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Current challenges in diagnosing gestational breast cancer

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ABSTRACT

Gestational (pregnancy-associated) breast cancer is diagnosed during pregnancy, within the first postpartum year, or while breastfeeding. Delayed diagnosis and treatment, often due to low physician awareness and the complexities in interpreting diagnostic data to assess the severity of disease, contribute to the poor prognosis of this condition. Russian literature concerning the diagnosis of gestational breast cancer is very limited. Therefore, further exploration of this issue is relevant. The aim of this review is to analyze existing literature on diagnosing gestational breast cancer. A search of PubMed, eLibrary, and Google Scholar was conducted using keywords such as "гестационный рак молочной железы," "рак молочной железы," "рак молочной железы, ассоциированный с беременностью," "беременность," "кормление грудью," "лактация," "МРТ," "КТ," "маммография," "УЗИ," "биопсия," "диагностика," and their English correlates "gestational breast cancer," "breast cancer," "pregnancy-associated breast cancer," "pregnancy," "breastfeeding," "lactation," "MRI," "CT," "mammography," "ultrasound," "biopsy," and "diagnosis." Gestational breast cancer remains a serious challenge for modern medicine. Various methods are employed in diagnosing and treating this disease, including needle aspiration biopsy, fine-needle biopsy, and surgical biopsy. Ultrasound plays a crucial role in monitoring the response to neoadjuvant chemotherapy and assessing regional lymph nodes. Advanced imaging techniques, such as ultrasound elastography, contrast-enhanced ultrasound, and the hybrid PET/MRI technique, may enhance the diagnosis and management of gestational breast cancer. The use of non-contrast diffusion MRI in pregnant and breastfeeding patients is an intriguing area for future research.

Keywords: breast cancer; gestational breast cancer; pregnancy-associated breast cancer; pregnancy; lactation; diagnosis; MRI; ultrasound; mammography; biopsy.

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Современное состояние вопроса диагностики гестационного рака молочной железы

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АННОТАЦИЯ

Гестационный (ассоциированный с беременностью) рак молочной железы — это заболевание, которое впервые диагностировано во время беременности, в первый год после родов или на протяжении всего периода грудного вскармливания. Длительная продолжительность лечения и неблагоприятный прогноз, связанные с гестационным раком молочной железы, могут быть объяснены задержками в диагностике и лечении, которые возникают из-за низкой настороженности врачей, а также из-за сложности интерпретации результатов оценки тяжести состояния молочных желез. Отечественная литература по диагностике гестационного рака молочной железы крайне ограничена, именно поэтому дальнейшее освещение данной темы является актуальным. Цель обзора — проанализировать литературные данные, посвящённые вопросу диагностики гестационного рака молочной железы. Проведён поиск научных публикаций в электронных базах данных PubMed, eLibrary и Google Scholar. При поиске использованы следующие ключевые слова и их сочетания: «гестационный рак молочной железы», «рак молочной железы», «рак молочной железы, ассоциированный с беременностью», «беременность», «кормление грудью», «лактация», «МРТ», «КТ», «маммография», «УЗИ», «биопсия», «диагностика», «gestational breast cancer», «breast cancer», «breast cancer associated with pregnancy», «pregnancy», «breastfeeding», «lactation», «MRI», «CT», «mammography», «ultrasound», «biopsy», «diagnosis». Гестационный рак молочной железы остаётся серьёзным вызовом для современной медицины. Для его диагностики и лечения применяют различные методы, включая пункционную биопсию, тонкоигольную биопсию и хирургическую биопсию. Ультразвуковое исследование играет важную роль в наблюдении за реакцией на неоадъювантную химиотерапию и при контроле состояния регионарных лимфатических узлов. Дальнейшие исследования в области визуализации (ультразвуковая эластография, ультразвук с контрастным усилением и гибридные методы ПЭТ/МРТ) могут значительно улучшить диагностику и лечение гестационного рака молочной железы. Использование неконтрастной диффузионной МРТ у беременных пациенток и кормящих женщин представляет особый интерес для дальнейших исследований в этой области.

Ключевые слова: рак молочной железы; гестационный рак молочной железы; рак молочной железы, ассоциированный с беременностью; беременность; лактация; диагностика; МРТ; УЗИ; маммография; биопсия.

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妊娠相关乳腺癌诊断问题的现状

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摘要

妊娠相关乳腺癌（Pregnancy-Associated Breast Cancer, PABC）是指在怀孕期间、产后一年内或整个哺乳期首次诊断的乳腺癌。这种疾病的长期治疗过程和不良预后可能与诊断和治疗的延误有关，这些延误通常源于医生对其警惕性不足以及乳腺健康状况评估结果解释的复杂性。关于妊娠相关乳腺癌诊断的国内文献非常有限，因此对这一主题的进一步探讨显得尤为重要。

本综述旨在分析现有文献中关于妊娠相关乳腺癌诊断的研究数据。研究通过检索PubMed、eLibrary 和 Google Scholar 等电子数据库中的学术文献完成，使用的关键词和组合包括：“妊娠相关乳腺癌”，“乳腺癌”，“怀孕”，“哺乳期”，“MRI”，“CT”，“乳腺X线摄影”，“超声”，“活检”，“诊断”及其对应的英文术语。

妊娠相关乳腺癌仍是现代医学的一项重大挑战。其诊断和治疗采用多种方法，包括穿刺活检、细针穿刺活检及外科活检。超声检查在监测新辅助化疗反应及评估区域淋巴结状况方面起着重要作用。在影像学领域的进一步研究（如超声弹性成像、对比增强超声及 PET/MRI 混合技术）有望显著提高妊娠相关乳腺癌的诊断和治疗效果。对于孕期及哺乳期患者而言，无对比剂的扩散加权 MRI 在未来研究中具有特别的应用潜力。

关键词：乳腺癌；妊娠相关乳腺癌；妊娠期乳腺癌；怀孕；哺乳期；诊断；MRI；超声；乳腺X线摄影；活检。

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BACKGROUND

Pregnancy-associated breast cancer (PABC), or gestational breast cancer, is first diagnosed during pregnancy, in the first year after childbirth, or during the entire breastfeeding period [1]. Literature provides several definitions for PABC. While some references include the 2–5-year postpartum period in this definition [2], others define PABC as a condition that can be diagnosed during pregnancy or at any time thereafter, or at any time while the patient is lactating [3].

