**ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW****ASSOCIAÇÃO DA RESSONÂNCIA MAGNÉTICA E MARCADORES TUMORAIS NAS PACIENTES SUBMETIDAS AO TRATAMENTO NEOADJUVANTE DO CÂNCER DE MAMA: UMA REVISÃO INTEGRATIVA****ASOCIACIÓN DE RESONANCIA MAGNÉTICA Y MARCADORES TUMORALES EN PACIENTES EN TRATAMIENTO NEOADYUVANTE POR CÁNCER DE MAMA: UNA REVISIÓN INTEGRATIVA**Cleidelane Rocha Coelho¹, Carlos Danilo Cardoso Matos Silva², Marcus Vinicius Cardoso Matos Silva³

e1424

<https://doi.org/10.47820/jht.v1i4.24>

RECEIVED: 11/01/2022

APPROVED: 12/01/2022

PUBLISHED: 12/11/2022

ABSTRACT

Breast cancer is the type of cancer that most affects women worldwide. In Brazil, this neoplasm is responsible for 28% of the new annual cases of cancer, it is estimated that one in ten women will develop this pathology throughout their lives and in 2021 the incidence was 66,280 cases and about 18,068 deaths, characterizing it if as well as a major public health problem among women. Thus, this study has the general objective of list the importance of magnetic resonance imaging and tumor markers in the prognosis and staging of patients undergoing neoadjuvant treatment for breast cancer. Therefore, an integrative literature review was carried out, using the following databases: SciELO, PubMed, and BVS, in addition to searching epidemiological data on the INCA and DATASUS websites. have been verified, in the analyzed studies that magnetic resonance imaging is efficient in making the evaluation after neoadjuvant therapy, depending on the subtype of breast cancer. The use of contrast can increase the effectiveness of MRI by enhancing normal breast tissues and breast parenchyma (BPE). MRI accuracy varies according to breast cancer subtype and tumor morphology, being more accurate in evaluating HER 2 positive and triple negative tumors. The main biomarkers mentioned were estrogen receptor (ER), progesterone receptor (PR), HER2, Ki67, CA 12.5 and CA 19.9.

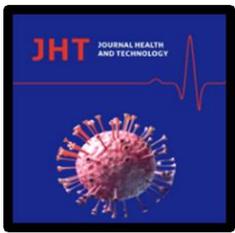
KEYWORDS: Neoplasm. Alternative therapy. Imagenology.**RESUMO**

O câncer de mama é o tipo de câncer que mais acomete as mulheres em todo o mundo. No Brasil essa neoplasia é responsável por 28% dos novos casos anuais de câncer, estima-se que uma em cada dez mulheres desenvolverá essa patologia ao longo da vida e em 2021 a incidência foi de 66.280 casos e cerca de 18.068 óbitos, caracterizando-se assim como um grande problema de saúde pública entre as mulheres. Desse modo, este estudo tem como objetivo geral relacionar a importância da ressonância magnética e marcadores tumorais no prognóstico e estadiamento das pacientes submetidas ao

¹ Bacharel em Biomedicina pelo Centro Universitário Maria Milza (UNIMAM) com habilitação em Patologia Clínica e Imagenologia.

² Bacharel em Biomedicina pela Universidade Estadual de Santa Cruz (UESC), especialista em Análises Clínicas pela Universidade Católica de Salvador (UCSal), pós-graduado em Imagenologia e mestrado em Biotecnologia. Secretário do Conselho Regional de Biomedicina da 2ª região (CRBM2), docente da pós-graduação em "Cardiologia e Hemodinâmica" e da especialização em "Urgência e Emergência" da Escola Bahiana de Medicina e Saúde Pública, professor da Pós-graduação em Hematologia e Hemoterapia da Faculdade Atualiza e docente do curso de Medicina da UniFTC. Leciona nos cursos de saúde da UNIFACS, Centro Universitário Nobre (UNIFAN) e Centro Universitário Maria Milza (UNIMAM).

³ Graduação em Biomedicina pela Universidade Estadual de Santa Cruz - UESC e Mestrado em Genética pela Universidade Federal de Pernambuco - UFPE. Professor de Graduação do curso de Medicina do Centro Universitário de Tecnologia e Ciências (UNIFTC) e dos cursos de Biomedicina, Enfermagem, Farmácia, Fisioterapia e Nutrição da Universidade Salvador (UNIFACS), da Faculdade Nobre de Feira de Santana (FAN) e da Unidade de Ensino Superior de Feira de Santana (UNEF), Docente da Pós-Graduação em Cardiologia e Hemodinâmica da Escola Bahiana de Medicina e Saúde Pública, e Diretor Científico da Associação Baiana de Biomedicina.



JOURNAL HEALTH AND TECHNOLOGY - JHT

ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

tratamento neoadjuvante do câncer de mama. Para tanto, foi realizada uma revisão integrativa da literatura, utilizando as seguintes bases de dados: SciELO, PubMed, e BVS, além de pesquisar dados epidemiológicos no site do INCA e DATASUS. Foram verificados, nos estudos analisados, que a ressonância magnética é eficiente em fazer a avaliação após a terapia neoadjuvante, a depender do subtipo do câncer de mama. Sendo que o uso do contraste pode aumentar a eficácia da RM por meio do realce dos tecidos mamários normais e do parênquima mamário (BPE). A precisão da RM varia de acordo com o subtipo do câncer de mama e a morfologia tumoral, sendo mais precisa em avaliar tumores HER 2 positivos e triplo negativo. Os principais biomarcadores mencionados foram o receptor de estrogênio (ER), receptor de progesterona (PR), HER2, Ki67, CA 12.5 e o CA 19.9.

PALAVRAS-CHAVE: Neoplasia. Terapia alternativa. Imagenologia.

RESUMEN

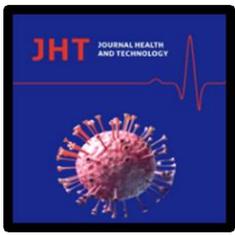
El cáncer de mama es el tipo de cáncer que más afecta a las mujeres en todo el mundo. En Brasil, esta neoplasia es responsable del 28% de los nuevos casos anuales de cáncer, se estima que una de cada diez mujeres desarrollará esta patología a lo largo de la vida y en 2021 la incidencia fue de 66.280 casos y alrededor de 18.068 muertes, así como un importante problema de salud pública entre las mujeres. Por lo tanto, este estudio tiene como objetivo general relacionar la importancia de la resonancia magnética y los marcadores tumorales en el pronóstico y la estadificación de pacientes sometidas al tratamiento neoadyuvante del cáncer de mama. Para ello, se realizó una revisión integradora de la literatura, utilizando las siguientes bases de datos: SciELO, PubMed y BVS, además de investigar datos epidemiológicos en el sitio web INCA y DATASUS. En los estudios analizados, se verificó que la resonancia magnética es eficiente para hacer la evaluación después de la terapia neoadyuvante, dependiendo del subtipo de cáncer de mama. El uso de contraste puede aumentar la eficacia de la resonancia magnética al resaltar los tejidos mamarios normales y el parénquima mamario (BPE). La precisión de la RM varía según el subtipo de cáncer de mama y la morfología del tumor, siendo más precisa en la evaluación de los tumores HER 2 POSITIVOS Y Triple NEGATIVOS. Los principales biomarcadores mencionados fueron receptor de estrógeno (RE), receptor de progesterona (PR), HER2, Ki67, CA 12.5 y CA 19.9.

