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The Reliability and Accuracy of Magnetic Resonance Imaging for the Diagnosis of Malignant Breast Lesions

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ABSTRACT

Objective: Examining the reliability of magnetic resonance spectroscopy in diagnosing malignant breast lesions, with histology serving as the gold standard, is the objective of this study. **Methods:** In this cross-sectional research 110 females were included. Before collecting data, patients signed a consent form acknowledging the risks. Dynamically enhanced magnetic resonance (MRS) images were studied for their kinematics and morphology. MRS's choline peak (Cho) was used to detect cancer. Single-voxel technique was used to evaluate MRS' diagnostic accuracy in cancer. MRS and biopsies were compared. **Results:** The patients mean age was 48.13±12.54 years and had mean BMI 26.25±9.61 kg/m2. Histological analysis revealed malignant lesions in 82 cases (74.5%), whereas magnetic resonance imaging (MRI) confirmed the presence of malignant lesions in 90 patients (81.8%). When using MRS to diagnose malignant tumors, the most common morphologies observed were ductal enhancement and peripheral enhancement. In terms of specificity, accuracy, sensitivity, NPV, and PPV, MRS demonstrated a performance of 88%, 92%, 72%, and 94%, respectively. **Conclusion:** The superior specificity, sensitivity, and accuracy of MRS make it an indispensable tool for identifying breast masses. When it comes to diagnosing breast cancer, MRS is a specialized, sensitive, and efficient method.

INTRODUCTION

On a global scale, breast cancer is the leading cause of cancer-related deaths among females and the most common malignancy overall. This holds true in countries that are both developing and well-developed. In 2011, the incidence of breast cancer was low in most developing countries of the world, while it was high in industrialized parts of the globe (>80 per 100,000) [1,2].

Patients' chances of survival from breast cancer are still influenced by how fast the disease is identified and treated in its early stages, even with therapeutic advancements [3,4]. Imaging techniques like magnetic resonance imaging (MRI), ultrasonography (US), and mammography can commonly detect breast cancer in its early stages. Mammography is the go-to method for breast cancer screening programs due to its benefits in terms of reliability, simplicity of use, and direct comparison with mammograms from previous research [3].

Although the MMG is capable of detecting masses, breast USG remains the most effective method for describing them or for use as an extra screening tool [5]. There is already evidence that ultrasound can detect small cancers that are not apparent to the naked eye, even when viewed by mammography, in women with dense breasts. As far as breast imaging techniques go, magnetic resonance imaging (MRI) is the most sensitive for detecting invasive breast cancer, regardless of the density or quantity of fibroglandular tissue, fibrous scarring, radiation, breast implants, or any other type of breast reconstruction. But this method has a lot of problems that make it not good for regular use. The method's low specificity and high false positive rate are debated, and there is no globally agreed standard for acquisition procedures or interpretation guidelines. Additionally, it is more expensive [6].

For early detection, magnetic resonance imaging (MRI) is superior to mammography in high-risk patients, especially those with dense breast tissue, because of MRI's high sensitivity. Because MRI can detect breast tumors that are invisible to the human eye or mammography, it has the ability to change patient care [7]. Moreover, MRI findings can be used to improve the evaluation of cancer residual after neoadjuvant chemotherapy [8]. Nevertheless, MRI can lead to unnecessary biopsies, patient anxiety, and expense due to its high sensitivity and low-to-moderate specificity [9].

The utilization of high-field-strength (3 T) MRI machines is on the rise in clinical settings. You can obtain the spatial and temporal resolution you need to reliably

detect lesions and associated increased patterns with the right acquisitions since these systems are designed with a high signal-to-noise ratio [10].

Researchers found that 89.5% of the time, benign breast cancers could be accurately identified using magnetic resonance spectroscopy (MRS), while 92.3% of the time, malignant ones could be. the eleith Our goal was to fill the gaps left by earlier research by determining how well magnetic resonance spectroscopy (MRS) identified cancerous breast lesions in a population-based sample. It would be helpful for practitioners to know whether there is a noninvasive pre diagnostic method that can accurately diagnose these individuals so they can lessen their morbidity and mortality. The general public and the sufferers alike would gain from this. [12] Patients would feel less burdened and healthcare costs would go down as a result of fewer breast lesions requiring pure diagnostic biopsies.