Although PABC is rare, it is typically aggressive and associated with adverse prognostic factors, including high nuclear mitotic activity, lymph node involvement, drug resistance, and HER2 positivity [4]. The long treatment duration and poor prognosis for PABC may be explained by delays in diagnosis and treatment due to low physician awareness, as well as challenges in interpreting the findings of breast status assessment. The Russian literature on the PABC diagnosis is extremely limited, so further discussion of this issue is relevant.

It should be noted that the majority of breast neoplasms detected during pregnancy are benign [5]. However, careful examination of suspicious or persistent breast lesions remains crucial for early PABC detection. Accurate and timely diagnosis is necessary to avoid undue stress to the patient and to minimize adverse effects on the fetus. Breast ultrasound examination is the preferred imaging modality for pregnant and lactating women who have a palpable lump [6, 7], regardless of age.

STUDY AIM

The aim of this study was to review literature data on the PABC diagnosis.

METHODOLOGY OF STUDY SEARCH

The authors searched the electronic databases PubMed, eLibrary, and Google Scholar for scientific publications. The following keywords and combinations thereof were used in the search: “gestational breast cancer,” “breast cancer,” “pregnancy-associated breast cancer,” “breast cancer associated with pregnancy,” “pregnancy,” “breastfeeding,” “lactation,” “MRI,” “CT,” “mammography,” “ultrasound,” “biopsy,” and “diagnosis.” The search was conducted for studies published before July 2024. Each author independently reviewed the titles and abstracts of the articles found and, if relevant studies were found, received the full text of the article. Duplicates and incomplete versions of the articles were excluded. Full-text versions of the articles were reviewed for compliance with the following inclusion criteria: the study was published in English or Russian; the study was published in a peer-reviewed scientific journal; the study enrolled human subjects; the study described the diagnostic value of a specific diagnostic modality for PABC.

EPIDEMIOLOGY AND RISK FACTORS

PABC is a relatively rare diagnosis. Some studies have reported that PABC is diagnosed in approximately 15 to 35 per 100,000 births [8–10]. PABC corresponds to less than 3%–5% of breast cancers, but up to 20% of breast cancers are diagnosed in women under the age of 30 years [11]. The mean age of women diagnosed with PABC is 32–34 years, which is significantly lower than the mean age of women diagnosed with breast cancer [12]. A study conducted in Sweden between 1963 and 2002 reported similar incidence rates in 1,161 cases of PABC in women aged 15–44 years [8]. The overall incidence was 2.4 per 100,000 deliveries during pregnancy, 10.6 in the first year postpartum, and 15.0 up to two years postpartum [8]. The incidence rate decreases during pregnancy, with most cases being detected in the first six postpartum months [11, 12]. Study findings are inconsistent due to the lack of a clear definition of the postpartum period, which ranges from one to five years [2, 3].

Although PABC still needs to be better understood, some potential risk factors are identified, including age at first pregnancy, lack of breastfeeding, and adverse family history [13]. Late maternity predisposes to PABC more than early maternity [13, 14]. Women over the age of 35 years have a higher risk of breast cancer during their first pregnancy than nulliparous women [14]. Parous women have a transient increased risk of breast cancer of approximately 5% in the first few postpartum years compared with nulliparous women; however, this risk decreases over time [13, 14].

Women with germline mutations in breast cancer–susceptibility genes, *BRCA1* or *BRCA2*, have a high risk of PABC, possibly because breast tissue is exposed to elevated levels of estrogen and progesterone during pregnancy [2, 13, 15]. Some studies show that a family history of breast cancer is also associated with a higher risk of PABC, but others report that the majority of patients diagnosed with PABC do not have a family history of breast cancer [2, 10, 12, 13].

A meta-analysis of 50,302 women with invasive breast cancer and 96,973 controls demonstrated a 4.3% reduction in the lifetime risk of any type of breast cancer for every 12 months of breastfeeding [16]. Breastfeeding may be an effective way to reduce the incidence rate of breast cancer, although no studies found specific correlations between breastfeeding and PABC [13].

CLINICAL PRESENTATION

Diagnosing PABC in pregnant women may be challenging due to the physiological changes that occur during pregnancy and lactation and can mask the early signs and symptoms of breast cancer. In pregnant and postpartum women, breast cancer usually presents as in non-pregnant women, with a painless palpable mass, breast thickening, and/or bloody or purulent nipple discharge [11, 17]. Lymph node involvement

is often observed at the time of diagnosis [10, 11]. Breast cancer is often diagnosed at a late stage when the tumor is large and has metastases [4, 11, 17]. The delay in diagnosis may be attributed to the physiological changes that occur during pregnancy and lactation, as well as the delay in appropriate examination due to the risk of adverse effects on the fetus. Several studies reported lower rates of estrogen and progesterone receptor expression in PABC compared to non-pregnant patients [18, 19]. Suspicious lesions or clinical manifestations should be evaluated promptly and thoroughly due to the PABC's aggressive nature.

THE ROLE OF IMAGING MODALITIES IN THE DIAGNOSIS OF PREGNANCY-ASSOCIATED BREAST CANCER

When breast cancer is suspected, breast ultrasound examination is the first step in diagnostic imaging. Locoregional imaging, including mammography and ultrasound of the affected breast and ipsilateral axilla, is required to diagnose PABC. The goal is to determine the size, extent of the primary tumor, and regional lymph node involvement. This information is used for treatment planning [20]. Additional imaging may be chosen depending on the clinical stage of the cancer and the overall pregnancy status.

THE ROLE OF MAMMOGRAPHY

Mammography is used in addition to ultrasound to assess the condition of a pregnant or lactating woman when a palpable lump is detected. If ultrasound does not identify the tumor origin, mammography may be considered to evaluate features such as suspicious calcifications or distortion of the breast parenchymal architecture [6]. Mammography is recommended for pregnant or lactating women with a suspicious ultrasound finding and for patients with a verified diagnosis of PABC [6, 21]. The ability of ultrasound to detect tumor invasiveness in PABC is complemented by the ability of mammography to detect microcalcifications associated with cancer *in situ*, providing a global assessment of disease extent [2, 22, 23].

Mammography is effective in detecting malignant tumors in pregnant and lactating women [21, 24, 25]. Available data show that the mammography sensitivity for PABC is 63%–91%, and a mass with or without concomitant calcifications is the most common mammographic sign [21, 24–30]. Even if the mass cannot be detected by mammography due to tissue density in this population, it may still demonstrate abnormalities such as malignant calcifications, asymmetry, axillary lymphadenopathy, changes in skin thickness and trabecular structure, and architectural changes [21, 25, 30]. Suspicious mammographic findings and signs of malignancy in PABC are the same as in non-gestational breast cancer [2, 31].