PALABRAS CLAVE: Neoplasia. Terapia alternativa. Imagenológico.

INTRODUCTION

Breast cancer is the type of cancer that most affects women worldwide. According to data from the National Cancer Institute (INCA, 2021), in 2020 breast cancer was the most common type, with about 66,280 new cases per year, followed by Colón and Recto with 20,470 new cases per year and cervical cancer with 16,710. new cases per year. Regarding mortality according to the primary location of the tumor in 2019, the most common was in the breast with about 18,068 deaths. In view of the above, it is clear that breast cancer is a public health problem among women and requires some care such as early diagnosis and methodologies that improve women's self-esteem, with the use of breast-conserving surgeries, but for this it needs application of neoadjuvant treatment to minimize tumor extension (ANDRADE, 2018).

Neoadjuvant treatment consists of the application of certain substances for therapeutic purposes before the removal of the tumor, aiming at reducing the extent of surgery and providing information on the biological behavior of the tumor. Magnetic Resonance which is the target of the current research (DAGNONI et al., 2016).



JOURNAL HEALTH AND TECHNOLOGY - JHT ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO
NEOAJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

The Magnetic Resonance (MR) is a diagnostic imaging method in which it does not use ionizing radiation and forms the images in a detailed way, so it is widely used to evaluate the region of the skull, elbow, joint, ankles, soft parts, among others. The image acquisition can be done in different anatomical planes in a non-invasive way and with extraordinary spatial resolution (NEGRÃO et al., 2018).

For the formation of the image, it is important that the interaction between the magnetic field generated by the equipment, the radiofrequency pulse also generated by the equipment with the hydrogen protons that are present in the human body occur. As it is a method that displays the images in a three-dimensional way, it provides the exact resolution of the tumor extension (SANTANA; BORGES, 2015). For MRI findings to be reliable, it is important to associate them with other forms of diagnosis that detect the basal characteristics of the tumor, such as the use of tumor markers (VARGAS, 2018).

Tumor markers are biomolecules that are present in cells with tumor characteristics. These substances are used to detect possible neoplastic changes, as well as to assess whether there is a good response to treatment. Among the markers that show greater specificity for the screening and prognosis of breast cancer are CA15.3, CEA (Carcinoembryonic Antigen), MCA (Mucoid Carcinoma Associated Antigen), CA-27.29, cathepsin D and C-erbB- 2 (human epidermal growth factor type 2) (BARBOSA, 2020). And recently others such as estrogen receptor (ER), progesterone receptor (PR), Ki67, CA 12.5 and CA 19.9 are being described. Thus, a question arises:

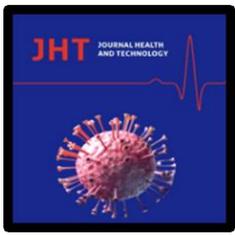
The use of magnetic resonance imaging has been growing in recent years and it is more accurate in evaluating the progression of neoadjuvant treatment when compared to mammography and ultrasound, and thus directs the mastologist to breast-conserving surgery, as three-dimensional images are captured through breast surgery. magnetic fields, favoring a broader view of the breasts and thus facilitating the visualization of the tumor extension (SANTANA; BORGES, 2015).

In order for the MRI findings to be reliable, it is important that an association is made with the tumor markers, since these have high sensitivity in the quantitative assessment of cancer cases by identifying which type of neoplasm was formed after the process of cellular hyperproliferation and thus allows the evaluation of behavior in the face of neoadjuvant treatment and whether metastasis or regression of the condition has occurred (NEGRÃO et al., 2019).

Therefore, within this context, this study aims to list the importance of resonance magnetic and tumor markers in the prognosis and staging of patients undergoing neoadjuvant treatment for breast cancer, in addition to describing the risk factors related to breast cancer, highlight the main biomarkers associated with MRI that are used to evaluate neoadjuvant treatment and, finally, evaluate the accuracy of MRI in identifying pathological complete response (pCR) in patients undergoing neoadjuvant treatment of breast cancer.

THEORETICAL REFERENCE

Breast cancer is the most common pathology among women in Brazil and in the world, responsible for high mortality rates, and considered a major public health problem (MIGOWSKI et al.,



JOURNAL HEALTH AND TECHNOLOGY - JHT ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO
NEOAJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

2018). It is a disease that involves several causes, such as environmental, genetic, cultural risk factors, lifestyles and aging itself (FRANCISCO et al., 2020).

According to data from the National Cancer Institute (INCA, 2021), the estimate for 2020 was 66,280 new cases per year and about 18,295 deaths, with 18,068 women and 227 men. During the years 2015 to 2020, the highest incidence rates were in the age group of 50 to 59 years (27%) followed by 60 to 69 years (23.1%) (MATOS, 2020).

Deaths associated with breast cancer may be related to the biological profile of the tumor and this analysis is performed using molecular markers and immunohistochemistry (CECILIO et al., 2015). Among the biological factors, 5 to 10% of breast cancers are hereditary and related to mutations in the BRCA1 and BRCA2 genes (MATOS et al., 2021).

Breast cancer is heterogeneous and multifactorial in nature, including biological-endocrine, reproductive and behavioral factors. Aging is considered a risk factor due to prolonged exposure to endogenous and exogenous factors, such as early menarche, late menopause, nulliparity, first pregnancy after 30 years, obesity, alcohol consumption, sedentary lifestyle, smoking, exposure to ionizing radiation between puberty and thirty years and hormonal changes (such as use of oral contraceptives or hormone replacement after menopause) (COSTA et al., 2021).

The main tests used for diagnosis are mammography (the main technique used), clinical examination, ultrasound, magnetic resonance imaging, tumor markers dosages, blood tests, X-rays, scintigraphy, biopsy, cytopathological, histopathological and molecular tests - BRCA1 and BRCA2 (BERNARDES et al, 2019). Diagnosis in the initial phase allows a greater chance of successful treatment and confirmation is through biopsy (BARBOSA, 2020).

Imaging exams are the most used for early diagnosis and screening, and magnetic resonance imaging has been widely used to follow the local staging and monitoring of the breast lesion. It has a specificity lower than the other exams with 88% and a sensitivity superior to ultrasonography. It is more suitable for detecting the possibility of tumor invasion in ductal carcinoma in situ, evaluating the washout curves of breast lesions and evaluating the response to neoadjuvant treatment. It has already been shown that MRI is able to reveal 96% of multifocal and multicentric breast pathologies (DELMONICO; AMARAL, 2015).

The first studies focused on magnetic resonance were in 1930 by Isidor Rabi, Rv Poud and EM Purcell in the creation of NMR (Nuclear Magnetic Resonance) spectroscopy, something so important that the pioneers won the Nobel Prize in Physics at the time. The technique is based on an external magnetic field that aligns the unpaired electrons unequally to this field, and the magnetic moment of the electron is what is related to the response of the device (DIEGUEZ et al., 2018).

