Article

The Use of Artificial Intelligence in the Diagnosis of Breast Cancer

Polina Zakharova [1], Tamara Tkebuchava [1], Parvana Ibrokhimova [1], Nuray Ibragimova [2,*]

[1] Patrice Lumumba Peoples' Friendship University of Russia, 117198, Moscow, Russia
[2] First Moscow State Medical University I.M. Sechenov, 119991, Moscow, Russia
* Correspondence: nur_ibragimova@mail.ru;
zakharovapolina17@gmail.com, https://orcid.org/0000-0001-8630-175X (Z.P.);
tomka_05@mail.com, https://orcid.org/0000-0002-3995-3103 (T.T.);
1032164453@pfur.ru, https://orcid.org/0009-0001-0110-9476 (I.P.);
nur_ibragimova@mail.ru, https://orcid.org/0000-0001-9260-8169 (I.N.).

Abstract: The paper presents a brief overview of the tasks and methods of artificial intelligence, as well as a review of works devoted to its use in the field of diagnostics of oncological diseases, in particular, breast cancer. To reduce mortality and complications, it is necessary to conduct timely screening and improve methods of diagnosing the disease. It is especially important to diagnose and start treatment in the early stages. The goal is to study and summarize data on the use of various methods of artificial intelligence in the timely diagnosis of breast cancer. The analysis of scientific publications on this topic was carried out. The methods of Watson supercomputer, Microsoft Healthcare NExT, radiomics processes, automatic detection systems, Smart Detect for Breast are considered. The prospect of using artificial intelligence, as a screening method, it can allow for better detection of formations at an early stage, as well as lead to automation of this process, which entails a decrease in mortality from breast cancer. Comparing the performance of the artificial intelligence system in breast cancer screening with that of 101 individual radiologists, the researchers found that the former performed better than 61% of the radiologists. Currently, variations of artificial intelligence are presented. It is necessary to specify the methods and create a single program for use in the practice of a doctor.

Keywords: artificial intelligence, breast, screening, cancer, mammography, radiomics, diagnostics, automatic detection system, ultrasound, stages.

Citation: Zakharova P., Tkebuchava T., Ibrokhimova P., Ibragimova N. The Use of Artificial Intelligence in the Diagnosis of Breast Cancer. Journal of Clinical Physiology and Pathology (JISCPP) 2023; 2(2): 8-11.

https://doi.org/10.59315/JISCPP.2023-2-2.8-11

Academic Editor: Igor Kastyro

Received: 25.04.2023
Revised: 10.05.2023
Accepted: 16.05.2023
Published: 30.06.2023

Publisher's Note: International Society for Clinical Physiology and Pathology (ISCPP) stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

Currently, breast cancer occupies a leading position in statistics according to the World Health Organization. In 2020, over 2.2 million cases of this disease were registered. It is also noted that approximately every twelfth woman will suffer from breast cancer during her life. Breast cancer is the leading cause of cancer death in women. In 2020, approximately 685,000 women died from this disease.

To reduce mortality and complications, it is necessary to conduct timely screening and improve methods of diagnosing the disease. It is especially important to diagnose and start treatment in the early stages. According to the data for 2021 in Russia, breast cancer is diagnosed at the in-situ stage in only 0.2% of cases [1].

The need for early diagnosis also lies in the prevention and minimization of surgical intervention, which improves the quality of life of patients with breast cancer. Currently, for screening, the method of digital mammography is being widely introduced, which is performed for women aged 35 to 49 once every 1-2 years, for women over 50 every year. However, it should be noted that the mammography method has a variable sensitivity from 67.3% to 93.3% [2,3].

Also, in the diagnosis, additional methods are used, such as ultrasound and MRI of the breast. The combined approach makes it possible to more accurately determine the nature and prevalence of education [4-6].

Today, thanks to the development of computer technology and the digitization of mammography images, it has become possible to use artificial intelligence in breast cancer screening. Thanks to artificial intelligence, the detection of formations in the early stages is increased. In developed countries, it is becoming increasingly important to study this area for diagnosis, including cancer [7-9].

The aim of the work is to study the possibilities of timely diagnosis in the case of breast cancer using artificial intelligence methods.