THE ROLE OF ULTRASOUND EXAMINATION

Breast ultrasound is the preferred imaging modality in pregnant and lactating women with a palpable mass [5, 6], regardless of age. A breast lump is the most common clinical manifestation of PABC, with 100% ultrasound sensitivity in most cases. Ultrasound also effectively evaluates benign breast lesions in pregnant or lactating patients [6]. Ultrasound helps differentiate between normal glandular tissue and a neoplasm. If a neoplasm is present, its type (solid or cystic) can be determined to decide whether a biopsy is needed [6, 21].

Numerous published studies show that breast ultrasound has 100% sensitivity for diagnosis of PABC [21, 24–29]. Doppler ultrasound visualizes PABC as an irregular lesion with poorly defined margins and internal vascularization [21, 25, 26, 28]. In addition, complex cystic lesions on ultrasound indicate rapid growth followed by tumor necrosis [2, 28]. PABC may or may not produce shadowing artifacts [21, 25]. This is in contrast to the acoustic artifacts typical of invasive breast cancer. Some sonographic PABC features are similar to those of benign lesions, including parallel orientation, complex or anechoic appearance, and acoustic enhancement [25, 26, 28].

Breast ultrasound can detect multifocal, multicentric, and bilateral lesions [21], which can guide surgery planning. Yang et al. suggest that in patients with confirmed PABC, breast ultrasound findings should be considered to rule out carcinoma in the contralateral breast [21]. In the general population of women with newly diagnosed breast cancer, whole breast ultrasound increases the detection rate by 15.5% in the ipsilateral breast and by 3.9% in the contralateral breast [32].

In addition to demonstrating malignancy of the primary tumor in patients with PABC, ultrasound can evaluate regional lymph nodes, i.e., axillary, subclavian, internal, and supraclavicular ones [21]. Ultrasound of regional lymph nodes may reveal their clinically silent involvement [21]. Based on the American College of Radiology (ACR) criteria, axillary ultrasound is considered appropriate for the locoregional diagnosis of PABC [5].

Ultrasound is helpful not only in the initial clinical evaluation of patients with PABC but also in the follow-up of women who receive neoadjuvant therapy to improve the patient's condition prior to surgery [21].

THE ROLE OF MAGNETIC RESONANCE IMAGING

The role of magnetic resonance imaging (MRI) in the PABC diagnosis is to assess tumor extent and local staging, guide surgery planning, identify silent malignancy in the contralateral breast, and evaluate response to neoadjuvant chemotherapy [23, 33]. The US Food and Drug Administration

(FDA) classifies gadolinium contrast medium as a pregnancy category C agent [23]. Dynamic contrast-enhanced breast MRI (DCE-MRI) is not recommended for pregnant women due to safety concerns because gadolinium can cross the placenta [5, 33]. Contrast-enhanced breast MRI is an appropriate modality for assessing the health status of women after childbirth or pregnancy termination [5] and is safe for use in lactating patients [2].

Contrast enhancement of lactating breast parenchyma occurs rapidly after contrast administration, in contrast to non-lactating parenchyma, which tends to enhance gradually [22]. DCE-MRI has excellent sensitivity (97–100%) in diagnosing PABC in both lactating and non-lactating patients, despite moderate-to-severe underlying breast parenchymal enlargement [22, 27–30]. Espinosa et al. found that in five cases of breast cancer, the change in signal intensity was significantly greater than in lactating breast tissue 1 minute after the contrast administration [22]. Taron et al. reported that enhancement kinetics were effective in distinguishing tumor from normal tissue, with tumors demonstrating a contrast washout pattern that could be distinguished from plateau or sustained enhancement of lactating breast tissue [29]. Neoplasms in this study were also visualized on non-contrast-enhanced T2-weighted images as low signal intensity lesions in diffuse T2-hyperintense parenchyma of the lactating breast [22]. This was also observed in five of nine cancer types in the study by Oh et al. [28]. Therefore, breast changes associated with pregnancy and lactation do not significantly affect the diagnostic value of MRI for PABC.

PABC, which usually presents as invasive ductal carcinoma, is most commonly detected as an enlarging lesion with washout kinetics on DCE-MRI [22, 26, 28, 29]. MRI most commonly visualizes PABC as a lesion with irregular shape and margins [27, 28] and may show homogeneous or heterogeneous enhancement as well as rim-type enhancement [22, 26, 28]. Some areas appear to be sites of contrast enhancement rather than neoplasms [26, 27, 30]. DCE-MRI may also show signs that are unrelated to the primary lesion, such as skin thickening, edema, and regional lymphadenopathy [26].

Myers et al. performed MRI in 53 women and found a confirmed multicentric lesion in 6% of subjects, a lesion in the contralateral breast in 4%, and previously undiagnosed metastases in 4% [27]. Based on these data, medical or surgical treatment strategies were changed in 28% of patients, while biopsy confirmed the MRI findings in 33% of cases [27]. In a study published by Oh et al., MRI detected PABC in three (33%) of nine lactating women, and this diagnostic test was more accurate than mammography or ultrasound in determining the tumor extent [28]. Taron et al. found tumor lesions on MRI in six (31%) of 19 patients, of whom 4 underwent biopsy and 2 were confirmed to have malignant tumors [29]. Task et al. reviewed the MRI findings of 47 women with PABC; 18 women were found to have previously undiagnosed cancer in the contralateral breast, and one patient was found to have 5 lesions that were not detected by ultrasound [30].

MRI may show a larger than expected tumor size or extent than mammography or ultrasound. However, in rare cases, MRI may overestimate the disease severity [26, 27]. Taron et al. evaluated the correlation between imaging and histopathology findings in five patients. The authors found that ultrasound was the most accurate modality in determining tumor size compared to mammography and MRI, and MRI tended to overestimate tumor size [29].

In addition to diagnostic use, MRI can be used to assess the response to neoadjuvant chemotherapy (NCT). Oh et al. evaluated MRI findings before and after NCT in six patients. In all patients with confirmed residual disease at surgery, MRI showed partial response or stable disease. Notably, the rate of contrast enhancement after NCT decreased from significant to moderate or minimal in this study [28].