MRI has high potential to differentiate tissues and analyze anatomical and functional conceptions. The image is formed through the relationship between the magnetic field emitted by the equipment with the hydrogen protons emitted by the patient's own body and thus favors the sending of the radiofrequency pulse through the receiving coil or antenna and generates the image. It is a safe method that does not use ionizing radiation, but requires some care, such as the use of a physical

mechanism to restrict access to the sector and prohibiting the entry of patients carrying metallic objects (MAZZOLA et al., 2019).

The magnetic properties of hydrogen protons and the high concentration of water in the human body made the creators of this technique choose this atom to associate with the equipment and promote the magnetic signal. It uses the longitudinal relaxation times (T1) which is the magnetization time for the longitudinal axis, being influenced by the relationship of the spins with the environment and the transverse (T2) which mentions the reduction of magnetization in the transverse plane and is influenced by the relationship spin-spin (GONÇALVES; RAMALHO, 2017).

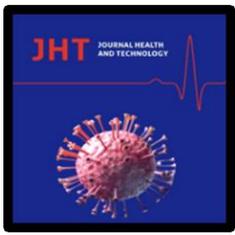
Conventional MRI is the most used in clinics, it allows the visualization of anatomical and morphological details through dynamic contrast and spatial resolution but presents little information about the pathophysiology. Due to this, new techniques have been developed that have more specificity, such as multiparametric resonance in which three different methods are used: DWI (diffusion), DCE (dynamic contrast) and spectroscopy (PEIXOTO, 2018).

Studies have shown that the physiology and morphology of malignant tumors are different from normal tissue and benign lesions, mainly due to the presence of abnormal vessels, with increased permeability and densities and various changes at the molecular and morphological level (YAN; SUN; SHEN, 2017). The use of the contrast agent enables dynamic visualization through its uptake on MRI and thus identifies tumor angiogenesis, related changes in tumor microcirculation, including increased permeability of newly formed vessels (NEGRÃO et al., 2019).

The contrast makes it possible to dynamically and continuously monitor the vascularization of the lesion, and through a post-processing system it acquires quantitative and semi-quantitative parameters to analyze the vascular density of the tumor tissue, integrity and permeability. Contrast agents move from the intracellular to the extracellular space, resulting in an increase in signal on T1-weighted MRI, with the extravasation rate depending on vascular surface area, permeability, perfusion, and the increase in the region of interest to that can be recorded on a curve as a function of time and thus enables a dynamic physiological image of the tumor's blood vessels (YAN; SUN; SHEN, 2017).

One of the main designations of breast MRI is for preoperative staging of recurrences in the same place of origin or when lymph nodes or tissues close to the origin of the first tumor have been compromised, as it has high sensitivity in the analysis of tumor extension and in the finding of multicentric, contralateral and multifocal tumors. In patients with denser breasts, such as young women and in invasive tumors, MRI is more accurate for visualization than other techniques (FRANÇA et al., 2017).

In the literature, the main indications for breast MRI are for screening women with a risk greater than 20% for the development of cancer, carriers of mutations in the BRCA 1/2 genes, patients who between 10 and 30 years of age underwent treatment with radiotherapy or have Li-Fraumeni and Cowden syndromes and have a personal or family history of cancer. Another very accurate form of MRI is to observe the response to neoadjuvant treatment with the findings of the pathological anatomy of the surgical specimen together with tumor markers (FERREIRA et al., 2021).



JOURNAL HEALTH AND TECHNOLOGY - JHT ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

Tumor markers are macromolecules present in the tumor, blood and other biological fluids due to the presence of neoplastic cells, these substances are synthesized by the tumor itself or by the body's immune system in response to the presence of this foreign agent. The main markers of breast cancer are MCA (carcinoma-associated mucoid antigen), CA15.3, CA 27.29, Cathepsin D, C-erbB-2 (human epidermal growth factor type 2) and CEA (carcinoembryonic antigen) 27. which are represented in table 02 (BARBOSA, 2020).

Cancer antigen 15.3 (CA-15.3) is a marker that has high sensitivity depending on the size of the tumor and at what stage it is, it is used as a marker for breast and ovarian cancer (BARBOSA, 2020). It was initially defined as part of mucin glycoprotein 01 (MUC-01), being detected with two antibodies, one that recognizes the repeat in the peptide core and the other is a carbohydrate epitope. Changes in the level of CA 15.3 are evidence of metastatic disease in approximately 70% of asymptomatic patients (SILVA; CAMPOS; SIMIONI, 2020).

While the tumor antigen 27.29 (CA-27.29) does not have good sensitivity and specificity, therefore it should not be used alone for definitive diagnosis. Its main indication is for detection of recurrent cancer and monitoring of advanced treatment. This marker belongs to the MUC-1 glycoprotein family, as does CA-15.3, so they share similar epitope sites and similar sensitivity and specificity (BONILLA-SEPULVEDA, 2020).

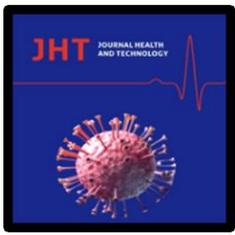
Cathepsin D is found in all mammalian cells, its function is to stimulate DNA synthesis and mitosis during tissue regeneration. It is synthesized by means of pre-enzymes that degrade normal or pathological tissue proteins and, therefore, tumor cells secrete this enzyme to facilitate the initiation and progression of the metastasis process (SILVA; CAMPOS; SIMIONI, 2020).

It is a protease present in lysosomes, its protein precursor is pro-cathepsin D and is found elevated in some breast tumors. This enzyme causes proteolysis of basement membranes and thus favors invasion and metastasis development (SÁNCHEZ et al., 2018).

In turn, the carcinoembryonic antigen is a high molecular weight oncofetal protein, was identified for the first time in a patient with colon cancer. Its highest concentration is in the intestinal tract and fetal blood, but with advancing age this concentration decreases in serum, in a normal situation, almost 30 is not detected. It is found at high levels in cases of adenocarcinomas of the colon, rectum, breast, lung, pancreas, among others. It has been widely used to relate the extent and prognosis of breast cancer, mainly to assess whether there has been an extension to the lymph nodes or axillary invasion (VARGAS, 2018). It can be used for screening for melanoma, lymphoma, thyroid, stomach, kidney, pancreas, liver, cervix, prostate and ovary cancer and the higher its serum concentration,

The carcinoma-associated mucoid antigen (MCA) is a glycoprotein widely used to monitor the development of breast cancer, with 87% specificity and 60% sensitivity in case of metastasis. Its reference values are 11U/MI. Its concentration can be altered in benign breast diseases, tumors of the ovary, cervix, endometrium and prostate (MACHADO et al., 2017).

C-erbB-2 belongs to the family of membrane receptors and its extracellular domain can be measured in culture or released into the circulation. When it is found with high concentration, it is an



indication of primary breast carcinoma, as its values change early in the development of carcinogenesis, even before the clinical diagnosis (MACHADO et al., 2017).

About 15 to 20% of breast cancers have human epidermal growth factor receptor type 2 (HER2) amplification on the surface of tumor cells. This receptor favors cell multiplication and thus contributes strongly to tumor extension to other tissues and greater aggressiveness and progression of this, so patients who have tumors that overexpress HER2 have worse prognoses (BENEVIDES; BATISTA; VILELEA, 2020).