MATERIAL AND METHODS

This cross-sectional study was conducted at Syed Naseer Ahmed

Assistant Professor, Department of Radiology, Sheikh Khalifa Bin Zayyed Hospital, Pakistan comprised of 110 females. Every patient was asked to sign an informed consent form before any demographic information was collected. No one who had previously had surgery or chemotherapy, or who was less than 20 years old, could take part in this trial.

Using dynamically enhanced photos acquired from 1.5 Tesla MRI scanners, the structure and dynamics of magnetic resonance spectroscopy (MRS) were studied. A biomarker for cancer called the choline peak (Cho) was located and measured using MRS. To find out how well MRS could detect cancerous breast tumors, a single-voxel study was run.

To reduce the effect of the patient's mobility when lying down, a double breast coil was used for each scan. Both breasts were gently compressed throughout the imaging. An intervention line's 20-22 cannula gauges, which are secured by a three-way stopcock, can be fine-tuned for precise contrast infusion. Maximum intensity projection (MIP) in three dimensions using multi-planar reconstruction with narrow slices for fat suppression and subtraction. In order to facilitate the use of MRS for contrast-enhanced pictures, a 20 mL intravenous saline flush was given following the initial 20-second injection, at a dosage of 0.2 mL/kg. A total of seven minutes and thirty-five seconds were required for the complete process, which involved four scans following contrast. Types II and III kinetic curves, which show spiculated boundaries and ductal patterns or peripheral rims, were employed for MRS cancer diagnosis.

By examining the morphological and kinetic features of breast cancer lesions, the frequency and percentage were calculated using SPSS version 26. We compared the MRS diagnostic tests' NPV, PPV, specificity, accuracy, and sensitivity to values derived from histopathology.

RESULTS

Among all 25 (22.7%) had age 21-30 years, 27 (24.5%) cases had age 31-40 years and 58 (52.7%) case had age > 40 years. (Table 1)

Table 1

Characteristics of enrolled cases

Age	Frequency	Percentage
21-30 (years)	25	22.7
31-40 (years)	27	24.5
41-50 (years)	58	52.7

Histological analysis revealed malignant lesions in 82 cases (74.5%), whereas magnetic resonance imaging (MRI) confirmed the presence of malignant lesions in 90 patients (81.8%). (table 2)

Table 2

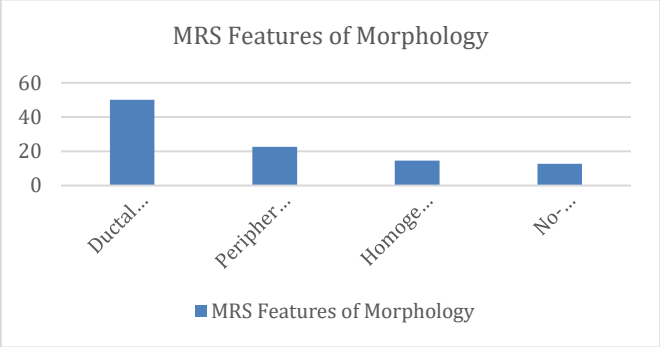
The prevalence of malignant lesion MRS and its histopathological consequences

Malignant Lesion	Frequency	Percentage
Histological analysis		
Yes	82	74.5
No	28	25.5
MRI		
Yes	90	81.8
No	20	18.2

When using MRS to diagnose malignant tumors, the most common morphologies observed were ductal enhancement and peripheral enhancement.(figure 1)

