

Application of Radiomics in Breast Cancer Diagnoses

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IMPORTANCE The emerging technology of Radiomics has brought a revolution in the field of medicine regarding the diagnoses. The technique is being used to diagnose and interpret the various types of cancers based on imaging characterizations. The manual methods of diagnosis have many limitations in terms of reliability. There are many annotations of tumors, and to recognize a specific type of tumor is not less than a challenge, which could be fulfilled through this technology. In this study, diagnostic approaches and the potential of radiomics has been assessed. Moreover, all the MRI-derived parameters were also explained to make the discussion strong.

METHODS The analyses of data were made based on secondary data. 450 researched articles were reviewed, 57 articles were identified and 9 articles were selected for the scientific literature review.

RESULT Radiomics modalities are advanced and accurate in their approach. The value of Ki67 is associated with the growth rate of a tumor. Radiologists have increased the accurate diagnostic percentage by using radiometric technology. Texture technique as a diagnostic has the highest accuracy level. Various imaging techniques depict different diagnostic results based on their principles. The Expression of the Ki67 strongly correlated with three texture features.

CONCLUSION This study aimed to help clinicians and radiologists to know the basic information of radiomics for better application in clinical practice.

KEY WORDS Radiomics and Breast cancer, Radiomics modalities, Prognostic factors, Tumors

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Systematic Literature Review

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Breast cancer is one of the most emerging and hot burning health hazards among women. A large number of women lost their lives, every day due to this disease¹. The recovery and treatment of the disease depends upon early diagnosis. The survival rate in the disease depends upon accurate and timely diagnoses. The concept of data system and Breast imaging reporting provide strong and reliable communication between the radiologists and clinicians and help to evaluate the types of tumors in the patient of breast cancer. Moreover, a hormonal and molecular feature of the disease is also related to successful treatment. There are two major diagnostic tools for the disease; one is the conventional method and the other is the technology-based Radiomics method². The former method is invasive and carried out by taking the tissue and making histopathological analyses. The method has many limitations and its reliability depends upon the expertise of the radiologists. The other drawback of the disease is that it couldn't provide the heterogeneity of the whole tumor rather provides a piece of limited information about the type of lesions³. While in the latter method, imaging data is extracted and analyzed by comparing tissue images with many parameters. Basically, It is the non-invasive and tissue-based imaging characterization technology that is developing day by day³. The quantitative data is extracted from the medical images and analyzed the underlying features of the pathological conditions of tumors through machine learning. The technique analyzes the condition on a molecular and genetic level for breast cancer, Archives of Surgical Research

prostate cancer, and brain cancer⁴. The results obtained from these analyses are compared with the existing medical data of the disease, and most of the results are divergent. There are also some limitations of the technique including; the results of the Radiomics analyzes depend upon the inter-reader viability of the tumor annotation. Studies require manual or semi-automated segmentation of the tumor carried out by the radiologists. Due to this reason, the results which are obtained are divergent for different tumor annotations⁴.

METHODS:

The research was carried out based on existing scientific data. Data was obtained from the most reliable scientific cites named, PubMed, NCBI online library, NIH, BioMed central, Web MD, and open MD. Qualitative and metaanalyses were performed to analyze the selected data. The keywords to search the articles from the database are breast cancer and radiomics, Radiomics and mammography, breast-ultrasound, breast elastoplastic, Radiomics and breast lesions, texture analyses and mammography.

Inclusion and Exclusion Criteria

The data is not selected randomly, but has a certain inclusion criterion.

Inclusion Criteria

To include the data, the guidelines of PRISMA are followed in the research review. In the first category, 450 scientific articles were identified. Out of 450 articles, 57 were selected. For scientific review, 9 most reliable and relevant articles were selected. All the selected articles were peer-reviewed, randomized trials, review articles, and systemic review articles published from Jan 2010. All the researched articles were able to give detailed information about the application of radiomics in breast cancer diagnoses.

