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Advances Of AI In Cancer Breast Review

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Abstract – The breast imaging landscape has changed dramatically since the introduction of mammography in the 1960s, led by ultrasound and biopsies in the 1990s. The advent of magnetic resonance imaging (MRI) in the 2000s added valuable features to advanced imaging. Multimodal and multiparametric imaging have established a central role in breast radiology and the management of breast problems. The transition from conventional radiology to digital radiology occurred in the late 20th and early 21st centuries, enabling advanced techniques such as digital breast tomosynthesis, contrast-enhanced mammography, and the introduction of artificial intelligence (AI). AI integration within breast radiology can improve diagnostic and surgical procedures. It includes computer-aided design (CAD) algorithms, surgical procedure support algorithms, and data processing algorithms. The CAD system, developed since the 1980s, improves cancer detection rates by fighting benign and malignant tumors. The role of radiologists will become that of clinical experts working with AI for effective patient care and the use of advanced multiparametric indicators in radiology. Wearable technologies, non-contrast MRI, and new modalities such as photoacoustic imaging can improve diagnostic imaging. Image-guided treatments, including cryotherapy and theranostics, are gaining ground. Theranostics, which combines treatment and diagnosis, offers the potential for precision medicine. AI, new treatments , and Advanced imaging will revolutionize breast radiology, providing more refined diagnosis and personalized treatment. Personalized monitoring, AI services and image-guided therapy will shape the future of breast radiology.

Keywords – Cognitive Function, Breast Imaging, Diagnostic Procedures, Diagnosis, Treatment, Radiology, Intervention.

Key points

- **The growing integration of artificial intelligence (AI): AI is becoming an important part of radiology, enabling operational processes, intelligent data processing, and facilitating diagnosis and analysis. , making the decision process better.**
- **Personalized screening and diagnosis: Advances in mammography, automated breast ultrasound, magnetic resonance imaging (MRI), and contrast-enhanced mammography offer personalized screening options and AI-powered enhancements for precision.**
- **New imaging and treatment methods: multiparametric MRI, virtual biopsy and photoacoustic imaging provide advanced diagnostic information. Image-guided therapy and theranostics promise targeted therapy, changing the future of breast radiology.**

I. Introduction

AI systems can accurately analyze mammograms and other breast exams. They can detect abnormalities that may be difficult for human radiologists to detect, such as microcalcifications or early-stage tumors. False-negative results, which occur when cancer is present but undetected, can be reduced with AI. AI can improve the chances of detecting tumors at an early stage by carefully examining x-rays for possible signs of cancer [1]. AI is used through computer-aided detection (CAD) systems to measure disease

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spots directly on medical images such as mammograms. Radiologists can carefully examine the marked areas, reducing the chance of missing abnormalities. Rapid analysis of large medical images using AI enables rapid interpretation and analysis. This is especially useful in busy healthcare settings where there may be a time limit for each case [2]. AI systems operate continuously and are not affected by variables such as human fatigue, distractions, or changes in human interpretation. This flexibility ensures that no pathology can be overlooked. Radiology workflows can quickly integrate artificial intelligence (AI) technologies. AI models benefit radiologists by providing them with more information when analyzing radiographic images, allowing them to make more accurate diagnoses [3]. By learning from large collection of radiological image datasets, AI models can constantly improve their performance. As they examine more cases, they become better at detecting early signs of breast cancer. AI can help categorize patients based on risk profiles, ensuring that those most at risk benefit from more frequent screening and monitoring. AI-assisted early detection can lead to earlier intervention and less effective treatment, potentially reducing the cost of breast cancer treatment [4].