2. Patients and Methods

The analysis of scientific literature on the topic of the possibilities and advantages of artificial intelligence in the diagnosis of formations was carried out. A variation of methods has been studied. The methods of Watson supercomputer, Microsoft Healthcare NExT, radiomics processes, automatic detection systems, Smart Detect for Breast are considered.

3. Results

AI data was first published in the 1950s, and application spread in the 1990s. Currently, global companies are developing their projects.

IBM has developed research projects using the Watson supercomputer to diagnose and improve treatment regimens for various diseases, including cancer. Also, Microsoft announced the launch of the Microsoft Healthcare NExT project, aimed at combating cancer. Google is implementing a number of diagnostic projects: "smart lenses", which will include a chip that analyzes the state of the environment and the wearer's body and provides information about health threats.

In 2017, British scientists published a report entitled "Artificial Intelligence in the UK National Health System", in the United States in December 2017, a group of leading American technology scientists JASON published a report "Artificial Intelligence for Health and Healthcare". These papers discuss the use of AI to provide highly qualified medical care to the population [10, 11].

Artificial intelligence includes machine learning and deep learning. The data obtained by the neural network is based on the processes of radiomics. Radiomics is the extraction of quantitative properties, named features from an image. Stages of radiomics: acquisition and reconstruction of images, selection of a zone and determination of its features, creation of a database [12].

This feature extraction operation is usually implemented using object recognition algorithms and results in a set of numbers, each of which represents a quantitative description of a particular geometric or physical property of the part of the image in question.

For oncological formations, the signs are size, shape, intensity and texture, which together provide a complex characteristic of the pathology, called the radiomic signature of the tumor. There is also a hypothesis that the selected features reflect the mechanisms that occur at the genetic and molecular levels [13, 14].

The first step involves image acquisition and reconstruction with loading of radiological images. After image adjustment, the second stage includes segmentation and feature extraction. The data is then sorted and collected in a database before analysis. After the segmentation is completed, the selected areas are converted to three dimensions to obtain volumetric images.

Special software then extracts the quantitative characteristics from the received data to create a report that is synchronized with a database based on various sample values.

The second stage in the implementation of artificial intelligence is machine learning, which includes a deep learning method. Deep learning allows you to train a model to predict an outcome given a set of input data.

Various deep irradiation architectures have been published in the literature, but most of these networks are based on some basic and similar neural network building blocks called "layers". The neural network consists of successive layers including an input layer (raw mammogram pixels), a hidden layer, and an output layer (prediction: benign/malignant) [15].

The earlier layers of deep irradiation act in a similar way to simple human brain cells that study low-level objects. Higher levels of abstraction are the result of layering multiple times. The information is propagated through the deep irradiation architecture and more complex features are extracted. These functions are then passed through the last layer of the network architecture for prediction and classification [16].

Automated detection systems can be used to provide second and follow-up opinions to radiologists for more accurate staging of breast cancer [17]. Ding et al proposed a new deep learning method for differentiating tumors into benign and malignant. The results of the experiment showed that the proposed method has an accuracy of 91%, high performance, and it can be useful for automatic irradiation systems in ultrasound examination of the mammary glands [18, 19].

Han et al used GoogLeNet to classify the breast image, with an accuracy of 90%. To train the deep neural network, the authors analyzed 4254 samples of benign tumors and 3154 samples of malignant tumors. The data obtained was sufficient to achieve acceptable performance.

Ultrasound manufacturers are introducing automated detection systems to assist clinicians. S-Detect Breast (Smart Detect for Breast) - a program for the automatic detection and analysis of breast formations in women, measurement and classification according to the BIRADS (Breast Imaging Reporting and Data System) system. The S-Detect™ technology showed agreement (91.2%) with the assessment of the breast radiologist in interpreting the nature of the formations in the mammary glands [20].

4. Discussion

Comparing the performance of the artificial intelligence system in breast cancer screening with that of 101 individual radiologists, the researchers found that the former performed better than 61% of the radiologists [21].

Kim et al used a dataset of over 4,000 cancer cases and nearly 25,000 normal cases, all without pixel-level annotations, to train, validate, and test deep learning of an ultra-precise neural network that could classify images as malignant or not, and generate heat maps highlighting the area that contributed the most to the final classification (Fig. 1) [22].

