemas of these entities⁸. Only O'Brien¹⁰, an oncological breast cancer surgeon, showed a simplified scheme in the coronal plane that illustrates the MF and MC patterns without showing their multiplanar (axial or sagittal) translation¹⁰. In a case-based review published in 2011, Dueñas et al.,¹⁵ a group of radiologists, defined the MF and MC distribution pattern from an imaging perspective but without diagrams illustrating their multiplanar features¹⁵. A systematic review and meta-analysis by Zhang et al.⁹ provided homogeneity in the definitions of MF and MC. Their descriptions are important, as these lesions are more biologically aggressive and pose a higher risk of mortality and metastasis, with a combined incidence ranging from 6% to 60%⁹. Radiologists must use these standardized definitions for MF and MC pattern, using a homogeneous lexicon in clear and complete B-MRI descriptions.

CONCLUSION

The images and schematics in this technical note have been developed for educational purposes from a

radiologist's perspective. The use of the structured and standardized reporting template for the distribution pattern of breast cancer on multiplanar B-MRI can (a) impact patient care by facilitating clear communication of the distribution pattern to the treating oncologists, surgeons, and pathologists; (b) be a visual guide for radiology trainees; (c) be useful for data comparison and reproducibility in research; and (d) help patients understand their disease.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of individuals. This study was conducted in compliance with the Declaration of Helsinki (1964) and its subsequent amendments.

Data confidentiality. The authors declare that they followed their center's protocol for sharing patient data.

Right to privacy and informed consent. Informed consent was not required to analyze and publish routinely acquired clinical and imaging data.

Use of artificial intelligence. The authors state that they did not use generative artificial intelligence to prepare this manuscript and/or create tables, figures, or figure legends.

Supplementary material

The digital blank template of the multiplanar B-MRI diagrams of the right and left breast is provided as complementary material for use in clinical practice, teaching, or research.

Supplementary data are available online in the Journal online DOI: 10.24875/JMEXFRI.24000001. These data are provided by the corresponding author and published online for the reader's benefit. The contents of supplementary data are the sole responsibility of the authors.

REFERENCES

- Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin.* 2021;71(3):209-249. doi:10.3322/caac.21660.
- Łukasiewicz S, Czeczulewski M, Forma A, Baj J, Sitarz R, Stanisławek A. Breast Cancer-Epidemiology, Risk Factors, Classification, Prognostic Markers, and Current Treatment Strategies-An Updated Review. *Cancers (Basel).* 2021;13(17):4287. doi:10.3390/cancers13174287.
- Steinhof-Radwańska K, Lorek A, Holecki M, Barczyk-Gutkowska A, Grażyńska A, Szczudło-Chraścina J, et al. Multifocality and Multicentricity in Breast Cancer: Comparison of the Efficiency of Mammography, Contrast-Enhanced Spectral Mammography, and Magnetic Resonance Imaging in a Group of Patients with Primarily Operable Breast Cancer. *Curr Oncol.* 2021; 28(5):4016-4030. doi:10.3390/curroncol28050341.
- Xiao J, Rahbar H, Hippe DS, Rendi MH, Parker EU, Shekar N, et al. Dynamic contrast-enhanced breast MRI features correlate with invasive breast cancer angiogenesis. *NPJ Breast Cancer.* 2021;7(1):42. doi: 10.1038/s41523-021-00247-3.
- Mann RM, Cho N, Moy L. Breast MRI: State of the Art. *Radiology.* 2019;292(3):520-536. doi: 10.1148/radiol.2019182947.
- Thomassin-Naggara I, Trop I, Lalonde L, David J, Péloquin L, Chopier J. Tips and techniques in breast MRI. *Diagn Interv Imaging.* 2012;93(11):828-839. doi:10.1016/j.diii.2012.06.004.
- Li S, Wu J, Huang O, He J, Chen W, Li Y, et al. Association of Molecular Biomarker Heterogeneity with Treatment Pattern and Disease Outcome in Multifocal or Multicentric Breast Cancer. *Front Oncol.* 2022;12:833093. doi:10.3389/fonc.2022.833093.
- Morris EA, Comstock CE, Lee CH, Lehman CD, Newstead GM, Tozaki M, et al. ACR BI-RADS® Magnetic Resonance Imaging. In: D'Orsi CJ, editor. *ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System.* 5th ed. 5th ed. Reston, VA (USA). American College of Radiology; 2013. p. 377, 442.
- Zhang Y, Liu F, Gao Q, Chai Y, Ren Y, Tian H, et al. Comparing the outcome between multicentric/multifocal breast cancer and unifocal breast cancer: A systematic review and meta-analysis. *Front Oncol.* 2022;12:1042789. doi:10.3389/fonc.2022.
- O'Brien MJ. Invasive/Infiltrating Lobular Carcinoma (ILC) [Internet]. Melbourne Breast Cancer Surgery; 2018 [cited 2023 July 03]. Available from: <https://www.melbournebreastcancersurgery.com.au/wp-content/themes/ypo-theme/pdf/infiltrating-lobular-carcinoma-18th-july-p1.pdf>.
- Zhou XZ, Liu LH, He S, Yao HF, Chen LP, Deng C, et al. Diagnostic value of Kaiser score combined with breast vascular assessment from breast MRI for the characterization of breast lesions. *Front Oncol.* 2023;13:1165405. doi:10.3389/fonc.2023.
- Bendifallah S, Werkoff G, Borie-Moutafoff C, Antoine M, Chopier J, Gligorov J, et al. Multiple synchronous (multifocal and multicentric) breast cancer: clinical implications. *Surg Oncol.* 2010;19(4):e115-123. doi: 10.1016/j.suronc.2010.06.001.
- Cardenas-Sanchez JC, Bargallo-Rocha JE, Cervantes-Sanchez G, Arce-Salinas C, Bautista-Piña V, Chavez-MacGregor MC, et al. Mexican Consensus on diagnosis and treatment of breast cancer [Internet]. Version 10. Mexico City (Mexico); [cited 2023 July 03]; p. 79. Available from: http://consensocancermamario.com/documentos/FOLLETO_CONSENSO_DE_CANCER_DE_MAMA_10aRev2023a.PDF
- Avera E, Valentic L, Bui L. Current understanding and distinct features of multifocal and multicentric breast cancers. *Cancer Rep (Hoboken).* 2023;6(9):e1851. doi: 10.1002/cnr2.1851.
- Dueñas VP, Gopegui-Andreu MR, Hodge SM, Manrique AS. Breast Magnetic Resonance Imaging of Multicentric, Multifocal and Bilateral Cancer - A Case-based Review. *Eur Oncol.* 2011;7:24. doi: 10.17925/EOH.2011.07.01.24.