The HER2+ cancer type has only this positive gene and about 75% of cases have p53 mutations. Tumors with these characteristics do not have hormone receptors for estrogen and progesterone and are considered the second worst prognosis, requiring targeted-specific therapy to improve the prognosis of patients (ROSA et al., 2021).

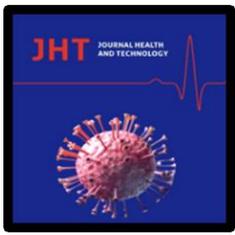
In the human body there are some hormones that have the function of regulating and presenting sexual characteristics, both male and female, but when there is an increase in some of these hormones it may be associated with the presence of tumor cells. Receptors are proteins that bind to certain blood substances. In the case of hormone receptors in oncology, it is when hormones bind to their proper receptor and thus favor tumor proliferation. Among the main hormones are estrogen and progesterone (BARBOSA et al., 2020).

Cancer that has an estrogen receptor is called ER+. The presence of this receptor indicates that tumor cells are sensitive to hormonal treatment and, therefore, have a good prognosis. While breast cancers with progesterone receptors are called PR+, it is also considered a marker, but has lower specificity when compared to estrogen. Both receptors circulate freely in the bloodstream but become active markers when they phosphorylate hormones. Thus, tumors that have negative hormone receptors have a worse prognosis (SILVA et al., 2019).

And finally, there is Ki67, which is a nuclear protein that is encoded by the Mki67 gene and is related to cell proliferation. When its expression is high, it is related to a decrease in survival and is considered a poor prognosis for breast cancer. This marker is present in all phases of cell division, with the exception of the G0 phase and with greater expression in the G2 and M phases. The level of tumor proliferation is known by determining the cellular index of proteins that are specific to its cycle, with this, ki67 is used due to its characteristics as a prognostic factor in breast carcinoma in women (ALEIXO, 2018).

METHODOLOGY

The study in question is characterized as an integrative literature review of a qualitative and exploratory nature, with emphasis on the study of breast cancer, magnetic resonance imaging and tumor markers in the field of oncology. The integrative review is a method that enables the development of knowledge through a systematic and absolute process, based on the same established principles of methodological rigor in research development. This method is divided into 6 phases, which are (1) writing a review question; (2) search and selection of primary studies; (3) data extraction from studies;



JOURNAL HEALTH AND TECHNOLOGY - JHT

ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

(4) critical evaluation of primary studies included in the review; (5) synthesis of the review results and (6) presentation of the method (MENDES; SILVEIRA; GALVÃO, 2019). The research was carried out in Portuguese and English, using the following keywords: “breast neoplasms”, “neoadjuvant therapy”, “magnetic resonance imaging and “tumor biomarker/marker”. “and its correspondents in the English language.

A search for articles was carried out in PubMed/Medline (*National Library of Medicine*), SciELO electronic library (*Scientific Electronic Library Online*) and BVS (Virtual Health Library) regarding breast cancer, risk factors associated with its development and the use of magnetic resonance imaging together with tumor markers in the prognosis after neoadjuvant therapy, in addition to researching relevant information on the website of the Ministry of Health/DATASUS (Department of Informatics of the Unified Health System in Brazil) and INCA (José Alencar Gomes Silva Cancer Institute) for epidemiological information.

In order to contribute to the thematic area and ensure the structure of the scientific work, articles were collected in Portuguese and English, available in full 42 and that addressed enlightening and notorious contents for the study, published between 2015 and 2022 and that presented concomitantly, the use of magnetic resonance imaging and tumor markers in the follow-up of patients undergoing neoadjuvant treatment for breast cancer. On the other hand, publications prior to the year 2015, which dealt only with other imaging exams other than magnetic resonance imaging and other therapies that were not neoadjuvant and, finally, that were not in accordance with OMS standards (World Health Organization).

83 articles were found in the Virtual Health Library (BVS), after filtering by year (2015-2022), language (Portuguese and English) and selection of some keywords, 54 articles were obtained. In addition to these, 53 articles were found in PubMed/Medline (*National Library of Medicine*) and 9 articles in the electronic library SciELO (*Scientific Electronic Library Online*). The collected documents were analyzed in detail and critically and after the screening, the selection of publications that provide contributions within the field of research and that are based on scientific evidence was made. To this end, all care has been taken with regard to copyright, preserving the citations of all works used. After that, the abstract and title of the articles were read and after this analysis, 29 articles were selected,

Table 01- Articles searched in the databases.

Data base	publications found	Selection based on reading the title and abstract	Final sample after reading the full text
BVS	83	13	5
SciELO	9	0	0
PubMed	53	16	8
Total	145	29	13

RESULTS

According to the planning of this work, the methodology used was efficient in achieving the objectives of this study and elucidating the research problem, as it made it possible to identify the main arguments and describe them. Therefore, after carrying out the bibliographic survey in the selected databases, 145 studies were found and only 13 were chosen, because they were in agreement with the theme and correspond to the inclusion criteria, thus delimiting the final sample.

The summary of the works chosen based on the theme of the study is presented in table 02.

Table 02- Distribution of references included in the integrative review, according to with authors, year, title of the work, study methodology, general objective and main results.

AUTHOR/YEAR	TITLE	STUDY METHODOLOGY	OBJECTIVE	MAIN RESULTS
MICHOUX et al., 2015.	Texture analysis on MR images helps predicting non-response to NAC in breast cancer	Two-year retrospective study	Assess the value of pre-NAC imaging parameters to predict NAC non-responders.	BI-RADS mass/non-mass enhancement, biological markers and histological grade did not contribute significantly to the prediction.
LO et al., 2016.	Effect of Imaging Parameter Thresholds on MRI Prediction of Neoadjuvant Chemotherapy Response in Breast Cancer Subtypes	Retrospective study	To assess the predictive performance of magnetic resonance imaging (MRI) markers in breast cancer patients by subtype	Imaging plays a critical role in monitoring tumor regression during NACT. In the neoadjuvant setting, although tumor regression measured by MRI using standard parameter thresholds is in agreement with the pathologic response, such agreement varies widely by breast cancer subtype.
LOO et al., 2016	Survival is associated with complete response on MRI after neoadjuvant chemotherapy in ER-positive HER2-negative breast cancer	Retrospective study.	To explore whether MRI is associated with recurrence-free survival after neoadjuvant chemotherapy in ER-positive/HER2-negative breast cancer	Complete radiological response on MRI after NAC in patients with ER-positive/HER2-negative tumors is associated with an excellent outcome.