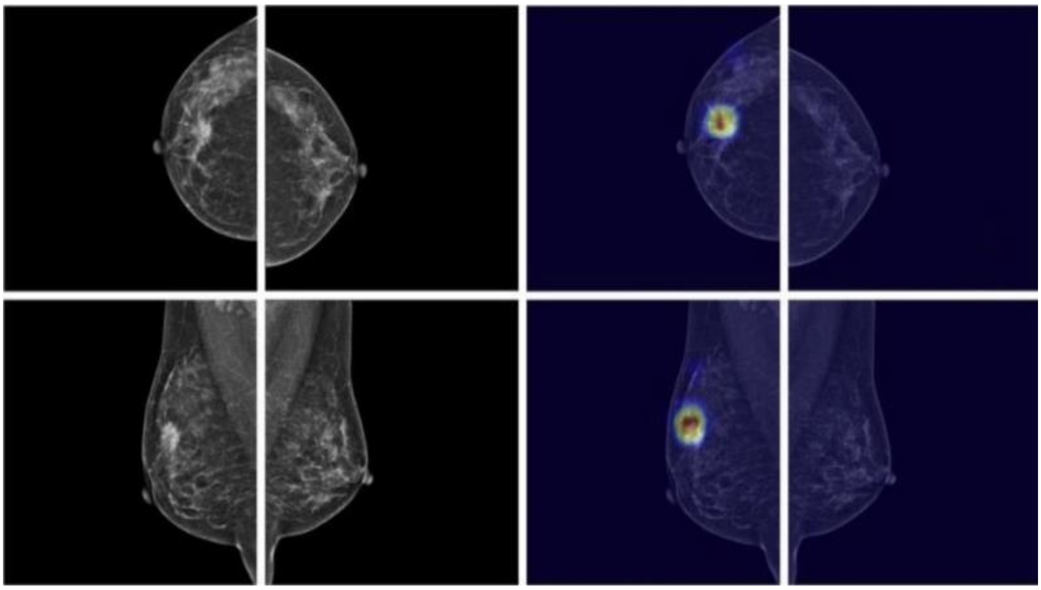

Figure 1. Digital mammography of a 44-year-old woman with invasive ductal carcinoma in the right breast (left), with a heat map overlay highlighting the area that most influenced the final classification decision (right). Application of data-driven imaging biomarker in mammography for breast cancer screening: a pilot study.

Published in the journal Nature, the results of an international study led by a research team led by McKinney in the US and UK demonstrate the advantages of an artificial intelligence model over a radiologist in both productivity and overall accuracy of screening mammography cases [23-26].

5. Conclusions

The prospect of using artificial intelligence as a screening method can make it possible to better detect formations at an early stage, as well as lead to automation of this process, which entails a decrease in mortality from breast cancer. Scientific literature data show that when comparing the work of diagnosticians and the capabilities of artificial intelligence, the prerogative is the use of artificial intelligence. Further research is needed in this area for standardized data sets and the creation of a single method with implementation for widespread use in medical practice.

Author Contributions: Conceptualization, Zakharova P. and Ibragimova N.; methodology, Tkebuchava T.; validation, Ibrokhimova P; writing—original draft preparation, Zakharova P., Ibragimova N., Tkebuchava T., Ibrokhimova P; project administration, Zakharova P. All authors have read and agreed to the published version of the manuscript.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Samala RK, Chan HP, Hadjiiski LM. Multi- task transfer learning deep convolutional neural network: application to computer- aided diagnosis of breast cancer on mammograms, Phys. Med. Biol. 2017; 62 (23): 8894–8908.
2. Sechopoulos I, Teuwen J, Mann R. Artificial intelligence for breast cancer detection in mammography and digital breast tomosynthesis: State of the art. Semin Cancer Biol. 2021. V. 72. No.6. P.214-225.
3. Al-masni MA, Al-antari MA, Park JM, Simultaneous detection and classification of breast masses in digital mammograms via a deep learning YOLO- based CAD system, Comput. Methods Programs Biomed. 2018; 157: 85–94
4. Qiang G, Zhiwu D, Lei Zh, Chunping Ning, Ziyao L, Dongmo W, Chong L, Ming Zh, Jiawei T. Ultrasound Features of Breast Cancer for Predicting Axillary Lymph Node Metastasis. J Ultrasound Med 2018; 37(6): 1354-1353.