THE ROLE OF OTHER IMAGING MODALITIES

As mentioned above, mammography and ultrasound are used for locoregional staging of PABC because these modalities can be potentially used to evaluate both the primary tumor and regional lymph nodes. Digital breast tomosynthesis (DBT) is shown to improve lesion detection in dense tissues, thereby improving the diagnostic value of mammography, so it may be helpful in the PABC diagnosis [6, 34, 35], but there are no studies evaluating DBT in PABC. The value and reasons for DBT are the same as for mammography in pregnant and lactating women, according to ACR criteria [6, 36].

Additional imaging modalities that may be used for staging PABC in pregnant women depend on the clinical stage and include chest radiography with an abdominal shield, liver ultrasound, and possibly non-contrast-enhanced MRI of the spine [37–39]. Computed tomography and bone scintigraphy are generally not recommended for pregnant patients due to the high risk of fetal radiation exposure [37]. Positron emission tomography (PET) is also not indicated [37, 40]. If the risk of distant metastases is considered low, a possible strategy is to wait for the postpartum period to perform the necessary evaluation [40]. In lactating patients, staging imaging may be performed according to the National Comprehensive Cancer Network (NCCN) guidelines [38].

DIAGNOSTIC CHALLENGES

Breast tissue is difficult to evaluate clinically and radiologically in pregnant and postpartum women [6, 23], which contributes to late diagnosis of PABC [24, 25]. A palpable mass is more difficult to detect during and after pregnancy due to tissue hypertrophy and other changes in the breast, including increased elasticity and nodularity, so it may sometimes be mistaken for a benign lesion [24, 25].

It is important for patients, clinical teams, and radiologists to understand the risks and safety issues associated with imaging in general and breast imaging in pregnancy in particular. The ALARA (As Low As Reasonably Achievable) principle can be applied when considering appropriate imaging modalities, dose reduction strategies, and protection of pregnant patients when ionizing radiation needs to be used [40].

Based on ACR criteria and NCCN guidelines, mammography is safe in pregnant or lactating women [6, 38]. With abdominal shielding, fetal radiation exposure during conventional mammography is negligible [6], by an order of magnitude lower than fetal exposure to background radiation during pregnancy [26]. In pregnant patients, ultrasound and mammography are the key modalities for locating and assessing the extent of PABC, as contrast-enhanced breast MRI is contraindicated.

There are special requirements for breast imaging in lactating women. If mammography is performed in a lactating woman, it is currently recommended to perform it immediately after breastfeeding or expressing breast milk to reduce breast density [5, 6, 23]. This is also recommended for lactating patients undergoing DCE-MRI [23]. Lactating women may ask if they have to stop breastfeeding after the administration of gadolinium for DCE-MRI. According to the ACR manual on contrast media and the American College of Obstetrics and Gynecology guideline, there is no need to discontinue breastfeeding after gadolinium administration because the excretion rate in breast milk is less than 0.04% of the administered dose, and the expected dose that would be received by an infant through intestinal absorption is less than 0.0004% [41, 42]. If a patient is still concerned, milk can be expressed and breastfeeding can be avoided for 12–24 hours after the scan; in this case, milk expression the day before the scan should be considered to ensure that milk is available for the baby after the scan [41].

The risk of ionizing radiation in mammography is negligible, and the advantage of mammography is that it visualizes features such as calcifications and architectural distortions that are not visible with ultrasound. The diagnostic challenge in mammographically detecting PABC is that most patients have heterogeneous or extremely dense tissue, which is a known limitation of mammography in general as it may mask malignancy. In women, mammograms show increased breast density due to pregnancy-related changes, accompanied by an increase in glandular tissue and water content [24]. These changes may reduce the sensitivity of mammography and limit its ability to detect additional subclinical non-calcified lesions in the ipsilateral and contralateral breasts [24], which is critical for accurate staging of established PABC.

The advantages of using ultrasound in pregnant and lactating women include the absence of ionizing radiation and 100% sensitivity to PABC. The diagnostic challenge in ultrasound detection of PABC is not to confuse it with a benign neoplasm. PABCs have typical benign sonographic features such as well-defined margins, parallel orientation to the skin, and acoustic enhancement, mimicking benign lesions such as galactocele or cysts [6, 25, 26]. A complex cystic lesion visualized by ultrasound may also present a diagnostic challenge, as the differential diagnosis may include abscess and galactocele in addition to PABC, requiring aspiration and possibly biopsy for differentiation [2]. The advantage of MRI in the PABC diagnosis is its ability to simultaneously evaluate the affected breast, contralateral breast, and regional lymph nodes. Identifying PABC within a moderately or significantly elevated range is the diagnostic challenge. In addition to standard diagnostic modalities, subtraction imaging can be used to examine breast tissue by DCE-MRI [29]. When using DCE-MRI, subtraction images are typically created in post-processing by subtracting each post-contrast dynamic series (typically 4 series) from the pre-contrast data. Subtraction images are created by subtracting the last dynamic series of post-contrast images from the second dynamic series of post-contrast images, rather than from the pre-contrast series [29]. Taron et al. reported that these images better demonstrate a malignant lesion with poorly defined margins [29], which helps a radiologist to assess the extent of the disease. This modality should be used with caution because it may not always visualize a malignant lesion with a constant kinetics of increase or plateau, similar to lactating breast tissue. This was observed in one patient (5%) in the study by Taron et al. and in over half the patients in the study by Taskin et al. [29, 30].

BIOPSY

Indications for breast biopsy do not consider pregnancy and include solid or complex cystic lesions, suspicious microcalcifications on mammography, and refractory inflammatory changes [21]. If inflammatory changes are observed on imaging without suspicious lesions and persist after antibiotic therapy, a skin biopsy is indicated to evaluate for inflammatory carcinoma [40]. Although mammary fistula is a possible but rare biopsy complication in this patient population [43], biopsy is safe in pregnant and lactating women and should not be delayed or avoided in the presence of an indeterminate or suspicious lesion [3, 26]. Pregnant and lactating patients should also be cautioned about the potential for increased bleeding or infectious complications with needle biopsy.

When a suspicious neoplasm is detected in a pregnant or lactating patient, ultrasound-guided biopsy is preferred if the neoplasm can be visualized with this modality [23]. For suspicious lesions visualized only by mammography, stereotactic biopsy or mammographic needle localization can be safely performed in early pregnant or lactating patients [23]. For suspicious breast lesions visualized by DCE-MRI in a lactating woman, MRI-guided breast biopsy may be performed [23].