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
 Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

<p>DONG et al., 2018.</p>	<p>Chang in background parenchymal enhancement in HER2-positive breast cancer before and after neoadjuvant chemotherapy Association with pathologic complete response</p>	<p>retrospective study</p>	<p>To analyze the relationship between pathologic complete response (pCR) and changes in background parenchymal enhancement (BPE) levels in human epidermal growth factor receptor 2 (HER2) positive breast cancer patients who received neoadjuvant chemotherapy (NAC)</p>	<p>Decreased HER2-positive tumor size was associated with decreased BPE (background parenchymal enhancement) and pCR. Tumor size on MRI can be used to predict the pathological tumor response during NAC. Furthermore, patients with HR-negative tumors are more likely to achieve pCR than those with HR-positive tumors.</p>
<p>WU et al., 2018.</p>	<p>Intratumoral Spatial Heterogeneity at Perfusion MR Imaging Predicts Recurrence-free Survival in Locally Advanced Breast Cancer Treated with Neoadjuvant Chemotherapy</p>	<p>A retrospective study, a discovery cohort (one=60) and a multicenter validation cohort (one=186) were analyzed.</p>	<p>To characterize intratumoral spatial heterogeneity on perfusion magnetic resonance imaging (MRI) and to investigate intratumoral heterogeneity as a predictor of recurrence-free survival (RFS) in breast cancer.</p>	<p>Multiregional imaging features extracted from baseline DCE MRI images can be used to characterize intratumoral spatial heterogeneity and detect aggressive disease in breast cancer. Image-based stratification provided additional prognostic value beyond traditional clinicopathological and genomic factors such as ER, PR, and HER2 status.</p>
<p>BENG et al., 2019</p>	<p>Association of Peritumoral Radiomics With Tumor Biology and Pathologic Response to Preoperative Targeted Therapy for HER2 (ERBB2) –</p>	<p>Retrospective diagnostic study.</p>	<p>To determine whether clinical breast magnetic resonance imaging (MRI) signatures can non-invasively characterize HER2-positive tumor biological factors and estimated</p>	<p>Peritumoral DCE-RM radiomics may allow non-invasive intrinsic subtyping of HER2+ breast cancer in response-associated subgroups.</p>

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

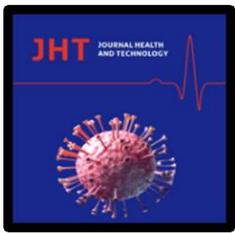
ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
 Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

	Positive Breast Cancer.		response to HER2-targeted neoadjuvant therapy.	
BITENCOURT et al., 2020.	MRI-based machine learning radiomics can predict HER2 expression level and pathologic response after neoadjuvant therapy in HER2 overexpressing breast cancer.	Retrospective study.	Use MRI-based clinical and radiomic features, along with machine learning, to assess the level of HER2 expression in HER2-overexpressing breast cancer patients who received NAC and correlate these findings with the pathologic response.	MRI features are associated with differences in HER2 expression levels and pathological response after NAC. However, the HER2 status of a core biopsy specimen, even when obtained from multiple sites within a tumor, is limited in providing comprehensive information about the pathological heterogeneity of the tumor as a whole. In contrast, MRI combined with radiomic analysis allows for a non-invasive evaluation of the entire tumor.
HEACOCK et al., 2020.	Dynamic contrast-enhanced MRI evaluation of pathologic complete response in human epidermal growth factor receptor 2 (HER2)-positive breast cancer after HER2-targeted therapy	Retrospective study	Explore patterns of tumor shrinkage and early tumor enhancement with pCR in HER2-positive breast cancer.	Only the pattern of tumor shrinkage and full-image response was associated with pCR. Concentric shrinkage demonstrates high specificity for HER2-positive breast cancer pCR and is easily assessed at the time of clinical reading.
RAGUSI et al., 2020.	Prognostic value of breast MRI characteristics before and	Retrospective exploratory observational cohort study.	To investigate whether MR characteristics before and	Research on the use of MRI during ENT is limited.

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
 Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

	during neoadjuvant endocrine therapy in patients with ER+/HER2-breast cancer		during ENT were associated with PEPI after ENT. We focused on features that were previously associated with response or prognosis in NAC, namely: MRI features of the breast imaging data and reporting system (BIRADS), diffusion-weighted imaging (DWI) findings. and radiological response.	A concentric shrinkage pattern was associated with improved survival. Although pCR is typically used as a surrogate endpoint in neoadjuvant breast cancer trials, it is poorly associated with prognosis in ER+/HER2 breast cancer.
KIM et al., 2021.	Criteria for identifying residual tumors after neoadjuvant chemotherapy of breast cancers: a magnetic resonance imaging study	Retrospective study and applied the derived criteria in a prospective pilot cohort study.	To investigate the MRI evaluation criteria for detecting residual tumors in patients with NT and HER2+ breast cancer after NAC and apply these preliminary criteria to a pilot cohort.	50% of patients (145 of 290 patients) achieved a breast pCR, and among the subtypes, HR-HER2+ tumors achieved the highest pCR rate (62 of 90 patients), while HR+HER2+ tumors had the highest rate of pCR (62 of 90 patients). lower pCR rate (42 of 103 patients).
KOLIOS et al., 2021.	MRI texture features from tumor core and margin in the prediction of response to neoadjuvant chemotherapy in patients with locally advanced breast cancer.	Retrospective study.	To investigate whether pretreatment T2-weighted magnetic resonance imaging (MRI) can be used to predict response to neoadjuvant chemotherapy (NAC) in breast cancer.	Radiomic analysis of MR images using simple machine learning classifiers can predict the response and guide clinicians in prescribing effective treatments. Classifiers trained with pre-treatment MRI textures were shown to be 87% accurate in predicting the



JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

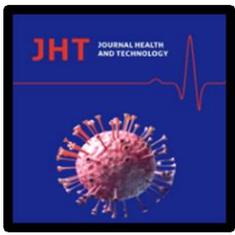
ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
 Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

				response to treatment of NAC.
ZHANG et al., 2021.	Potential of combination of DCE-MRI and DWI with serum CA125 and CA199 in evaluating effectiveness of neoadjuvant chemotherapy in breast cancer	Prospective study with 65 patients.	Provide useful information for improving the clinical diagnosis and treatment of breast cancer.	DCE-MRI and DWI imaging are effective in reflecting changes in lesions in breast cancer patients after neoadjuvant therapy. Serum levels of CA125 and CA199 reflect the impact of neoadjuvant chemotherapy in patients with regard to the risk of cancer cell metastasis and changes in some small lesions.
HWANG et al., 2022.	Phase II Single-Arm Study of Preoperative Letrozole for Estrogen Receptor-Positive Postmenopausal Ductal Carcinoma In Situ: CALGB 40903 (Alliance)	Phase II, single-arm, multicenter cooperative group study.	To assess the feasibility and evaluability of preoperative endocrine therapy for ductal cancer in situ (DCIS), to determine whether future studies of endocrine therapy alone for DCIS could be supported.	Biomarkers ER, PR and Ki67 were evaluated at baseline and at surgical excision after letrozole treatment. All three markers were significantly reduced with endocrine therapy. Breast MRI has been shown to be a useful indicator of response to neoadjuvant therapy in invasive cancer and is more highly correlated with pathologic extent than mammography.

Source: Prepared by the author, 2022.

DISCUSSION

Neoadjuvant therapy has advantages over adjuvant therapy, as it can reduce the tumor mass and thus safely lead to breast-conserving surgery, instead of total mastectomy, as well as to evaluate in vivo the biological behavior of the tumor against the adopted therapy. However, according to Michoux et al., (2015) indicated that the response rate to neoadjuvant therapy is limited and depends largely on the subtypes of breast cancer, as, for example, in patients with luminal B tumor / factor receptor 2 Human



epidermal growth (HER 2) negative, HER 2 positive (non-luminal) and triple negative tumors have longer disease-free survival, whereas luminal B/HER2 positive or luminal A tumors do not have good results.