1. Artificial intelligence in pathological diagnosis

AI systems can accurately analyze digital pathology images of breast tissue slides. They allow pathologists to diagnose cancer by identifying cellular processes, abnormalities, and malignant sites [5]. The use of AI can speed up the work of pathologists and reduce the risk of human error by instantly recognizing and interpreting tumor size on pathology slides. Using AI, it is possible to count the mitotic figures in tissue samples, an important factor in assessing the aggressiveness of breast cancer. To help pathologists determine the extent of the disease, AI algorithms can distinguish breast cancer subtypes (for example, estrogen receptor (ER) positive and human epidermal growth factor 2 (HER2) positive) and assign a grade. AI produces consistent results, reducing the turnover of experts among clinicians in standardized diagnostic procedures [6]. By using AI, the diagnostic process can be accelerated, allowing pathologists to focus on difficult slides and complex cases. By identifying errors, artifacts, or slides with poor image quality, AI algorithms can ensure that only reliable data is used for analysis. AI can predict biomarkers (such as Ki-67 proliferation index) from pathology slides to aid in treatment decisions and prognosis [7]. In order to provide a detailed description of the patient's history and assist in treatment planning, AI systems can combine pathology findings with patient records. AI supports analysis of pathology and statistical data, helping researchers discover new biomarkers, treatment responses, and disease processes. By allowing pathologists to examine and discuss issues remotely, AI-powered telepathology systems facilitate access to knowledge and remove regional barriers. Pathology students can benefit from using AI-assisted tools as a good learning tool to help them better recognize and diagnose breast cancer [8].

2. Artificial intelligence and risk analysis

By analyzing multiple factors related to patient and health data, artificial intelligence (AI) makes breast cancer risk analysis easier. AI models take into account a person's risk factors, such as age, family history, genetics, lifestyle and health history. AI can provide personalized breast cancer risk assessments by looking at these factors. To identify people with a high genetic risk for breast cancer, AI can analyze genetic data, such as mutations in the BRCA1 (breast cancer risk factor 1) gene and the BRCA2 gene. This knowledge facilitates the development of screening and prevention programs [9]. For those at high risk, AI-based risk assessment models can recommend more frequent screening or additional imaging, allowing for early detection of breast cancer. To determine the overall risk, AI can take into account environmental variables such as radiation exposure, in addition to lifestyle factors such as alcohol consumption, smoking and physical activity. To provide a comprehensive risk assessment, AI integrates various health data sources, including electronic medical records (EMR), radiographs, pathology reports and genetic test results. To maintain the accuracy of risk predictions over time, AI models can update risk assessments as new data becomes available [9]. AI provides risk assessment tools and recommendations to healthcare providers, empowering them to make decisions about risk assessment, prevention, and mitigation. AI can generate comprehensive risk assessment reports for patients, improve their education and make joint decisions with health professionals. AI-based risk assessment models can help identify new risk markers and improve existing research on breast cancer risk. AI can analyze population-level data to find conditions and risk factors in certain populations, helping public health officials develop tailored prevention strategies, such as the National Health Institute's breast cancer screening program Service (NHS) [10].

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3. AI for personalized treatment recommendations

AI combines genetic data, such as mutations and biomarkers, with clinical details, such as the person's age, cancer stage, tumor characteristics and complications. The most effective treatment plan is determined by analyzing this comprehensive data. To predict what a patient might do with different treatment options, AI algorithms analyze the patient's historical data. This helps oncologists make the most effective and efficient treatment decisions. AI analyzes genomic data from tumor samples to find mutations or genetic variants that may respond to targeted therapies. This makes it possible to prescribe the right medication based on a patient's genetic makeup. AI takes into account potential drug interactions and side effects, as well as the compatibility of different treatments and the patient's medical history. This reduces adverse effects and increases treatment effectiveness [11]. The latest treatment recommendations and scientific research are integrated into AI systems. They provide treatment recommendations consistent with evidence-based practices, ensuring patients receive the best possible care. AI is helping to develop personalized treatments that may include surgery, chemotherapy, radiation therapy, immunotherapy, or a combination of these. It also takes into account the best method and timing of treatment. Throughout the treatment, AI monitors the patient's condition and adjusts its recommendations based on emerging data. This allows for rapid adjustments to the treatment plan as the condition progresses. AI-powered treatment recommendations enable patients and healthcare professionals to make shared, informed choices. Patients are better prepared to understand treatment options and their implications. To provide eligible patients with access to cost-effective treatments, AI can find appropriate clinical trials that offer experimental treatments that match the patient's profile. AI considers cost-effectiveness when recommending treatment options, thereby helping patients and healthcare systems make decisions about the appropriate allocation of resources [12].