5. Walid Al-Dh, Mohammed G, Hussien Kh, Aly F. Dataset of breast ultrasound images. Data Brief 2019; 28: 104863.
6. Kim HE, Kim HE, Han BK, Changes in cancer detection and false- positive recall in mammography using artificial intelligence: a retrospective, multireader study, The Lancet Digital Health. 2020; 2 (3): e138–e148.
7. Sechopoulos I, Teuwen J, Mann R. Artificial intelligence for breast cancer detection in mammography and digital breast tomosynthesis: State of the art. Semin Cancer Biol. 2021; 72(6): 214-225.
8. McKinney SM, Sieniek M, Godbole V. International evaluation of an AI system for breast cancer screening Nature. 2020: 577 (7788): 89–94.
9. Conant EF, Toledano AY, Periaswamy S, Improving accuracy and efficiency with concurrent use of artificial intelligence for digital breast tomosynthesis. Radiology: Artificial Intelligence. 2019: 1 (4): e180096.
10. Gantsev ShKh, Franz MV. Artificial intelligence as a decision support tool for diagnosing oncological diseases. Medical Bulletin of Bashkortostan, 2018
11. Smistad E, Lïvstakken L. Real-time automatic ejection fraction and foreshortening detection using deep learning. IEEE Trans Ultrason Ferroelectr Freq Control 2020; 67(12):2595-2604.
12. Valdora F, Houssami N, Rossi F. Rapid review: radiomics and breast cancer. Breast Canc Res Treat. 2018; 169(2): 217-229.
13. Rodriguez-Ruiz A, Lång K, Gubern-Merida A. Stand-alone artificial intelligence for breast Cancer detection in mammography: comparison with 101 radiologists. J Natl Cancer Inst. 2019; 111 (9): 916–922.
14. Arieno A, Chan A, Destounis SV. A review of the role of augmented intelligence in breast imaging: from automated breast density assessment to risk stratification. Am J Roentgenol. 2018; 212: 259–270.
15. Kizildag YI, Koyluoglu YO, Seker ME. Diagnostic Performance of AI for Cancers Registered in A Mammography Screening Program: A Retrospective Analysis. Technol Cancer Res Treat. 2022; 21: 15330338221075172.
16. Schaffter T, Buist DSM, Lee CI. Evaluation of Combined Artificial Intelligence and Radiologist Assessment to Interpret Screening Mammograms. JAMA Netw Open. 2020; 3 (3): . 1-15.
17. Crivelli P, Ledda RE, Parascandolo N. A new challenge for radiologists: radiomics in breast cancer. BioMed Res Int. 2018: 2018.
18. Liu Z, Chan Sh-C, Zhang S, Zhang Z, Chen X. An automatic mus- cle fiber orientation tracking algorithm using Bayesian Kalman Filter for ultrasound images. IEEE Trans Image Process 2019; 28 (8): 3714-3727.
19. Lång K, Dustler M, Dahlblom V, Andersson I, Zackrisson S. Can Artificial Intelligence Identify Normal Mammograms in Screening. European Congress of Radiology, Vienna, Austria, 2019
20. Lebedev GV. Deep Machine Learning (Artificial Intelligence) in ultrasonic diagnosis. Journal of Telemedicine and eHealth. 2020
21. Aboutalib SS, Mohamed AA, Berg WA, Zuley ML, Sumkin JH, Wu S. Deep learning to distinguish recalled but benign mammography images in breast Cancer screening. Clin. Cancer Res. 2018; 24 (23): 5902–5909.
22. Kim E-K, Kim H-E, Han K. Applying data-driven imaging biomarker in mammography for breast cancer screening: preliminary study. Sci Rep. 2018; 8: 2762
23. Solodkiy VA, Kaprin AD. Artificial intelligence in breast cancer screening (literature review). Journal Bulletin of the Russian Scientific Center for Roentgen Radiology. 2022
24. Cleland T, Mainprize JG, Alonzo-Proulx O. Use of convolutional neural networks to predict risk of masking by mammographic density. Proceedings of SPIE 2019; 10950: 109501X.
25. Mann RM, Hooley R, Richard GB. Novel Approaches to Screening for Breast Cancer. Radiology. 2020; 297(2): 266-285.