Lidocaine for local anesthesia during percutaneous biopsy is safe in pregnant women [23]. Lactating women may be cautioned that their milk may contain blood or lidocaine after a biopsy. This poses no risk to an infant, but patients should be informed as they may choose to express milk or not breastfeed for up to 24 hours [23, 34]. Before a breast biopsy, a lactating woman can be advised to express milk or breastfeed to open the ducts. After the procedure, a patient should continue to express milk or breastfeed to guide milk from the ducts created by the biopsy to the nipple [33, 34]. A healthcare provider may consider reducing the size of the needle, shifting the needle insertion site away from the nipple, limiting the distance between the insertion site and the target lesion, and limiting needle movement during the procedure [33, 34]. However, these changes should not affect the accuracy and adequacy of biopsy material collection.

Breast cancer can be diagnosed with a needle aspiration, fine-needle aspiration, or surgical biopsy. Needle aspiration is the most common choice because it is the standard diagnostic procedure for suspected breast neoplasms [44]. Ahn et al. [25] found that fine-needle aspiration was the most common diagnostic modality for malignant tumors. Surgical biopsy was the less common modality, which was used to diagnose all six cancer cases in the study by Son et al. [45]. In some patients, the initial diagnosis is made by fine-needle aspiration, core biopsy, or axillary lymph node biopsy on the same side as the breast tumor.

FOLLOW-UP EXAMINATION

Breast ultrasound is used for both the initial evaluation and the subsequent monitoring of response to NCT [21]. Since the sonographic features of a breast mass are common in normal patients, ultrasound can be used to determine if a malignant lesion changes during treatment and to classify it using standardized criteria. In women with known metastatic disease, ultrasound may also be used for regional lymph node monitoring to assess treatment response.

CONCLUSION AND POSSIBLE DIRECTIONS FOR FUTURE RESEARCH

PABC presents unique diagnostic and treatment challenges that require continued research into new technologies. Gegios et al. describe several advances in imaging that can be used in routine breast cancer screening and treatment, including ultrasound elastography, contrast-enhanced ultrasound, and hybrid PET/MRI imaging. The use of non-contrast-enhanced diffusion MRI in pregnant patients is another area of interest in PABC imaging research. Diffusion modalities, including diffusion-weighted imaging (DWI) and diffusion tensor imaging (DTI), are based on the movement of water in tissue, which is abnormal in many malignant tumors, including breast cancer. DWI was evaluated as part of non-contrast-enhanced whole-body MRI for systemic staging of breast cancer in a study of 14 pregnant women. Breast DTI was shown to be feasible in pregnant women with PABC, but its low spatial resolution and other technical characteristics, including artifacts, were limiting factors. DTI was also evaluated in lactating women as an adjunct to standard DCE-MRI to improve visualization and quantification of PABC. Therefore, despite progress, further research and development are needed to improve the diagnosis and treatment of breast cancer, especially in the context of the unique challenges associated with pregnancy and breastfeeding.