Figure 1

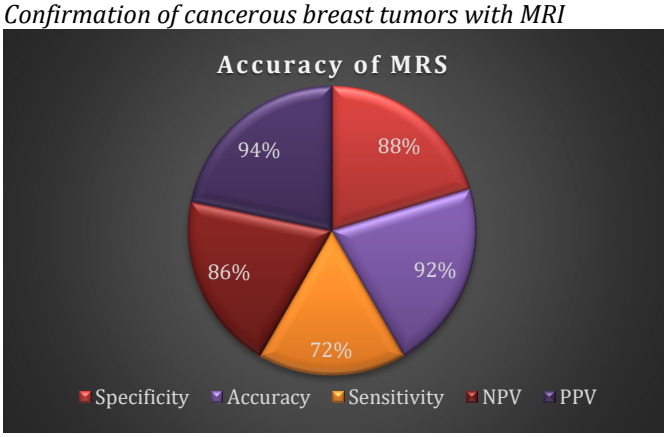
Analysis of MRS morphology



In terms of specificity, accuracy, sensitivity, NPV, and PPV, MRS demonstrated a performance of 88%, 92%, 72%, and 94%, respectively. (Figure 2)

Figure 2

Confirmation of cancerous breast tumors with MRI



DISCUSSION

Concerns over the health of the general population continue to be raised in relation to breast cancer [13]. There are two basic approaches that are applied in the treatment of breast cancer. These methods are conventional single-photon microscopy (SMG) and contrast-enhanced magnetic resonance imaging (CE-MRI). A somewhat high level of sensitivity is provided by the latter technique when it comes to the depiction of malignancy [14]. Because it makes use of the minute mobility of water molecules, it is possible to quantify the DW-ability of MRIs in order to differentiate between various types of cancer by measuring its ADC [15]. This is made possible by the fact that it relies on the mobility of water molecules. In light of the fact that it accomplishes this differentiation, this is a fundamental assumption. The evaluation of tissue stiffness that is carried out by elastography has the potential to be of assistance in raising the diagnostic certainty for cancer [16].

Their body mass index (BMI) was 26.25±9.61 kg/m2, and their average age was 48.13±12.54 years. The average age of the patients was 48.13±12.54 years. 65 (81.8%) of the patients were discovered to have malignant lesions by MRS, while 58 (74.5%) of the cases were identified to have malignant lesions according to the findings of the histological examination. Both of these findings were published in the journal Cancer Research. The results of this study displayed a significant degree of congruence with those of an earlier investigation. According to [17] the majority of individuals who were diagnosed with malignant lesions by MRS had either a ductal or peripheral enhancement present in their bodies. [18] Bartella et al. [19] conducted an investigation into the diagnostic efficacy of magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) by using a sample of 56 individuals who had 57 separate anomalies (level III-2 diagnostic evidence). There were 57 lesions that were biopsied throughout the course of the study, and only 17 of them were proven to be malignant. Additionally, an additional 40 lesions were recommended for further investigation. After conducting a biopsy, which is considered to be the gold standard, on each of the 57 lesions, it was found that 31 of them were potentially cancerous, while the remaining 26 were deemed to be benign. In contrast, all 31 of the malignant lesions that were biopsied had a substantial peak (100 percent) (88 percent specificity). This is in contrast to the fact that more than half of the benign lesions, or 23 out of 26, did not have a choline peak.

As far as specificity, accuracy, sensitivity, net present value, and positive predictive value are concerned, the MRS demonstrated a performance of 88%, 92%, 72%, and 94%, respectively, in the inquiry that is now being conducted. The sensitivity, specificity, net present value, and positive predictive value of MRS have been shown to range anywhere from 94% to 98%, according to the findings of the research that has been carried out [20]. In order to demonstrate that their findings were statistically significant, the researchers used a p-value of 0.001 in themselves. In the process of attempting to identify breast lesions that were cancerous, an estimated diagnosis accuracy of 86.7% was attained. When it comes to the MRS guideline for preoperative illness features and reliable diagnosis, statistical research was the foundation upon which the guideline was built. The findings of Brennan S. and colleagues [21] indicated that MRS had the ability to eliminate the need for a biopsy in more than half of the BI-RADS 4 lesions without resulting in the absence of any cancers. This was observed in the absence of any malignancies. When the results of other methods are compared to those of MRS, it has been discovered that MRS is accurate between 89.5% and 92.35% when it comes to detecting malignant breast cancers as opposed to benign breast tumors. This is the case when comparing the results of MRS to those of other methods. [22] The overall performance of quantitative DW-MRI was shown to be superior for BIRADS 3 lesions in comparison to BIRDS 4 lesions, as was discovered. While the former had a sensitivity of 100%, a specificity of 86.11, and an accuracy of 86.49, the latter had a sensitivity of 74.07%, a specificity of 50%, and an accuracy of 72.41%. The former was superior than the latter in terms of accuracy. One of the disadvantages of this research is that the sample population was only a small portion of the whole population. As a result, it is challenging to arrive at definitive findings on the subgroups. Previous investigations have showed that the ADC values of benign and malignant lesions are different from one another. Additionally, it has been established that DW-MRI can improve the diagnostic test of suspicious breast lesions and lower the number of samples that are undesirable [23].