According to research carried out by the Early Breast Cancer Trialists' Collaborative Group (EBCTCG), neoadjuvant therapy statistically correlates with a decrease in radical mastectomies and an increase in breast conservation than adjuvant therapy, with the greater effectiveness of the therapy was in patients who had large tumors (20-49mm or greater than 50mm) and thus made it possible to reduce the surgical extension, while in small tumors (less than 20mm) it did not have a good prognosis (ASSELAIN et al., 2018).

As breast cancer is a disease of heterogeneous nature, it has several subtypes and consequently different risks of progression and recurrence, as well as different treatment outcomes. Thus, therapies tend to be differentiated for each tumor type in order to obtain better results and significant improvements in disease-free survival. According to Loo et al., (2016), magnetic resonance imaging is effective in evaluating the pathological tumor response to neoadjuvant therapy, but the agreement between tumor regression and pathological response varies greatly according to the tumor subtype, as well as its prediction. survival outcome, reinforcing what was said in the 2015 study by Michoux.

Among the therapeutic forms for breast cancer are locoregional resection, radiotherapy, chemotherapy, endocrine therapy, targeted biological agents and a combination of the aforementioned, and the choice of method will be made according to the clinical, pathological and molecular characteristics. Biomarkers play a key role in replacing these features to establish prognoses and predict outcomes and thus contribute to the selection of patients most likely to benefit from adjuvant therapy, and predictive factors serve to predict the most effective therapy or measure the response to adjuvant therapy. neoadjuvant therapy (TAN et al., 2018).

According to Loo et al., (2016), several markers are routinely used to evaluate the treatment and choose the therapy that will be applied, and the most used include the estrogen receptor (ER), progesterone receptor (PR) and the epidermal growth receptor. human type 2. And according to immunohistochemical analysis it is possible to distinguish three main subtypes of breast cancer: triple negative (ER and PR and HER2 negative), HER2 positive (HER 2 positive (ER and PR can be positive or negative)) and ER positive/ HER2 negative (ER positive, HER2 negative (PR can be positive or negative)). Even within these subgroups, the response and outcome after chemotherapy varies greatly, as, for example, of patients with ER positive/HER 2 negative tumors, only a small fraction will achieve pCR.

In the review study by Tan et al., (2018) the status of ER, PR, HER2 and Ki-67 classifies into four molecular subtypes as luminal A, luminal B, HER2+ and TNBC (triple negative). Because they are different subtypes, the therapeutic strategies will also be different, for example, the best treatment for luminal A breast cancer is endocrine therapy alone without chemotherapy, while for luminal subtype B, a combination of endocrine therapy is required. with chemotherapy. In the HER2+ subtype, the best



JOURNAL HEALTH AND TECHNOLOGY - JHT ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO
NEOAJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

method is the treatment with double blockade of HER2 and TNBC, because it is a more complex and heterogeneous subtype, it presents different sensitivities of treatment and prognosis.

Many studies evaluate the role of MRI after neoadjuvant chemotherapy as a diagnostic tool to replace the final pathology by comparing the size of the tumor analyzed by MRI and by anatomopathological evaluation. Regarding the size of the tumor by MRI, an overestimation or underestimation may occur, resulting in false-negative and false-positive results. Other studies have shown that MRI accuracy in tumor estimation varies according to breast cancer subtype and tumor morphology, being more accurate in evaluating HER 2 positive and triple negative tumors.

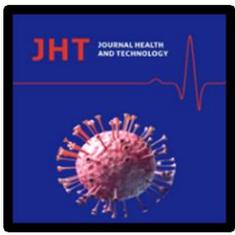
It is extremely important that the post-neoadjuvant therapy evaluation be carried out accurately and that it demonstrates the actual behavior of the tumor in the face of the adopted therapy, so it is essential to use effective diagnostic methods 55. Magnetic resonance imaging has already shown to be efficient in making this assessment, depending on the subtype of breast cancer. According to Dong et al., (2018), the use of contrast can increase the effectiveness of MRI through the enhancement of normal breast tissues and breast parenchyma (BPE). Where the greatest degree of reduction in BPE after neoadjuvant therapy was associated with a good tumor response according to tumor subtypes it varies greatly.

According to Bitencourt et al., (2020), MRI characteristics are directly associated with differences in HER2 expression levels and the pathological response after neoadjuvant therapy, being more accurate when the types of machine learning included clinical MRI parameters with the radiomic, as it allows the non-invasive evaluation of the entire tumor surface. This study showed 97% diagnostic accuracy to detect differences in HER2 expression, demonstrating that this model can contribute to the selection of patients with HER2 gene amplification without overexpression of this protein, being beneficial for anti-HER2 therapy.

Negrão et al., (2019) also corroborate, scoring in their retrospective study that MRI is 79% accurate in identifying the pathological response after neoadjuvant therapy, while its effectiveness in detecting the pathological complete response (pCR) was 75%. Its precision and sensitivity were higher in HER2 subtypes with 83% sensitivity and 74% specificity and triple negative.

Heacock and colleagues (2021) in their study evaluated potential predictors of pCR in mammography, ultrasound, and MRI for HER2+ patients and found that breast MRI is more accurate than ultrasound or mammography for staging and initial assessment of cancer. and MRI also demonstrated more accuracy in the assessment after neoadjuvant therapy when compared with ultrasound and mammography. Regarding the pCR evaluation, it was analyzed according to the concentric shrinkage pattern, which provides early identification when there is no good tumor response, which was proven in the study by Ragusi et al., (2021), where they demonstrated that the shrinkage pattern concentric is associated with improved survival.

According to Kolios et al., (2021) it is considered as locally advanced breast cancer (LABC) when the tumor mass is larger than 5 cm and when the primary disease involves the chest wall, skin or advanced metastasis in regional lymph nodes. MRI scans are frequently performed in patients with



JOURNAL HEALTH AND TECHNOLOGY - JHT ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO
NEOAJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

LABC to assess the staging of the disease and also to verify the response after neoadjuvant therapy (NAC) and thus assist in surgical decision making and to visualize the tumor extension and characterize the malignancy according to the morphological characteristics, it is essential that T1 and T2-weighted contrast sequences are performed.

While in some studies MRI demonstrates to underestimate or overestimate the tumor mass, mainly in invasive ductal carcinoma, in the study by Hwang et al. response to neoadjuvant treatment in invasive cancer.

In the study by Zhang et al., it was demonstrated that magnetic resonance imaging with contrast (DCE-MRI and DWI) is effective in evaluating the therapeutic effect of neoadjuvant chemotherapy and that some tumor markers reflect the biological behavior of the tumor in the face of the adopted treatment, such as the case of CA 15.3, CEA, CA 12.5 and CA 19.9. This evaluation is done through the serum dosage of these markers before therapy and after, where there was a reduction in the levels of these markers after neoadjuvant therapy, which is an excellent prognosis and the authors concluded that among the markers mentioned above, the ones that most apply in this post-neoadjuvant therapy assessment category are CA 12.5 and CA 19.9 together with the DCE-MRI and DWI diagnostic imaging technique.