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REFERENCES

1. Dobrokhotova YuE, Borovkova EI, Arutyunyan AM. Pregnancy-associated breast cancer. *Russian Bulletin of Obstetrician-Gynecologist*. 2019;19(4):77–81. EDN: AJBMTN doi: 10.17116/rosakush20191904177
2. Hou N, Ogundiran T, Ojengbede O, et al. Risk factors for pregnancy-associated breast cancer: a report from the Nigerian breast cancer study. *Ann Epidemiol*. 2013;23(9):551–557. doi: 10.1016/j.annepidem. 2013.06.008
3. Ayyappan AP, Kulkarni S, Crystal P. Pregnancy-associated breast cancer: spectrum of imaging appearances. *Br J Radiol*. 2010;83(990):529–534. doi: 10.1259/bjr/17982822
4. Langer A, Mohallen M, Stevens D, et al. A single-institution study of 117 pregnancy-associated breast cancers (PABC): presentation, imaging, clinicopathological data and outcome. *Diagn Interv Imaging*. 2014;95(4):435–441. doi: 10.1016/j.diii.2013.12.021
5. Novikova VA, Penzhoyan GA. Breast cancer and pregnancy: risks and opportunities for prevention. *Gynecology*. 2015;17(3):68–75. EDN: ULEAJZ
6. Expert Panel on Breast Imaging, di Florio-Alexander RM, Slanetz PJ, et al. ACR Appropriateness Criteria® Breast Imaging of Pregnant and Lactating Women. *J Am Coll Radiol*. 2018;15(11S):S263–S275. doi: 10.1016/j.jacr.2018.09.013
7. Busko EA, Semiglazov VV, Mishchenko AV, et al. The effectiveness of multiparametric ultrasound and compressive elastography in the early diagnosis of breast cancer // Diagnostic radiology and radiotherapy. 2019;(4):6–13. EDN: AQBKAB doi: 10.22328/2079-5343-2019-10-4-6-13
8. Boudy AS, Zaccarini F, Selleret L, et al. Oncological management of pregnancy-associated cancers: analysis from the French CALG (Cancer Associé à La Grossesse) network. *Acta Oncol*. 2020;59(9):1043–1050. doi: 10.1080/0284186X.2020.1767300
9. Johansson ALV, Stensheim H. Epidemiology of pregnancy-associated breast cancer. *Adv Exp Med Biol*. 2020;1252:75–79. doi: 10.1007/978-3-030-41596-9_9
10. Matos E, Ovcaricek T. Breast cancer during pregnancy: retrospective institutional case series. *Radiol Oncol*. 2021; 55(3):362–368. doi: 10.2478/raon-2021-0022
11. Galati F, Magri V, Arias-Cadena PA, et al. Pregnancy-associated breast cancer: a diagnostic and therapeutic challenge. *Diagnostics (Basel)*. 2023;13(4):604. doi: 10.3390/diagnostics13040604
12. Soto-Trujillo D, Santos Aragón LN, Kimura Y. Pregnancy-associated breast cancer: what radiologists must know. *Cureus*. 2020;12(9):e10343. doi: 10.7759/cureus.10343
13. Gooch JC, Chun J, Kaplowitz E, et al. Pregnancy-associated breast cancer in a contemporary cohort of newly diagnosed women. *Breast J*. 2020;26(4):668–671. doi: 10.1111/tbj.13510
14. Suelmann BBM, Bakhuis CFJ, van Dooijeweert C, et al. Prognosis of pregnancy-associated breast cancer: inferior outcome in patients diagnosed during second and third gestational trimesters and lactation. *Breast Cancer Res Treat*. 2022;192(1):175–189. doi: 10.1007/s10549-021-06471-6
15. Johannsson O, Loman N, Borg A, Olsson H. Pregnancy-associated breast cancer in BRCA1 and BRCA2 germline mutation carriers. *Lancet*. 1998;352(9137):1359–1360. doi: 10.1016/S0140-6736(05)60750-7
16. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50302 women with breast cancer and 96973 women without the disease. *Lancet*. 2002;360(9328):187–195. doi: 10.1016/S0140-6736(02)09454-0
17. Chernyshova AL, Chernyakov AA, Garbukov EYu, et al. Combination of pregnancy and breast cancer. *Tumors of Female Reproductive System*. 2023;19(3):85–91 EDN: PHPCSE doi: 10.17650/1994-4098-2023-19-3-85-91
18. Reyes E, Xercavins N, Saura C, et al. Breast cancer during pregnancy: matched study of diagnostic approach, tumor characteristics, and prognostic factors. *Tumori*. 2020;106(5):378–387. doi: 10.1177/0300891620925158
19. Reed W, Hannisdal E, Skovlund E, et al. Pregnancy and breast cancer: a population-based study. *Virchows Arch*. 2003;443(1):44–50. doi: 10.1007/s00428-003-0817-z
20. Pavlovskaya EA, Bagnenko SS, Burovik IA, et al. Medical visualization in pregnancy: indications, limitations and prospects. *Medical Visualization*. 2024;28(2):95–107. EDN: CCTLVV doi: 10.24835/1607-0763-1408
21. Makanjuola DI, Alkushi A, Al Anazi K. Defining radiologic complete response using a correlation of presurgical ultrasound and mammographic localization findings with pathological complete response following neoadjuvant chemotherapy in breast cancer. *Eur J Radiol*. 2020;130:109146. doi: 10.1016/j.ejrad.2020.109146
22. Espinosa LA, Daniel BL, Vidarsson L, et al. The lactating breast: contrast-enhanced MR imaging of normal tissue and cancer. Radiology. 2005;237(2):429–436. doi: 10.1148/radiol.2372040837
23. Sun J, Lee MC. Clinical presentation, diagnosis and prognosis of pregnancy-associated breast cancer. *Adv Exp Med Biol*. 2020;1252:87–93. doi: 10.1007/978-3-030-41596-9_11
24. Zafrakas M, Papasozomenou P, Gerede A, et al. Screening and Diagnostic Mammography During Pregnancy and Lactation: A Systematic Review of the Literature. *Cureus*. 2024;16(8):e66465. doi: 10.7759/cureus.66465.
25. Ahn BY, Kim HH, Moon WK, et al. Pregnancy- and lactation-associated breast cancer: mammographic and sonographic findings. *J Ultrasound Med*. 2003;22(5):491–499. doi: 10.7863/jum.2003.22.5.491
26. Fazeli S, Sakala M, Rakow-Penner R, Ojeda-Fournier H. Cancer in pregnancy: breast cancer. *Abdom Radiol (NY)*. 2023;48(5):1645–1662. doi: 10.1007/s00261-023-03824-1
27. Myers KS, Green LA, Lebron L, Morris EA. Imaging appearance and clinical impact of preoperative breast MRI in pregnancy-associated breast cancer. *AJR Am J Roentgenol*. 2017;209(3):W177–W183. doi: 10.2214/AJR.16.17124
28. Oh SW, Lim HS, Moon SM, et al. MR imaging characteristics of breast cancer diagnosed during lactation. *Br J Radiol*. 2017;90(1078):20170203. doi: 10.1259/bjr.20170203
29. Taron J, Fleischer S, Preibsch H, et al. Background parenchymal enhancement in pregnancy-associated breast cancer: a hindrance to diagnosis? *Eur Radiol*. 2019;29(3):1187–1193. doi: 10.1007/s00330-018-5721-7

30. Taşkın F, Polat Y, Erdoğdu İH, Soyder A. Pregnancy-associated breast cancer: A review of 47 women. *Clin Imaging*. 2019;58:182–186. doi: 10.1016/j.clinimag.2019.07.012
31. Peterson MS, Gegios AR, Elezaby MA, et al. Breast Imaging and Intervention during Pregnancy and Lactation. *Radiographics*. 2023;43(10):e230014. doi: 10.1148/rg.230014
32. Candelaria RP, Huang ML, Adrada BE, et al. Incremental cancer detection of locoregional restaging with diagnostic mammography combined with whole-breast and regional nodal ultrasound in women with newly diagnosed breast cancer. *Acad Radiol*. 2017;24(2):191–199. doi: 10.1016/j.acra.2016.11.015
33. Xu K, Chung M, Hayward JH, et al. MRI of the lactating breast. *Radiographics*. 2024;44(2):e230129. doi: 10.1148/rg.230129
34. Langer AK. Breast imaging in pregnancy and lactation. *Adv Exp Med Biol*. 2020;1252:17–25. doi: 10.1007/978-3-030-41596-9_3
35. Pyle C, Hill M, Sharafi S, et al. Pregnancy-associated breast cancer: why breast imaging during pregnancy and lactation matters. *J Breast Imaging*. 2023;5(6):732–743. doi: 10.1093/jbi/wbad074
36. McCormick A, Peterson E. Cancer in pregnancy. *Obstet Gynecol Clin North Am*. 2018;45(2):187–200. doi: 10.1016/j.ogc.2018.01.009
37. Ter-Ovanesov MD, Shal EP, Kukosh MYu, Oganisyan AN. Breast cancer during pregnancy: diagnosis, treatment, prognosis. *Medical Alphabet*. 2018;2(29):10–16. EDN: YXDKIH
38. Gradishar WJ, Moran MS, Abraham J, et al. Breast Cancer, Version 3.2024, NCCN Clinical Practice Guidelines in Oncology. *J Natl Compr Canc Netw*. 2024;22(5):331–357. doi: 10.6004/jnccn.2024.0035
39. Paris I, Di Giorgio D, Carbognin L, et al. Pregnancy-associated breast cancer: a multidisciplinary approach. *Clin Breast Cancer*. 2021;21(1):e120–e127. doi: 10.1016/j.clbc.2020.07.007
40. Amant F, Deckers S, Van Calsteren K, et al. Breast cancer in pregnancy: recommendations of an international consensus meeting. *Eur J Cancer*. 2010;46(18):3158–3168. doi: 10.1016/j.ejca.2010.09.010
41. ACR Manual on Contrast Media: ACR Committee on Drugs and Contrast Media, 2024.
42. Little JT, Bookwalter CA. Magnetic resonance safety: pregnancy and lactation. *Magn Reson Imaging Clin N Am*. 2020;28(4):509–516. doi: 10.1016/j.mric.2020.06.002
43. Alipour S. Local complications of breast surgery during pregnancy and lactation. *Adv Exp Med Biol*. 2020;1252:101–105. doi: 10.1007/978-3-030-41596-9_13
44. Schad A, Slostad J, Rao R. Gestational breast cancer: current challenges in staging and treatment of breast cancer. *BMJ Case Rep*. 2020;13(11):e235308. doi: 10.1136/bcr-2020-235308
45. Son EJ, Oh KK, Kim EK. Pregnancy-associated breast disease: radiologic features and diagnostic dilemmas. *Yonsei Med J*. 2006;47(1):34–42. doi: 10.3349/ymj.2006.47.1.34