4. AI and predicting treatment response

Medical records, treatment regimens, and patient outcomes are analyzed by AI models using historical patient data. By looking at how patients with similar conditions have responded to different treatments in the past, AI creates patterns and associations that can be used to predict how new patients will respond to different treatments. AI can analyze diagnostic images such as MRI, CT or positron emission tomography (PET) to determine how tumors change in size, shape and density during treatment. This helps determine how the tumor responds to treatment. Data from genomic profiling and biomarker analysis is analyzed by AI. It identifies genetic changes or mutations that may affect a patient's response to treatment and provides information about targeted therapies [13]. AI analyzes changes in tumor characteristics, including tumor grade, cell proliferation and molecular markers, which can predict treatment response, from pathology reports and tissue samples. AI constantly monitors the progress of the patient's treatment. As updated data becomes available, predictions are adjusted by comparing the patient's actual response to the expected response. AI aligns with known clinical guidelines and practices based on treatment response predictions. When results differ from expectations, a message is sent to health professionals, encouraging them to review their treatment options. AI uses algorithms based on machine learning, such as decision trees, random forests, support vector machines, or neural networks, to analyze complex relationships between patient data and treatment outcomes [14]. Evaluating the effectiveness of AI therapy can take into account outcomes and patient-reported responses to adverse effects, symptoms, and quality of life. To provide a comprehensive overview of patient response to treatment, AI combines data from multiple sources, such as electronic health records, imaging systems, genetic testing systems and databases [12].

5. Artificial Intelligence-Mediated Escalation Strategy

A cost-reduction strategy has been developed for a small group of breast cancers. Tumor type, stage, biomarker status (e.g. hormone receptor or HER2 status), and patient preferences often influence the selection process. AI-induced elimination may involve the use of specific drugs to target cancer cells, such as hormone therapy or HER2-targeted drugs, thereby reducing the need for more aggressive treatments. such as chemotherapy [15]. Instead of a full mastectomy, breast-conserving surgery (lumpectomy) followed by radiation therapy may be recommended in many cases. In some people, this method preserves breast tissue and produces similar results. To reduce the burden of radiotherapy on the patient's daily life, partial breast irradiation (APBI) or hypofractionated radiotherapy can be used [16]. To reduce the risk of lymphedema and shoulder dysfunction, sentinel lymph node (SLN) biopsy may be used instead of axillary lymph node dissection (ALND) in some people with breast cancer. The goal of the reduction strategy is

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to avoid overtreatment. This means avoiding placing patients on a medical intervention that may only provide a small benefit but has a large impact. AI-assisted active surveillance, in which patients continue to follow regular screening and clinical trials after definitive treatment is withdrawn, may be an option for some low-risk, early-stage breast cancers [17]. De-escalation aims to reduce the treatment given to the patient, but it is important to maintain the same survival rate and ensure that the patient's long-term prognosis is not compromised. Long-term follow-up is important for patients receiving intermittent regimens to monitor treatment efficacy and detect any disease progression or relapse [18].

6. Patient stratification using intelligence

AI enables the creation of personalized therapies through comprehensive data analysis. Estrogen (ER) and progesterone (PR) receptor levels are the two most common hormones used to predict breast cancer. Hormone therapy can help patients with tumors that express hormone receptors. Another important factor is the status of human epidermal growth factor receptor 2 (HER2/neu). Targeted therapies such as trastuzumab (Herceptin) can be effective in treating HER2-positive breast tumors [19]. Patients who may be at high risk of developing breast cancer or who may benefit from specific treatments or interventions can be identified through genetic testing, such as screening for BRCA1 and BRCA2 mutations. The lifetime risk of a patient with breast cancer can be calculated using various risk assessment models, including the Tyrer-Cuzick model and the Gail model. This knowledge can guide research and prevention methods [20].