Exclusion Criteria

Articles without strong background or abstract were excluded. Articles that were very old and dated back to 20 years old were excluded. Articles in which sufficient numbers of references were not given were also excluded. No article from an ordinary website was included in research.

Data Extraction and Analyses

The electronic raw material from the articles was extracted and organized in a specific form. Irrelevant information was excluded and most relevant information about the hypothesis was organized in a table form. To locate the data specific coding was used, named physical coding. Extracted data organized in a table form. The selected data was cross-checked three times by two reviewers. The thematic analyses were also performed to make the analyses more advanced.

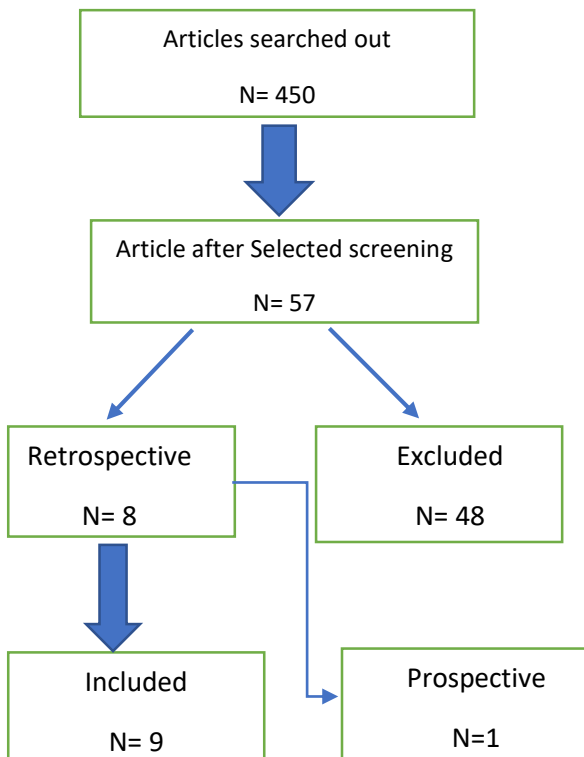


Figure 1: Demonstration method used to select articles

RESULTS:

After analyzing the data, it was confirmed that the radiomics modalities are far better than any other modalities in terms of efficiency and reliability. When median and coefficient median modalities were compared with the radiomics modalities, there was a clear difference between these modalities in terms of specificity and sensitivity for the diagnoses and differentiation of the lesions. The other study disclosed that expert radiologist when using constrained and unconstrained MRI, they perform better than the models of the radiomics. It was a peculiar and new discovery as it was always expected that radiomics models are more efficient, but it is not true under certain conditions. The efficiency and accuracy for diagnoses of breast cancer are increased when experts utilize the radiomics technology. So, the combination of manual expertise with technology always mimics in terms of efficiency.

Holli et al have investigated features of the tissue, based on texture. Then, he utilized the MRI-DCE technique to differentiate between normal breast tissue and breast cancer tissue. The accuracy level for the breast cancer diagnoses by using the texture technique was 100%. Another study disclosed that the accuracy of the diagnoses can be increased up to 90% by combining various models such as the multivariant model, kinetic parameters, morphological models, and ADC values. It was also found that the encashment of the normal breast tissues on the DCE-MRI would create a negative impact on the MRI radiological diagnoses. In this way, the accuracy rate of breast cancer decreased as normal tissues mimic the abnormal cancerous tissues leading to false diagnoses. The results of the texture-based macrocalcification for the breast tumors were high and accurate.

The results of the type of imaging are different from each other. The diagnostic results which are obtained through T1-weighted imaging are more accurate than the T2-weight imaging.

KI67 AS A PROGNOSTIC FACTOR:

Ki67 is an important prognostic marker of prognoses, especially in breast cancer patients. The factor is not only used to diagnose the tumors related to cancer, but also assess the therapeutic response. Basically, high and low ki67 lesions are classified through three machine learning methodologies or schemes. Those tumors which had a low rate of proliferation were found with a low level of Ki67, and conversely those with a high level of Ki67 have a greater proliferation rate of the tumor. The Expression of the Ki67 is linked with structural features including; entropy, contrast, and line likeness.