СПИСОК ЛИТЕРАТУРЫ

1. Доброхотова Ю.Э., Боровкова Е.И., Арутюнян А.М. Ассоциированный с беременностью рак молочной железы // Российский вестник акушера-гинеколога. 2019. Т. 19, № 4. С. 77–81. EDN: AJBMTN doi: 10.17116/rosakush20191904177
2. Hou N., Ogundiran T., Ojengbede O., et al. Risk factors for pregnancy-associated breast cancer: a report from the Nigerian breast cancer study // Ann Epidemiol. 2013. Vol. 23, N 9. P. 551–557. doi: 10.1016/j.annepidem. 2013.06.008
3. Ayyappan A.P., Kulkarni S., Crystal P. Pregnancy-associated breast cancer: spectrum of imaging appearances // Br J Radiol. 2010. Vol. 83, N 990. P. 529–534. doi: 10.1259/bjr/17982822
4. Langer A., Mohallen M., Stevens D., et al. A single-institution study of 117 pregnancy-associated breast cancers (PABC): presentation, imaging, clinicopathological data and outcome // Diagn Interv Imaging. 2014. Vol. 95, N 4. P. 435–441. doi: 10.1016/j.diii.2013.12.021
5. Новикова В.А., Пенжоян Г.А. Рак молочной железы и беременность: риски и возможности профилактики // Гинекология. 2015. Т. 17, № 3. С. 68–75. EDN: ULEAJZ
6. Expert Panel on Breast Imaging, di Florio-Alexander R.M., Slanetz P.J., et al. ACR Appropriateness Criteria® Breast Imaging of Pregnant and Lactating Women // J Am Coll Radiol. 2018. Vol. 15, N 11S. P. S263–S275. doi: 10.1016/j.jacr.2018.09.013
7. Бусько Е.А., Семиглазов В.В., Мищенко А.В., и др. Эффективность мультипараметрического ультразвукового исследования с применением компрессионной эластографии в ранней диагностике образований молочной железы // Лучевая диагностика и терапия. 2019. № 4. С. 6–13. EDN: AQBKAB doi: 10.22328/2079-5343-2019-10-4-6-13
8. Boudy A.S., Zaccarini F., Selleret L., et al. Oncological management of pregnancy-associated cancers: analysis from the French CALG (Cancer Associé à La Grossesse) network // Acta Oncol. 2020. Vol. 59, N 9. P. 1043–1050. doi: 10.1080/0284186X.2020.1767300
9. Johansson A.L.V., Stensheim H. Epidemiology of pregnancy-associated breast cancer // Adv Exp Med Biol. 2020. Vol. 1252. P. 75–79. doi: 10.1007/978-3-030-41596-9_9
10. Matos E., Ovcaricek T. Breast cancer during pregnancy: retrospective institutional case series // Radiol Oncol. 2021. Vol. 55, N 3. P. 362–368. doi: 10.2478/raon-2021-0022
11. Galati F., Magri V., Arias-Cadena P.A., et al. Pregnancy-associated breast cancer: a diagnostic and therapeutic challenge // Diagnostics (Basel). 2023. Vol. 13, N 4. P. 604. doi: 10.3390/diagnostics13040604
12. Soto-Trujillo D., Santos Aragón L.N., Kimura Y. Pregnancy-associated breast cancer: what radiologists must know // Cureus. 2020. Vol. 12, N 9. P. e10343. doi: 10.7759/cureus.10343
13. Gooch J.C., Chun J., Kaplowitz E., et al. Pregnancy-associated breast cancer in a contemporary cohort of newly diagnosed women // Breast J. 2020. Vol. 26, N 4. P. 668–671. doi: 10.1111/tbj.13510
14. Suelmann B.B.M., Bakhuis C.F.J., van Dooijeweert C., et al. Prognosis of pregnancy-associated breast cancer: inferior outcome in patients diagnosed during second and third gestational trimesters and lactation // Breast Cancer Res Treat. 2022. Vol. 192, N 1. P. 175–189. doi: 10.1007/s10549-021-06471-6
15. Johannsson O., Loman N., Borg A., Olsson H. Pregnancy-associated breast cancer in BRCA1 and BRCA2 germline mutation carriers // Lancet. 1998. Vol. 352, N 9137. P. 1359–1360. doi: 10.1016/S0140-6736(05)60750-7
16. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50302 women with breast cancer and 96973 women without the disease // Lancet. 2002. Vol. 360, N 9328. P. 187–195. doi: 10.1016/S0140-6736(02)09454-0
17. Чернышова А.Л., Черняков А.А., Гарбуков Е.Ю., и др. Сочетание беременности и рака молочной железы // Опухоли женской репродуктивной системы. 2023. Т. 19, № 3. С. 85–91. EDN: PHPCSE doi: 10.17650/1994-4098-2023-19-3-85-91
18. Reyes E., Xercavins N., Saura C., et al. Breast cancer during pregnancy: matched study of diagnostic approach, tumor characteristics, and prognostic factors // Tumori. 2020. Vol. 106, N 5. P. 378–387. doi: 10.1177/0300891620925158
19. Reed W., Hannisdal E., Skovlund E., et al. Pregnancy and breast cancer: a population-based study // Virchows Arch. 2003. Vol. 443, N 1. P. 44–50. doi: 10.1007/s00428-003-0817-z
20. Павловская Е.А., Багненко С.С., Буровик И.А., и др. Показания, ограничения и возможности применения методов лучевой диагностики у беременных женщин // Медицинская визуализация. 2024. Т. 28, № 2. С. 95–107. EDN: CCTLVV doi: 10.24835/1607-0763-1408
21. Makanjuola D.I., Alkushi A., Al Anazi K. Defining radiologic complete response using a correlation of presurgical ultrasound and mammographic localization findings with pathological complete response following neoadjuvant chemotherapy in breast cancer // Eur J Radiol. 2020. Vol. 130. P. 109146. doi: 10.1016/j.ejrad.2020.109146
22. Espinosa L.A., Daniel B.L., Vidarsson L., et al. The lactating breast: contrast-enhanced MR imaging of normal tissue and cancer // Radiology. 2005. Vol. 237, N 2. P. 429–436. doi: 10.1148/radiol.2372040837
23. Sun J., Lee M.C. Clinical presentation, diagnosis and prognosis of pregnancy-associated breast cancer // Adv Exp Med Biol. 2020. Vol. 1252. P. 87–93. doi: 10.1007/978-3-030-41596-9_11
24. Zafrakas M., Papasozomenou P., Gerede A., et al. Screening and Diagnostic Mammography During Pregnancy and Lactation: A Systematic Review of the Literature. // Cureus. 2024. Vol. 16. N 8. P. e66465. doi: 10.7759/cureus.66465.
25. Ahn B.Y., Kim H.H., Moon W.K., et al. Pregnancy- and lactation-associated breast cancer: mammographic and sonographic findings // J Ultrasound Med. 2003. Vol. 22, N 5. P. 491–499. doi: 10.7863/jum.2003.22.5.491
26. Fazeli S., Sakala M., Rakow-Penner R., Ojeda-Fournier H. Cancer in pregnancy: breast cancer // Abdom Radiol (NY). 2023. Vol. 48, N 5. P. 1645–1662. doi: 10.1007/s00261-023-03824-1
27. Myers K.S., Green L.A., Lebron L., Morris E.A. Imaging appearance and clinical impact of preoperative breast MRI in pregnancy-