7. Ethical concerns and limitations

AI is based on patient data, including medical records and possibly photos. It is important to protect the privacy of the patient and ensure that there are strong information security measures in place to protect against damage and unauthorized access. The introduction of AI into healthcare must be clearly communicated to patients, who must provide informed consent for data sharing and analysis. Understanding the impact of AI on the diagnosis, processing, and use of data is essential [21]. Hospital administrators may struggle to understand how AI systems generate recommendations due to their complexity. To build trust among healthcare professionals, we must ensure that AI systems are clear and understandable. It can be difficult to hold accountable for errors or incorrect advice made by AI systems. That's why it's important to establish clear standards for accountability and fault. The implementation of AI must be done in a way that does not exacerbate the conflict in healthcare. The focus should be on providing fair access to AI-enhanced healthcare for disadvantaged and marginalized communities [22]. It is good to find a balance between clinical autonomy and the role of AI. The final choice of treatment should rest with doctors, with AI acting as a valuable guide and support. The cost of investing in AI in breast cancer management can affect how healthcare organizations allocate resources. Overall health priorities should be considered when making decisions about AI investment [23]. To keep AI systems accurate and up-to-date with the latest health information, they must be regularly updated and reviewed. Failure to comply with this duty could result in incorrect advice. It is important to develop and implement ethical and legal guidelines for the use of AI in breast cancer treatment. These guidelines should take into account patient autonomy, data privacy, and accuracy. It is important to ensure that patients trust the advice AI provides and feel empowered in their treatment. To build patient trust, open communication and shared decision-making are essential. Healthcare workers may be concerned about job losses or job changes resulting from AI adoption. The impact on health workers must be taken into account when making the right decision [24]. Advances in AI in breast cancer treatment are limited. Incomplete or bad training data can create bad algorithms. Clinical decision making is hampered by a lack of understanding in complex AI models such as deep learning neural networks. It is important to protect sensitive patient data, which requires significant investment in data security. Lack of clinical confirmation can undermine trust. Relying on AI can lead to errors that require human intervention. Concerns about the impact of AI on users, ethics, law, and regulation are common, as are implementation costs and data privacy issues. We must recognize and overcome these barriers to successfully incorporating AI into breast cancer care [25,26].

8. From Volume Screening to Personalized Screening

Breast cancer screening, which started with a simple MG screening, has now evolved into a standardized screening process. A better understanding of the importance of breast density has led to changes in the screening process for women with fibroglandular masses, which has increased awareness of its impact on the negative and high risk of breast cancer. Ultrasound screening is widely used in women with breast cancer. A recent study of ultrasound screening showed an additional two cases of breast cancer per 1,000 women, consistent with previous studies (27). However, ultrasound has significant limitations, including its time-consuming and user-dependent nature, leading to problems in data collection and retrospective analysis. An Abdominal Ultrasound System (ABUS) can be used for examination and diagnosis, providing a three-dimensional view of the volume (28). There is no doubt that the AI algorithms that will be developed in the future will allow a better view of this 3D data, make the detection of lesions and CAD solutions easier and allow faster analysis and decision making. As ABUS can also assist in teleradiology, ultrasound can be performed where radiologists are not available. Research is continuing into automated ultrasound imaging and tomography systems that allow the breast to fall under gravity in an easier position than being overhead (29). In this way, it is possible to consider other parameters, such as sound speed, which can show a high definition and differentiation of lesions (30). Breast MRI is also a useful and effective adjunctive screening tool not only in women with high risk but also in those with average risk but dense breasts (31).

In addition, a recent controlled MRI study included women with high-risk breast tissue as part of a national breast cancer screening program. These women were given an additional MRI scan every two years, which resulted in a significant reduction in median cancer and the detection of 15 additional cancers per thousand scans (32). However, breast MRI is expensive and not as readily available as advanced diagnostic procedures. Contrast-enhanced MRI may be a viable alternative to MRI and offers an economical and cost-effective solution for screening high-risk women and those with breast cancer (33,34). This approach could enable effective and rapid screening of women on a large scale. Wearable technologies, such as special bras with ultrasound sensors, have the potential to revolutionize the way we monitor and diagnose (35). At the same time, non-contrast MRI techniques are gaining ground, providing valuable information, especially for studies without contrast agents. Combining T2 or STIR images with radiographic imaging can provide results that are similar to MRI (36, 37). Future advances are aimed at making breast MRI scans faster, without contrast, more suitable for women with different contraindications.