In the research by Hwang et al., (2022) the main biomarkers evaluated were ER, PR and Ki67, these were analyzed at baseline and at surgical excision after treatment with letrozole and there was a significant reduction with endocrine therapy in invasive ductal carcinoma (DCIS). Also in this study, neoadjuvant endocrine therapy was shown to improve resectability and increase breast conservation rates, this benefit was first described by Boland et al., (2003), where they observed that women diagnosed with invasive ductal carcinoma who used Exogenous hormones had a reduction in Ki67 if therapy was stopped before surgery.

According to Simioni, Campos and Silva (2020), biomarkers are important because of their ability to assess clinical progression and also for allowing a more objective and targeted treatment, thus contributing to the increase in the survival of patients who are diagnosed with breast cancer. Also according to these authors, tumor markers are useful to detect cases of tumor recurrence and help in the development of new therapeutic measures. In this study, estrogen receptor, progesterone receptor, HER2/c-erbB-2 oncoprotein and Ki67 antigen markers were mentioned as a way to classify the luminal A, luminal B, Her2 and basal/triple negative molecular subtypes and thus direct the choice of treatment.

For Rosa et al., (2021), although the knowledge of molecular subtypes is recent, when compared with traditional parameters (size, tumor proliferation and lymph node status) it is very important for therapeutic planning and determination of prognosis in those patients affected by cancer, stating what was said by the other authors mentioned above. Since the behavior of each tumor subtype can be predicted according to its clinicopathological characteristics, together with other prognostic indicators.

FINAL CONSIDERATIONS

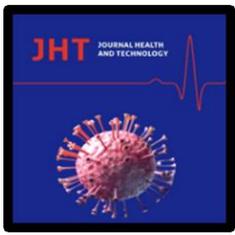
According to the study, it was possible to verify that breast cancer is the type that most affects women worldwide, being considered a major public health problem. It is characterized as a pathology of heterogeneous nature for having several types, and these are classified according to the place where it originated (ductal, lobular, mucinous and inflammatory) and also according to some molecular aspects, such as the presence of receptors (PR, ER, HER2 and TNBC). It is also considered as multifactorial because it has several risk factors that are associated with its development, these are classified based on lifestyle/environmental (obesity, alcohol consumption and frequent exposure to ionizing radiation), according to the life history. reproductive and hormonal (early menarche, late menopause, nulliparity...) and finally.

Neoadjuvant treatment proved to be efficient mainly in patients with a large tumor mass (50mm) and thus can direct those who were inappropriate due to tumor extension to surgery, or even direct those who were already destined for mastectomy to breast-conserving surgery. total. Some authors have reported that the response to therapy, despite being efficient, has some limitations according to tumor subtypes, such as, in luminal B/HER2-, HER2+ (non-luminal) and triple negative tumors, there is greater disease-free survival, whereas in luminal B/HER2+ or luminal A tumors they do not show a good response.

It is important to associate magnetic resonance imaging and tumor markers to predict the biological behavior of the tumor in the face of neoadjuvant therapy, because through the markers it is possible to identify the tumor subtype and thus define which type of therapy will be adopted (chemotherapy, radiotherapy, target, endocrine therapy and immunotherapy) and assess the level of cell proliferation. The main biomarkers cited were CA 15.3, CA 19.9, HER2, Ki67, PR and ER. Just as the response to neoadjuvant therapy varies by tumor subtype, the effectiveness of MRI in assessing this response also varies by subtype, being more effective in analyzing HER2+ and triple negative tumors. It is noteworthy that the use of contrast increases the effectiveness of MRI by enhancing the tissues.

REFERENCES

- ALEIXO, A. A. R. **Characterization of cellular infiltrate, evaluation of microvascular density markers (CD31, CD105) and cell proliferation marker (Ki67) in 4T1 breast cancer in mice treated with dendritic cell vaccine, interferon-alpha therapy and combined therapy.** 2018. Thesis (Doctorate) - Graduate course in Health Sciences at the Federal University of Triângulo Mineiro, Uberaba, MG, 2018.
- ANDRADE, N. P. P. **Study of magnetic resonance imaging with diffusion in the evaluation of response to neoadjuvant chemotherapy for patients with breast cancer.** 2018. Thesis (Doctorate) - Graduate Course in Sciences, Antônio Prudente Foundation, São Paulo, 2018.
- ASSELAIN, B. *et al.* Long-term outcomes for neoadjuvant versus adjuvant chemotherapy in Early breast cancer: meta-analysis of individual patient data from ten randomised trials. **The Lancet Oncology**, v. 19, n. 1, p. 27-39, 2018.



JOURNAL HEALTH AND TECHNOLOGY - JHT

ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

BARBOSA, M. G. A. *et al.* Cytological changes and specific tumor markers for breast cancer. **Braz. J. of Develop**, n. 8, v. 6, p. 59977-59992, 2020.

BENEVIDES, V. C.; BATISTA, R. C.; VILELA, L. F. Targeted therapy for HER2 positive breast cancer. **Rev. Episteme Transversalis**, v.11, n.3, p.319-339, 2020.

BERNARDES, N. B. *et al.* Breast Cancer X Diagnosis. **Id on Line Rev. Mult. Psic**, v. 13, n. 44, p. 877-885, 2019.

BITENCOURT, A. G. V. *et al.* MRI-based machine learning radiomics can predict HER2 expression level and pathologic response after neoadjuvant therapy in HER2 overexpressing breast cancer. **E Bio Medicine**, n. 61, p. e103042, 2020.

BONILLA-SPÚLVEDA, O. A. Marcadores tumorales em câncer de mama. Revisión sistemática. **Ginecol Obstet Mex.**, v. 88, n.12, p.860-869, 2020.

CECILIO, A. P. *et al.* Breast cancer in Brazil: epidemiology and treatment challenges. **Breast Cancer: Targets and Therapy**, v. 7, p. 43-49, 2015.

COSTA, L. S. *et al.* Risk factors related to breast cancer and the importance of early detection for women's health. **Electronic Magazine Scientific Collection**, v. 31, p. e8174, 2021.

DAGNONI, C. *et al.* Clinical and tumoral profile of patients undergoing neoadjuvant treatment for breast cancer at Erasto Gaertner Hospital. **Rev Bras Mastologia**, n. 26, v. 4, p. 158-163, 2016.

DELMONICO, L.; ALVES, G.; AMARAL, L. The biology of breast cancer and molecular prognostic tests. **Revista Hupe**, v. 14, n. 1, p. 59-65, 2015.

DIEGUEZ, C. M. T. The quantum fundamentals of Nuclear Magnetic Resonance. **Brazilian Journal of Physics Teaching**, v. 40, n. 1, p. e1310, 2018.

DONG, J. M. *et al.* Changes in background parenchymal enhancement in HER2-positive breast cancer before and after neoadjuvant chemotherapy Association with pathologic complete response. **Medicine**, v. 97, n. 43, 2018.

FERREIRA, S. S. Indications for breast magnetic resonance imaging at a reference center for the diagnosis and treatment of breast cancer in Brazil. **Radiol Bras.**, v. 54, n. 2, p. 83-86, 2021.

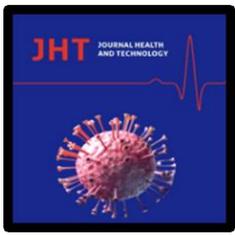
FRANÇA, L. K. L. *et al.* Role of magnetic resonance imaging in the therapeutic planning of patients with breast cancer: comparison with conventional exams. **Radiol Bras.**, v. 50, n. 2, p. 76-81, 2017.