associated breast cancer // AJR Am J Roentgenol. 2017. Vol. 209, N 3. P. W177–W183. doi: 10.2214/AJR.16.17124
28. Oh S.W., Lim H.S., Moon S.M., et al. MR imaging characteristics of breast cancer diagnosed during lactation // Br J Radiol. 2017. Vol. 90, N 1078. P. 20170203. doi: 10.1259/bjr.20170203
29. Taron J., Fleischer S., Preibsch H., et al. Background parenchymal enhancement in pregnancy-associated breast cancer: a hindrance to diagnosis? // Eur Radiol. 2019. Vol. 29, N 3. P. 1187–1193. doi: 10.1007/s00330-018-5721-7
30. Taşkın F., Polat Y., Erdoğdu İ.H., Soyder A. Pregnancy-associated breast cancer: A review of 47 women // Clin Imaging. 2019. Vol. 58. P. 182–186. doi: 10.1016/j.clinimag.2019.07.012
31. Peterson M.S., Gegios A.R., Elezaby M.A., et al. Breast imaging and intervention during pregnancy and lactation // Radiographics. 2023. Vol. 43, N 10. P. e230014. doi: 10.1148/rg.230014
32. Candelaria R.P., Huang M.L., Adrada B.E., et al. Incremental cancer detection of locoregional restaging with diagnostic mammography combined with whole-breast and regional nodal ultrasound in women with newly diagnosed breast cancer // Acad Radiol. 2017. Vol. 24, N 2. P. 191–199. doi: 10.1016/j.acra.2016.11.015
33. Xu K., Chung M., Hayward J.H., et al. MRI of the lactating breast // Radiographics. 2024;44(2):e230129. doi: 10.1148/rg.230129
34. Langer A.K. Breast imaging in pregnancy and lactation // Adv Exp Med Biol. 2020. Vol. 1252. P. 17–25. doi: 10.1007/978-3-030-41596-9_3
35. Pyle C., Hill M., Sharafi S., et al. Pregnancy-associated breast cancer: why breast imaging during pregnancy and lactation matters // J Breast Imaging. 2023. Vol. 5, N 6. P. 732–743. doi: 10.1093/jbi/wbad074
36. McCormick A., Peterson E. Cancer in pregnancy // Obstet Gynecol Clin North Am. 2018. Vol. 45, N 2. P. 187–200. doi: 10.1016/j.ogc.2018.01.009
37. Тер-Ованесов М.Д., Шаль Е.П., Кукош М.Ю., Оганисян А.Н. Рак молочной железы, ассоциированный с беременностью: диагностика, лечение, прогноз // Медицинский алфавит. 2018. Т. 2, № 29. С. 10–16. EDN: YXDKIH
38. Gradishar W.J., Moran M.S., Abraham J., et al. Breast Cancer, Version 3.2024, NCCN Clinical Practice Guidelines in Oncology // J Natl Compr Canc Netw. 2024. Vol. 22, N 5. P. 331–357. doi: 10.6004/jnccn.2024.0035
39. Paris I., Di Giorgio D., Carbognin L., et al. Pregnancy-associated breast cancer: a multidisciplinary approach // Clin Breast Cancer. 2021. Vol. 21, N 1. P. e120–e127. doi: 10.1016/j.clbc.2020.07.007
40. Amant F., Deckers S., Van Calsteren K., et al. Breast cancer in pregnancy: recommendations of an international consensus meeting // Eur J Cancer. 2010. Vol. 46, N 18. P. 3158–3168. doi: 10.1016/j.ejca.2010.09.010
41. ACR Manual on Contrast Media: ACR Committee on Drugs and Contrast Media, 2024.
42. Little J.T., Bookwalter C.A. Magnetic resonance safety: pregnancy and lactation // Magn Reson Imaging Clin N Am. 2020. Vol. 28, N 4. P. 509–516. doi: 10.1016/j.mric.2020.06.002
43. Alipour S. Local complications of breast surgery during pregnancy and lactation // Adv Exp Med Biol. 2020. Vol. 1252. P. 101–105. doi: 10.1007/978-3-030-41596-9_13
44. Schad A., Slostad J., Rao R. Gestational breast cancer: current challenges in staging and treatment of breast cancer // BMJ Case Rep. 2020. Vol. 13, N 11. P. e235308. doi: 10.1136/bcr-2020-235308
45. Son E.J., Oh K.K., Kim E.K. Pregnancy-associated breast disease: radiologic features and diagnostic dilemmas // Yonsei Med J. 2006. Vol. 47, N 1. P. 34–42. doi: 10.3349/ymj.2006.47.1.34

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