9. New in diagnostic imaging

The cornerstone of breast MRI is the contrast-enhanced imaging. MRI, which is highly sensitive to breast radiation, evaluates multiple parameters such as diffusion-weighted imaging, spectroscopy, and contrast-enhanced imaging (38, 39, 40). Multiparametric MRI can assess neovascularization, tissue fluid distribution, and cellular markers, allowing imaging at the molecular level (31). Tumor characteristics such as proliferation, angiogenesis, apoptosis, metabolism, and hypoxia can also be demonstrated (41). Contrast-enhanced MRI shows the kinetics of the contrast product, highlighting neovascularization through tumor perfusion. The proliferation of tumor cells reduces intercellular spaces and impedes fluid movement, as detected by diffusion imaging , diffusion vector and diffusion tensor imaging. These methods help to diagnose breast cancer without contrast and with better image quality. In addition, thanks to these different parameters, radiological information is obtained, which improves the diagnostic accuracy. Magnetic resonance spectroscopy (MRS) can analyze different molecules; choline, which is used in cell membranes, enables genetic mapping for virtual biopsy. Hyperpolarized NMR imaging detects particles. Although the current MRI is visible for hydrogen atoms, other rare elements such as carbon (C) and phosphorus (P) can be supported, different MRI results can be obtained (42). Photoacoustic or optoacoustic imaging is a hybrid imaging technique that combines optical and ultrasound (43). Angiogenesis and hypoxia are some of the main characteristics of cancer, and the ability of optical analysis to detect different types of hemoglobin improves its impact (43,44). The oxygenation capacity of blood vessels can be shown in the treatment-induced changes in blood vessels (44).

The functional aspect of optoacoustic ultrasound has the potential to address some of the challenges associated with morphological similarity and distinguishing benign from malignant lesions (45,46,47). In recent studies, optoacoustic ultrasound (OA/US) integration has shown an increase in the specificity of breast mass detection by 14.9% and a high predictive value for malignancy (45,48). Other studies show that the use of OA/US can help radiologists distinguish between different types of breast cancer cells (49). Virtual biopsy, especially with multiparametric MRI scans, has become an important diagnostic tool. Genomic imaging (radiomics) plays an important role here. Radiomics involves the systematic integration of the genetic characteristics of different cancer cells and their multiparametric imaging characteristics. This approach associates disease phenotypes with their genotypes, thereby representing their genetic makeup—a topic that has been the subject of much research (50). With the AI-enhanced field, lesion features identified by radiologists and computers can be matched to genotypes. This approach allows the design and development of predictive models, answering health and biological questions (50, 51).

As MRI is the most commonly used method for diagnosis, diagnosis and management in breast radiography, there are often difficulties when identifying lesions that are only detected by MRI scans. MRI-guided biopsy is important for these lesions, but it is technically difficult, time-consuming, and expensive. MRI-guided biopsy can be done in a few places around the world. MG has enhanced contrast, a good alternative to MRI, and also allows biopsy (52). In this way, lesions that are only detected by contrast-enhanced MRI can be identified by MG-guided stereotaxic vacuum biopsy. This technique can be used in many settings as a useful alternative to MRI-guided biopsy. Performing MRI scans on a patient in a prone position while performing surgical procedures and biopsy in a prone position presents challenges in making MRI lesions clearly visible. This poor patient positioning hinders preoperative planning, lesion assessment, and procedures such as biopsy or marking (53,54). However, real-time ultrasound imaging can combine MRI with ultrasound images, allowing for precise localization and guidance of lesions during the interventional procedure (55,56). Therefore, ultrasound-guided biopsy is an alternative to MRI-guided biopsy (56). With the advancement of fusion biopsy techniques and their integration with non-contrast MRI methods, this challenge will be better addressed in the future. The shift from the top view to the bottom view is also important in the early staging and staging of tumors before and after neoadjuvant chemotherapy, providing important guidance for surgery.

