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Role of AI in Cancer Detection with reference to Breast and Oral Cancer

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Abstract
Artificial Intelligence (AI) is a new system in cancer diagnosis with unexplored opportunities in diagnosing the disease at an early stage, determining the risk, and designing a treatment based on the needs of the patient. Imaging, histopathology, and clinical data can be used to diagnose malignancies by training machine learning, deep learning, and neural network algorithms by AI systems to achieve maximum accuracy and efficiency. AI has enhanced mammography and digital breast tomosynthesis, MRI and ultrasound interpretation of breast cancer by identifying micro-calcifications, asymmetries and masses as well as the use of predictive modeling in individualized care. When applied to the diagnosis of oral cancer, AI will facilitate non-invasive diagnostics to read digital and autofluorescence images and cytological samples that make it possible to feel precancerous lesions and oral squamous cell carcinoma at their initial stages. Despite these improvements, it is still characterized by issues of data quality, algorithm biases, interpretabilities, ethical issues and clinical integration. The emerging trends are explainable AI, multimodal data consumption, mobile/cloud based and personalized oncology. The construction of the existing applications, advantages, drawbacks, and the future of AI in breast and oral cancer screening with the help of this chapter. It can make the diagnostic process more accurate and reducing the waiting period, as well as improving patient outcomes.

Keywords: *Artificial Intelligence (AI), Explainable AI (XAI), Carcinoma, Breast Cancer, Oral Cancer, Diagnosis, Machine Learning, Deep Learning, Early Detection, Predictive Modeling.*

1. Introduction

One of the new disruptive technologies in the modern sphere of oncology is Artificial Intelligence (AI), as today, the advent of computational technologies, such as machine learning (ML), deep learning (DL), and artificial neural network (ANNs), leads to the possibility to identify the existence of a particular cancer earlier and more accurately. Iqbal et al. (2021) and Shastry and Sanjay (2022) argue that AI systems can manipulate large sets of imaging, histopathological and genomic data and identify patterns that indicate the occurrence of malignancy thereby assisting in the process of clinical decision-making. These have been particularly observed in cancer diseases where early detection is vital to survival since the AI can analyze such high-dimensional data as fast and consistently as it can be analyzed by human research. Bini (2018) and Sarker (2021) also provide that convolutional neural networks (CNNs) deep learning methods play a vital role in acquiring intricate features of medical images, which can be used to detect the existence of small lesions that would otherwise have been unnoticed.

This is especially concerning breast cancer where AI has been massively applied with respect to mammography, digital breast tomosynthesis, MRI, and ultrasound to improve early diagnosis and risk stratification. It is established that AI can be very sensitive and specific at identifying microcalcifications, asymmetries and masses and when compared to the expert radiologists its sensitivity and specificity is usually equal (Reviews by Sechopoulos, Teuwen and Mann (2021), Nassif et al. (2022) and Houssami et al. (2019)). Factors that change AI performance (including breast density and quality of the imaging) have already been examined e.g. in Yoen et al. (2024), however the complementary nature of MRI on high-risk groups has been considered by Lord et al. (2007). Tiwari, Mishra and Kuo (2025) and Goel, Goel and Kumar (2023) also mention the introduction of predictive modeling and spatial feature analysis that can enable the derivation of a personalized screening strategy and description of the location of the tumor more accurately. However, the standardization of datasets, the interpretability of the model, or the potential to integrate AI into clinical practice without any issues are the issues, to which Diaz, Rodriguez-Ruiz and Sechopoulos (2024) allude.

AI can be used not only to detect breast cancer but also used in oral cancer and its early diagnosis, which may be undermined by the insidiousness of the manifestations. The authors of this study and other researchers have observed that AI has high accuracy in identifying the signs of precancerous lesions and oral

squamous cell carcinoma using digital images, autofluorescence, and cytology samples (Al-Rawi et al., 2022; Hegde et al., 2022 and Kavyashree, Vimala and Shreyas, 2024). The timely intervention classification became important as highlighted by Sciubba (2001) when Monteiro et al. (2025), Ilhan, Guneri and Wilder-Smith (2021) emphasized that timely diagnosis can be considered helping to reduce the length of time required to arrive at a diagnosis. Explainable AI (XAI), ethical accountability and regulatory adherence are essential in any instance of cancer to introduce transparency, less bias, and provide equitable healthcare as suggested by Alshuhri et al. (2024), Corti et al. (2023), Nouis, Uren and Jariwala (2025) and Mohammed and Malhotra (2025). All these studies render AI one of the most significant instruments of modern oncology that can provide better accuracy, efficiency, and access to cancer diagnosis and responsively indicate the areas that need to be treated with care and additional research.