CONCLUSION

MRS must be employed because of its better specificity, sensitivity, and accuracy in characterizing breast lumps. MRS is a specific, sensitive, and effective diagnostic technique for breast cancer.

REFERENCE

1. Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R. L., Torre, L. A., & Jemal, A. (2018). 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), 394–424. https://doi.org/10.3322/caac.21492
2. Quintanilha, L. F., Souza, L. N., Sanchez, D., Demarco, R. S., & Fukutani, K. F. (2019). The impact of cancer campaigns in Brazil: A Google trends analysis. *ecancermedicalscience*, *13*. https://doi.org/10.3332/ecancer.2019.963
3. Becker, S. (2015). A historic and scientific review of breast cancer: The next global healthcare challenge. *International Journal of Gynecology & Obstetrics*, *131*, S36–S39. https://doi.org/10.1016/j.ijgo.2015.03.015
4. Barke, L. D., & Freivogel, M. E. (2017). Breast Cancer Risk Assessment Models and High-Risk Screening. *Radiologic Clinics of North America*, *55*(3), 457–474. https://doi.org/10.1016/j.rcl.2016.12.013
5. Joe, B. N., & Sickles, E. A. (2014). The Evolution of Breast Imaging: Past to Present. *Radiology*, *273*(2S), S23–S44. https://doi.org/10.1148/radiol.14141233