II. Conclusion

In the future, breast radiology will be able to provide more patient-centered diagnostics and treatment strategies, thanks to the development of technological applications and the support of AI and radiologists in all areas, through work with images and CAD systems. The integration of genomic imaging will facilitate multi-dimensional diagnostics, addressing genetic and multiparametric traits through AI-powered solutions. New imaging-guided therapeutics will provide alternative treatment options. The future holds the perfect combination of imaging, AI and new therapies in breast radiology. From personalized diagnostics to new treatments, the state of breast imaging holds great promise, changing breast radiology and ultimately improving patient outcomes. The future of breast radiology is not one of replacement, but of transformation, as technology and human skills come together to advance patient care to new levels.

Conflict of Interest

All authors declare no conflicts of interest.

Author Contribution

Authors have equally participated and shared every item of the work.

References

[1]- Dileep, Gayathri, and Sanjeev G. Gianchandani Gyani. "Artificial intelligence in breast cancer screening and diagnosis." *Cureus* 14.10 (2022).

[2]- Bi, Wenya Linda, et al. "Artificial intelligence in cancer imaging: clinical challenges and applications." *CA: a cancer journal for clinicians* 69.2 (2019): 127-157.

[3]- Tran, William T., et al. "Computational radiology in breast cancer screening and diagnosis using artificial intelligence." *Canadian Association of Radiologists Journal* 72.1 (2021): 98-108.

[4]- Gromet, Matthew. "Comparison of computer-aided detection to double reading of screening mammograms: review of 231,221 mammograms." *American Journal of Roentgenology* 190.4 (2008): 854-859.

[5]- Robertson, Stephanie, et al. "Digital image analysis in breast pathology—from image processing techniques to artificial intelligence." *Translational Research* 194 (2018): 19-35.

[6]- Rakha, Emad A., et al. "Breast cancer histologic grading using digital microscopy: concordance and outcome association." *Journal of clinical pathology* 71.8 (2018): 680-686.

[7]- Williams, Bethany Jill, et al. "Digital pathology for the primary diagnosis of breast histopathological specimens: an innovative validation and concordance study on digital pathology validation and training." *Histopathology* 72.4 (2018): 662-671.

[8]- Williams, Bethany Jill, David Bottoms, and Darren Treanor. "Future-proofing pathology: the case for clinical adoption of digital pathology." *Journal of clinical pathology* 70.12 (2017): 1010-1018.

[9]- Sun, Yi-Sheng, et al. "Risk factors and preventions of breast cancer." *International journal of biological sciences* 13.11 (2017): 1387.

[10]-Rabiei, Reza, et al. "Prediction of breast cancer using machine learning approaches." *Journal of biomedical physics & engineering* 12.3 (2022): 297.

[11]- Veronesi, Umberto, et al., eds. *Breast cancer: Innovations in research and management*. springer, 2017.

[12]- Bray, Freddie, et al. "Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries." *CA: a cancer journal for clinicians* 68.6 (2018): 394-424.

[13]- Bera, Kaustav, et al. "Predicting cancer outcomes with radiomics and artificial intelligence in radiology." *Nature reviews Clinical oncology* 19.2 (2022): 132-146.

[14]- McDonald, Elizabeth S., et al. "Clinical diagnosis and management of breast cancer." *Journal of Nuclear Medicine* 57.Supplement 1 (2016): 9S-16S.

[15]- van Ramshorst, Mette S., et al. "Neoadjuvant chemotherapy with or without anthracyclines in the presence of dual HER2 blockade for HER2-positive breast cancer (TRAIN-2): a multicentre, open-label, randomised, phase 3 trial." *The Lancet Oncology* 19.12 (2018): 1630-1640.

[16]- Fisher, Bernard, et al. "Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer." *New England Journal of Medicine* 347.16 (2002): 1233-1241.

[17]- Giuliano, Armando E., et al. "Effect of axillary dissection vs no axillary dissection on 10-year overall survival among women with invasive breast cancer and sentinel node metastasis: the ACOSOG Z0011 (Alliance) randomized clinical trial." *Jama* 318.10 (2017): 918-926.