2. Literature Review

Table 1.1, Literature Review

Reference	Focus / Study Area	Key Findings / Contributions
Iqbal et al., 2021	AI and ML in general cancer diagnosis	Reviewed clinical applications of AI and ML in oncology; highlighted AI's potential in early detection, prognosis prediction, and treatment planning.
Shastry & Sanjay, 2022	AI in cancer diagnosis	Comprehensive review of AI techniques, including ML and DL, in detecting various cancers; emphasized performance comparable to expert clinicians.
Tiwari, Mishra & Kuo, 2025	AI technologies in cancer diagnostics	Discussed current AI models, their diagnostic accuracy, and integration with clinical workflows; highlighted predictive modeling and personalized treatment.

Sarker, 2021	Deep learning techniques in healthcare	Overview of deep learning taxonomy and applications; identified CNNs and neural networks as pivotal in medical image analysis for cancer detection.
Bini, 2018	AI, ML, DL, and cognitive computing	Clarified definitions and distinctions between AI-related techniques; discussed potential impact on diagnostic accuracy and workflow efficiency in healthcare.
Goel, Goel & Kumar, 2023	ANN and ML in spatial data	Demonstrated the utility of artificial neural networks in analyzing spatial features in medical images; relevant for tumor localization and lesion detection.
Sechopoulos, Teuwen & Mann, 2021	AI in breast cancer detection	Reviewed AI applications in mammography and digital breast tomosynthesis; highlighted sensitivity in detecting microcalcifications and masses.
Nassif et al., 2022	AI techniques for breast cancer	Systematic review of AI methods for breast cancer diagnosis; discussed automated detection, classification, and risk assessment.
Díaz, Rodríguez-Ruíz & Sechopoulos, 2024	Breast cancer AI: tech & challenges	Discussed AI technologies, implementation challenges, and prospects in breast cancer screening; emphasized need for high-quality datasets and XAI.
Houssami et al., 2019	AI in early breast cancer detection	Scoping review of AI potential in screening programs; noted improvements in diagnostic accuracy and workflow efficiency.
Yoen et al., 2024	Mammography and AI performance factors	Examined factors affecting AI detection performance in mammography,

		including breast density and lesion characteristics.
Lord et al., 2007	MRI in breast cancer screening	Systematic review of MRI as an adjunct to mammography and ultrasound; emphasized importance for high-risk populations.
Al-Rawi et al., 2022	AI in oral cancer detection	Evaluated AI systems for non-invasive oral cancer diagnosis; reported high accuracy in lesion detection using digital imaging and cytology.
Kavyashree, Vimala & Shreyas, 2024	AI techniques for oral cancer	Systematic review of AI methods for oral cancer; highlighted image analysis, deep learning, and predictive modeling for early detection.
Hegde et al., 2022	Early diagnosis of oral cancer	Discussed AI applications in screening, risk assessment, and prevention; emphasized integration with clinical data and histopathology.
Ilhan, Guneri & Wilder-Smith, 2021	Reducing diagnostic delay in oral cancer	Showed AI's role in minimizing late diagnosis through automated image analysis and decision support systems.
Sciubba, 2001	Importance of early oral cancer diagnosis	Highlighted significance of early detection and treatment; underscored need for screening and timely intervention.
Monteiro et al., 2025	Early symptoms of oral cancer	Literature review identifying clinical "red flags"; relevant for AI systems targeting early detection.
Alshuhri et al., 2024	AI in cancer diagnosis: opportunities & challenges	Discussed AI potential across cancers; highlighted limitations such as bias,