DISCUSSION

MAGNETIC REASONING IMAGING:

The technique of magnetic reasoning imaging is widely used in high-risk women for screening purposes. Moreover, the technology is used for many other purposes including; monitoring recurrence, evaluation of the curative effect, the provision of complementary information for ultrasonography, and monography. To make the precise diagnoses and to make the accurate differentiation between lesions of the tumor for various types of cancers, newly developed dynamic contrast-enhanced and diffusion-weight imaging are used for analyzing the breast lesions to make the diagnoses of breast cancer more accurately⁵.

Diffusivity of the membrane is reflected through the integrity of the membrane and tissue of the microenvironment. The apparent diffusion coefficient is an important factor that is associated with the pathological process of tumor development. In studies, it has been proved that DWI is the most important tool to characterize and detect breast cancer⁵.

MRI TECHNIQUE IN THE RADIOMIC TO DIFFERENTIATE BENIGN AND MALIGNANT LESIONS

To evaluate and visualize the radiological images, radiomics feature maps were generated and a correlation between breast tissues and Radiomics features was deduced from the findings. In this way, different breast tissues were compared with the Radiomics parameters. The entropy for malignant lesions was higher than RFM entropy. Accurate differentiation between benign and malignant lesions is the paramount factor for an accurate treatment plan. Studies have confirmed that the Radiomics technologies are the best analytical tools to provide the best approach towards breast cancer diagnoses and differentiation of such tumors. The discrimination abilities are clearer and more authentic than the conventional invasive methods of diagnoses. In terms of modalities, DWI and DCE are the first line modalities for the Radiomics analyses⁶.

THE RELATION BETWEEN THE TUMOR AND HORMONE PRODUCTION

There are many hallmarks of breast cancer, but intra- and inter-tumoral heterogeneity are of the most important hallmark of breast cancer. The diagnoses are divided into three sub-categories; molecular classification, subtype, and

pathological driven classification. Each type is specified with a certain risk factor and radiologists propose the treatment according to the type and form of a breast tumor. Studies have demonstrated that there is a strong link between the type of tumor and hormone production⁷. For instance, Progesterone and estrogen receptors give a positive response to luminal tumors. These tumors provide a positive response through hormonal intervention. The use of anti-HER2 to suppress the ERBB2 has been proved effective. The result based on T-weight imaging suggest that the imaging process based on T1 extracts more and accurate information than T2. The reason behind the process is not simple, but there are molecular and genetic factors that influence the T-based imaging process⁷.

THE PREDICTION OF TUMOR RESPONSE

Non-adjuvant chemotherapy is carried out to treat patients with advanced stages of breast cancer. The response of tumors towards chemotherapeutic treatment is different. Some tumors show a remarkable positive response while some show the negligible response towards the treatment. Evaluation of the response is necessary to make the cost-effective and strategical treatment. Pathological assessment and solid-based evaluation of tumors were the gold standard to evaluate the action of chemotherapy in the past, but these methods couldn't make the exceptional results. MRI techniques now are able to make an accurate evaluation of the tissue response to the specific chemotherapeutic drugs⁸.

ANALYSES OF THE LYMPH NODES METASTASIS

Axillary lymph node status is correlated with breast cancer tumors. Lymph node metastasis obtained from the DWI sequences is more closely related to the metastasis of the tumor than the ADC sequence. Some scientists use mammography MRI tomography to predict axillary metastasis. They proved that MRI is a great diagnostic tool in this regard.

CONCLUSION

Radiomics is a new and potential technology with boundless applications. Its applications in the diagnostic field are recent with high accuracy. As early diagnoses are the key to effective treatment, so the role of radiomics in breast cancer treatment is remarkable.

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