[18]- Pfob, André, and Joerg Heil. "Artificial intelligence to de-escalate loco-regional breast cancer treatment." *The Breast* 68 (2023): 201-204.

[19]- Li, Qin, et al. "MRI-based radiomic signature as a prognostic biomarker for HER2-positive invasive breast cancer treated with NAC." *Cancer Management and Research* (2020): 10603-10613.

[20]- Wan, Tao, et al. "A radio-genomics approach for identifying high risk estrogen receptor-positive breast cancers on DCE-MRI: preliminary results in predicting onco type DX risk scores." *Scientific reports* 6.1 (2016): 21394.

[21]- Lippeveld, Theo. "Routine health facility and community information systems: creating an information use culture." *Global Health: Science and Practice* 5.3 (2017): 338-340.

[22]- Parikh, Ravi B., Stephanie Teeple, and Amol S. Navathe. "Addressing bias in artificial intelligence in health care." *Jama* 322.24 (2019): 2377-2378.

[23]- Henz, Patrick. "Ethical and legal responsibility for artificial intelligence." *Discover Artificial Intelligence* 1.1 (2021): 2.

[24]- Char, Danton S., Nigam H. Shah, and David Magnus. "Implementing machine learning in health care—addressing ethical challenges." *New England Journal of Medicine* 378.11 (2018): 981-983.

[25]- Zheng, Dan, Xiujing He, and Jing. "Overview of artificial intelligence in breast cancer medical imaging." *Journal of Clinical Medicine* 12.2 (2023): 419.

[26]- Glicksberg, Benjamin S., et al. "PatientExploreR: an extensible application for dynamic visualization of patient clinical history from electronic health records in the OMOP common data model." *Bioinformatics* 35.21 (2019): 4515-4518.

[27]- Ohuchi, Noriaki, et al. "Sensitivity and specificity of mammography and adjunctive ultrasonography to screen for breast cancer in the Japan Strategic Anti-cancer Randomized Trial (J-START): a randomised controlled trial." *The Lancet* 387.10016 (2016): 341-348.

[28]- Güldogan, Nilgün, et al. "Comparison of 3D-automated breast ultrasound with handheld breast ultrasound regarding detection and BI-RADS characterization of lesions in dense breasts: a study of 592 cases." *Academic radiology* 29.8 (2022): 1143-1148.

[29]- Sak, Mark, et al. "Using ultrasound tomography to identify the distributions of density throughout the breast." *Proceedings of Spie--the International Society for Optical Engineering*. Vol. 9790. NIH Public Access, 2016.

[30]- Sak, Mark, et al. "Using speed of sound imaging to characterize breast density." *Ultrasound in medicine & biology* 43.1 (2017): 91-103.

[31]- Kuhl, Christiane K., et al. "Supplemental breast MR imaging screening of women with average risk of breast cancer." *Radiology* 283.2 (2017): 361-370.

[32]- Bakker, Marije F., et al. "Supplemental MRI screening for women with extremely dense breast tissue." *New England Journal of Medicine* 381.22 (2019): 2091-2102.

[33]- Sorin, Vera, et al. "Contrast-enhanced spectral mammography in women with intermediate breast cancer risk and dense breasts." *American Journal of Roentgenology* (2018): W267-W274.

[34]- Jochelson, Maxine S., et al. "Comparison of screening CEDM and MRI for women at increased risk for breast cancer: a pilot study." *European journal of radiology* 97 (2017): 37-43.

[35]- Moreno, Marie-Valérie, and Edouard Herrera. "Evaluation on phantoms of the feasibility of a smart bra to detect breast cancer in young adults." *Sensors* 19.24 (2019): 5491.

[36]- Bu, Yangyang, et al. "Non-contrast MRI for breast screening: preliminary study on detectability of benign and malignant lesions in women with dense breasts." *Breast cancer research and treatment* 177 (2019): 629-639.

[37]- Kang, Ji Won, et al. "Unenhanced magnetic resonance screening using fused diffusion-weighted imaging and maximum-intensity projection in patients with a personal history of breast cancer: role of fused DWI for postoperative screening." *Breast Cancer Research and Treatment* 165 (2017): 119-128.