6. Stavros, A. T., Freitas, A. G., DeMello, G. G., Barke, L., McDonald, D., Kaske, T., Wolverton, D., Honick, A., Stanzani, D., Padovan, A. H., Moura, A. P., & De Campos, M. C. (2017). Ultrasound positive predictive values by BI-RADS categories 3–5 for solid masses: An independent reader study. *European Radiology*, *27*(10), 4307-4315. https://doi.org/10.1007/s00330-017-4835-7
7. Kuhl, C. (2007). The Current Status of Breast MR Imaging Part I. Choice of Technique, Image Interpretation, Diagnostic Accuracy, and Transfer to Clinical Practice. *Radiology*, *244*(2), 356–378. https://doi.org/10.1148/radiol.2442051620
8. Wadhwa, A., Sullivan, J. R., & Gonyo, M. B. (2016). Missed Breast Cancer: What Can We Learn? *Current Problems in Diagnostic Radiology*, *45*(6), 402–419. https://doi.org/10.1067/j.cpradiol.2016.03.001
9. Huynh, P. T., Jarolimek, A. M., & Daye, S. (1998). The false-negative mammogram. *RadioGraphics*, *18*(5), 1137–1154. https://doi.org/10.1148/radiographics.18.5.9747612
10. Stephens, T. W. (2012). Prosthetic Breast Implant Rupture: Imaging—Pictorial Essay. *Yearbook of Diagnostic Radiology*, *2012*, 45–46. https://doi.org/10.1016/j.yrad.2012.01.005
11. Orel, S. G., & Schnall, M. D. (2001). MR imaging of the breast for the detection, diagnosis, and staging of breast cancer. *Radiology*, *220*(1), 13-30. https://doi.org/10.1148/radiology.220.1.r01jl3113
12. Bhooshan, N., Giger, M. L., Jansen, S. A., Li, H., Li, L., & Newstead, G. M. (2010). Cancerous Breast Lesions on Dynamic Contrast-enhanced MR Images: Computerized Characterization for Image-based Prognostic Markers. *Radiology*, *254*(3), 680–690. https://doi.org/10.1148/radiol.09090838
13. Partridge, S. C., Mullins, C. D., Kurland, B. F., Allain, M. D., DeMartini, W. B., Eby, P. R., & Lehman, C. D. (2010). Apparent diffusion coefficient values for discriminating benign and malignant breast MRI lesions: effects of lesion type and size. *American Journal of Roentgenology*, *194*(6), 1664-1673. https://doi.org/10.2214/AJR.09.3534
14. Robbins, J., Jeffries, D., Roubidoux, M., & Helvie, M. (2011). Accuracy of diagnostic mammography and breast ultrasound during pregnancy and lactation. *American Journal of Roentgenology*, *196*(3), 716-722. https://doi.org/10.2214/ajr.09.3662
15. Yabuuchi, H., Matsuo, Y., Okafuji, T., Kamitani, T., Soeda, H., Setoguchi, T., Sakai, S., Hatakenaka, M., Kubo, M., Sadanaga, N., Yamamoto, H., & Honda, H. (2008). Enhanced mass on contrast-enhanced breast MR imaging: Lesion characterization using combination of dynamic contrast-enhanced and diffusion-weighted MR images. *Journal of Magnetic Resonance Imaging*, *28*(5), 1157-1165. https://doi.org/10.1002/jmri.21570
16. Newell, D., Nie, K., Chen, J., Hsu, C., Yu, H. J., Nalcioglu, O., & Su, M. (2009). Selection of diagnostic features on breast MRI to differentiate between malignant and benign lesions using computer-aided diagnosis: Differences in lesions presenting as mass and non-mass-like enhancement. *European Radiology*, *20*(4), 771-781. https://doi.org/10.1007/s00330-009-1616-y
17. El Khouli, R. H., Macura, K. J., Jacobs, M. A., Khalil, T. H., Kamel, I. R., Dwyer, A., & Bluemke, D. A. (2009). Dynamic contrast-enhanced MRI of the breast: Quantitative method for kinetic curve type assessment. *American Journal of Roentgenology*, *193*(4), W295-W300. https://doi.org/10.2214/ajr.09.2483
18. Kneeshaw, P. J., Turnbull, L. W., & Drew, P. J. (2003). Current applications and future direction of MR mammography. *British Journal of Cancer*, *88*(1), 4-10. https://doi.org/10.1038/sj.bjc.6600713
19. Bogner, W., Gruber, S., Pinker, K., Grabner, G., Stadlbauer, A., Weber, M., Moser, E., Helbich, T. H., & Trattnig, S. (2009). Diffusion-weighted MR for differentiation of breast lesions at 3.0 T: How does selection of diffusion protocols affect diagnosis? *Radiology*, *253*(2), 341-351. https://doi.org/10.1148/radiol.2532081718
20. Shafqat, G., Agha, A., Masror, I., Rehan, M., & Afzal, S. (2011). Dynamic contrast enhanced MRI breast for lesion detection and characterization with histopathological co relation: Preliminary experience at tertiary care hospital. *Journal of the Pakistan Medical Association*, *61*(3), 252. https://ecommons.aku.edu/pakistan_fhs_mc_radiol/26/
21. Berg, W. A., Gutierrez, L., NessAiver, M. S., Carter, W. B., Bhargavan, M., Lewis, R. S., & Ioffe, O. B. (2004). Diagnostic accuracy of mammography, clinical examination, US, and MR imaging in preoperative assessment of breast cancer. *Radiology*, *233*(3), 830-849. https://doi.org/10.1148/radiol.2333031484
22. Ko, E. Y., Han, B., Shin, J. H., & Kang, S. S. (2007). Breast MRI for evaluating patients with metastatic axillary lymph node and initially negative mammography and sonography. *Korean Journal of Radiology*, *8*(5), 382. https://doi.org/10.3348/kjr.2007.8.5.382
23. Hata, T., Takahashi, H., Watanabe, K., Takahashi, M., Taguchi, K., Itoh, T., & Todo, S. (2004). Magnetic resonance imaging for preoperative evaluation of breast cancer: A comparative study with mammography and ultrasonography. *Journal of the American College of Surgeons*, *198*(2), 190-197. https://doi.org/10.1016/j.jamcollsurg.2003.10.008