FRANCISCO, P. S. B. *et al.* Prevalence of diagnosis and types of cancer in the elderly: data from the 2013 National Health Survey. **Rev. Bras. Geriatr. Gerontol.**, v. 23, n. 2, p. e200023, 2020.

GONÇALVES, M. A.; RAMALHO, C.T. Contrast Agents for Magnetic Resonance Imaging: A Review. **Rev Virtual Quim.**, v. 9, n. 4, p. 1511-1524, 2017.

HEACOCK, L. *et al.* Dynamic contrast-enhanced MRI evaluation of pathologic complete response in human epidermal growth factor receptor 2 (HER2) -positive breast cancer after HER2-targeted therapy. **Acad Radiol.**, v. 27, n. 5, p. e87-e93, 2021.

JESUS, J. C. R.; OLIVEIRA, C.J.R. Tumor molecular markers. **Brazilian Journal of Biomedical Sciences**, v. 1, n. 1, p. 43-49, 2020.



JOURNAL HEALTH AND TECHNOLOGY - JHT

ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO NEOADJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

KOLIOS, C. MRI texture features from tumor core and margin in the prediction of response to neoadjuvant chemotherapy in patients with locally advanced breast cancer. **Oncotarget**, v. 12, n. 14, p. 1354-1365, 2021.

LO, W. C. *et al.* Effect of Imaging Parameter Thresholds on MRI Prediction of Neoadjuvant Chemotherapy Response in Breast Cancer Subtypes. **Journal pone**, p. e0142047, 2016.

LOO, C. E. *et al.* Survival is associated with complete response on MRI after neoadjuvant chemotherapy in ER-positive HER2-negative breast cancer. **Breast Cancer Research**, v. 18, n. 82, 2016.

MACHADO, D. *et al.* **Screening methods for detecting breast cancer and the importance of the applicability of cytological evaluation in the diagnosis.** [S. l.: s. n.], 2017. available in: <https://newslab.com.br/metodos-de-rastreamento-para-deteccao-do-cancer-mama-e-a-importancia-da-aplicabilidade-da-avaliacao-citologica-no-diagnostico/>. Acesso em: 08 set. 2021.

MATOS, S. E. M.; RABELO, M. R. G.; PEIXOTO, M. C. Epidemiological analysis of breast cancer in Brazil: 2015 to 2020. **Brazilian Journal of Health Review**, v. 4, n. 3, p.13320-13330, 2021.

MAZZOLA, A. A. *et al.* Safety in Magnetic Resonance Imaging. **Brazilian Journal of Medical Physics**, v. 13, n. 1, p. 76-91, 2019.

MENDES, K. D. S.; SILVEIRA, R. C. C. P.; GALVÃO, C. M. Use of a bibliographic reference manager in the selection of primary studies in an integrative review. **Text and context Nursing**, v. 28, p. e20170204, 2019.

MICHOUX, N. *et al.* Texture analysis on MR images helps predicting non-response to NAC in breast cancer. **BMC Cancer**, v.15, n. 574, 2015.

NATIONAL CANCER INSTITUTE (BRASIL). **Cancer statistics.** Brasilia: INCA, 2021. available in: <https://www.inca.gov.br/numeros-de-cancer>. Acesso em: 20 ago. 2021.

NEGRÃO, E. M. S. *et al.* Accuracy of breast magnetic resonance imaging in assessing response to neoadjuvant chemotherapy: study of 310 cases in an oncology center. **Radiol Bras.**, n. 52, v. 5, p. 299-304, 2019.

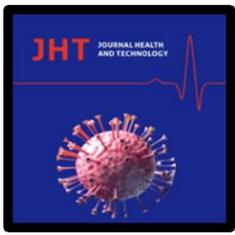
NEGRÃO, E. M. S. *et al.* Breast cancer phenotype influences MRI response evaluation after neoadjuvant chemotherapy. **European Journal of Radiology**, v. 120, 2019.

PEIXOTO, N. **Multiparametric breast MRI protocols: an integrative literature review.** Advisor: Jâmeson da Silva. 2018.41f. TCC (Technologist) - Radiology Technology Course, Department of Information, Environment, Health and Food Production, Federal Institute of Education, Science and Technology of Piauí, Teresina, Piauí, 2018. available in: <http://bia.ifpi.edu.br:8080/jspui/handle/prefix/449>. Acesso em: 30 ago.2021.

ROSA, K. G. *et al.* **The importance of molecular classification in breast cancer prognosis: Current perspectives,** 2021. available in: <http://revistas.unievangelica.com.br/index.php/refacer/article/download/5879/4094>. Acesso em: 08 set. 2021.

SÁNCHEZ, R. C. *et al.* Cáncer de mama: Modalidades terapêuticas y marcadores tumorales. **Cuad. Cird**, n. 22, p. 55-63, 2018.

SANTANA, N. P. P.; BORGES, A. R. maging exams in the screening and diagnosis of breast cancer: Magnetic resonance imaging of the breasts compared to mammography. **Psychology and Health in Debate**, v. 1, n.1, p. 19-38, 2015.



JOURNAL HEALTH AND TECHNOLOGY - JHT ISSN 2764-7625

ASSOCIATION OF MAGNETIC RESONANCE AND TUMOR MARKERS IN PATIENTS SUBMITTED TO
NEOAJUNCT TREATMENT OF BREAST CANCER: AN INTEGRATIVE REVIEW
Cleidelane Rocha Coelho, Carlos Danilo Cardoso Matos Silva, Marcus Vinicius Cardoso Matos Silva

SILVA, H. R. *et al.* Prevalence and risk factors association between obesity and breast cancer. **Research, Society and Development**, v. 9, n. 3, p. e62932385, 2020.

SILVA, M. P.; CAMPOS, R. A.; SIMIONI, P. U. Tumor serological biomarkers of breast cancer: literature review. **Saúde Rev.**, v. 20, n. 52, p.67-73, 2020.

VARGAS, D. A. M. **Valor predictivo de los marcadores tumorales Ca-15.3 y Antígeno Carcinoembrionario (CEA) em el tratamiento y seguimiento de las pacientes com câncer de mama atendidas em el Hospital de Especialidades Eugenio Espejo durante em ano 2016.** 2018. 86f. Monograph (Graduation) - Facultad de Ciencias Químicas, Universidad central del Ecuador, DMQ, Quito, 2018.

YAN, Y.; SUN, X.; SHEN, B. Contrast agents in dynamic contrast-enhanced magnetic resonance imaging. **Oncotarget.**, v. 8, n. 26, p. 43491-43505, 27 jun. 2017. doi: 10.18632/oncotarget.16482. PMID: 28415647; PMCID: PMC5522164.

ZHANG, A. *et al.* The role of Ki67 in evaluating neoadjuvant endocrine therapy of hormone receptor-positive breast cancer. **Frontiers in Endocrinology**, v.12, 2021.

ZHANG, J. *et al.* Potential of combination of DCE-MRI and DWI with serum CA125 and CA199 in evaluating effectiveness of neoadjuvant chemotherapy in breast cancer. **World Journal of Surgical Oncology**, v. 19, n. 284, 2021.