[38]- Aribal, Erkin, et al. "Multiparametric breast MRI with 3T: Effectivity of combination of contrast enhanced MRI, DWI and 1H single voxel spectroscopy in differentiation of Breast tumors." *European Journal of Radiology* 85.5 (2016): 979-986.

[39]- Partridge, Savannah C., et al. "Diffusion-weighted MRI findings predict pathologic response in neoadjuvant treatment of breast cancer: the ACRIN 6698 multicenter trial." *Radiology* 289.3 (2018): 618-627.

[40]- Chu, Wei, et al. "Diffusion-weighted imaging in identifying breast cancer pathological response to neoadjuvant chemotherapy: A meta-analysis." *Oncotarget* 9.6 (2018): 7088.

[41]- García-Figueiras, Roberto, et al. "How clinical imaging can assess cancer biology." *Insights into imaging* 10 (2019): 1-35.

[42]- Sharma, Uma, and Naranamangalam R. Jagannathan. "Magnetic resonance imaging (MRI) and MR spectroscopic methods in understanding breast cancer biology and metabolism." *Metabolites* 12.4 (2022): 295.

[43]- Toi, M., et al. "Visualization of tumor-related blood vessels in human breast by photoacoustic imaging system with a hemispherical detector array." *Scientific reports* 7.1 (2017): 41970.

[44]- Leo, Giovanni Di, et al. "Optical imaging of the breast: basic principles and clinical applications." *American Journal of Roentgenology* 209.1 (2017): 230-238.

[45]- Butler, Reni, et al. "Optoacoustic breast imaging: imaging-pathology correlation of optoacoustic features in benign and malignant breast masses." *American Journal of Roentgenology* (2018): 1155-1170.

[46]- Neuschler, Erin I., et al. "Downgrading and upgrading gray-scale ultrasound BI-RADS categories of benign and malignant masses with optoacoustics: a pilot study." *American Journal of Roentgenology* 211.3 (2018): 689-700.

[47]- Seiler, Stephen J., et al. "Optoacoustic imaging with decision support for differentiation of benign and malignant breast masses: a 15-reader retrospective study." *American Journal of Roentgenology* 220.5 (2023): 646-658.

[48]- Neuschler, Erin I., et al. "A pivotal study of optoacoustic imaging to diagnose benign and malignant breast masses: a new evaluation tool for radiologists." *Radiology* 287.2 (2018): 398-412.

[49]- Dogan, Basak E., et al. "Optoacoustic imaging and gray-scale US features of breast cancers: correlation with molecular subtypes." *Radiology* 292.3 (2019): 564-572.

[50]- Valdora, Francesca, et al. "Rapid review: radiomics and breast cancer." *Breast cancer research and treatment* 169 (2018): 217-229.

[51]- Braman, Nathaniel M., et al. "Intratumoral and peritumoral radiomics for the pretreatment prediction of pathological complete response to neoadjuvant chemotherapy based on breast DCE-MRI." *Breast Cancer Research* 19 (2017): 1-14.

[52]- Alcantara, R., et al. "Contrast-enhanced mammography-guided biopsy: technical feasibility and first outcomes." *European Radiology* 33.1 (2023): 417-428.

[53]- Aribal, Erkin. "MRI-detected breast lesions: clinical implications and evaluation based on MRI/ultrasonography fusion technology." *Japanese Journal of Radiology* 38.1 (2020): 94-95.

[54]- Aribal, E., et al. "Predicting location of breast lesions in supine position from prone MRI data using machine learning." European Congress of Radiology-ECR 2019, 2019.

[55]- Kucukkaya, Fikret, et al. "Use of a volume navigation technique for combining real-time ultrasound and contrast-enhanced MRI: accuracy and feasibility of a novel technique for locating breast lesions." *American Journal of Roentgenology* 206.1 (2016): 217-225.

[56]- Aribal, Erkin, et al. "Volume navigation technique for ultrasound-guided biopsy of breast lesions detected only at MRI." *American Journal of Roentgenology* 208.6 (2017): 1400-1409.