		interpretability, and clinical integration barriers.
Díaz, Rodríguez-Ruíz & Sechopoulos, 2024	Breast cancer AI: challenges & prospects	Reviewed technological and operational limitations in breast cancer AI applications; emphasized XAI and data standardization.
Katta et al., 2023	AI in pancreatic cancer	Narrative review on AI diagnosis; highlighted limitations and future prospects, providing insights transferable to other cancers.
Corti et al., 2023	AI in precision oncology	Discussed applications and limitations in precision medicine; emphasized equitable and unbiased AI implementation.
Nouis, Uren & Jariwala, 2025	Accountability & bias in AI healthcare	Qualitative study exploring transparency, accountability, and bias in AI-assisted clinical decision-making.
Kelly et al., 2019	Clinical impact challenges	Identified operational, technical, and ethical barriers to AI adoption in clinical practice.
Mohammed & Malhotra, 2025	Ethical & regulatory challenges	Reviewed implementation barriers for ML-based healthcare systems; emphasized governance, compliance, and future directions.

3. AI and its Application in Cancer Diagnosis

Artificial Intelligence (AI) has become a revolution in the field of modern medicine that allows machines to perform cognitive tasks (learning, reasoning, and decision-making) that are traditionally related to human intelligence. Bini (2018) proposes that AI has a continuum of computational methods such as machine learning, deep

learning, and cognitive computing which, among other purposes, supplement the ability of the healthcare system to read and analyze complex medical data. Technology has gained prominence in the field of cancer diagnosis in which radiological and histopathological data are often complex and voluminous enough to be beyond the ability of individuals to analyze them. In the case of diagnostic procedures AI is able to increase both efficiency and accuracy in identifying subtle abnormalities that may in turn be related to carcinoma through the process of automation.

Machine learning (ML) and deep learning (DL) models have played an essential role in improving cancer diagnostics based on the analysis of different types of data including radiographic, genomic, and pathological images. According to Sarker (2021), CNNs come in various formats, yet the latter has shown remarkable performance in image recognition and, in this instance, tumor early warnings and benign and malignant lesion classification. These computers are trained on a hierarchy basis to derive knowledge on input data and as a result they are able to identify complex features in either a breast cancer mammogram or oral cancer histopathologic slide which might otherwise go unnoticed by human eyes. According to Goel, Goel and Kumar (2023), artificial neural networks (ANNs) are the most appropriate to address spatial and morphological features, thus they are effective in tumor localization, image segmentation, and the extraction of diagnostic features that are important to reliable clinical diagnosis.

AI in oncology has clinical uses beyond image processing, which can include predictive computing and personalized medicine. Iqbal et al. (2021) emphasize the importance of AI-based systems, which can be used to predict the development of any disease, assess response to treatment, and help discover molecular biomarkers that are used in targeted therapies. Along the same lines, Shastry and Sanjay (2022) observe that AI models that are trained on large datasets of cancer can be as diagnostic as human oncologists, and in some cases, even more diagnostic. These systems have been effectively implemented to interpret mammographic images in breast cancer and cytological images in mouth cancer to give quicker and more dependable results as well as less human intervention. Tiwari, Mishra, and Kuo (2025) also mention that the use of AI in the diagnostic process allows recognizing real time and informing clinical decisions based on the data.

Although these developments have been made, the interpretability of the AI systems is an important issue to be addressed. Recently, Explainable

Artificial Intelligence (XAI) has been a solution to this weakness, as it offers transparency and explainability of model predictions. According to Shastry and Sanjay (2022), XAI instruments enable clinicians to know how AI-driven logically were reached, e.g., why a classifier considers a lesion as being malignant, and thus achieves trust and ethical responsibility in medical decision-making. Because it provides users with human control and interpretability, XAI makes AI act as a collaborator instead of as a substitute to a clinical expert. Coupled with XAI, AI makes the groundwork of precision oncology, where healthcare specialists are given intelligent, transparent, and reliable diagnostic solutions in the early detection and management of oral and breast carcinoma.

4. Artificial Intelligence in Breast Cancer Detection.

Breast cancer is one of the types of cancer that is very common among women in most part of the world and the importance of early diagnosis cannot be overemphasized before improving the survival prospects. Traditional methods of screening that have been applied in finding tumors at an early age are mammography, ultrasound and magnetic resonance imaging (MRI). However, in accordance with Lord et al., (2007), the experiment supplements the mammography process with ultrasound as the machine detects the existence of lesions, especially in young women with dense breast tissues; however, the analysis of the process is challenging, costly and time consuming. All such limitations have given rise to the Artificial Intelligence (AI) technologies to complement the accuracy of diagnosis, reduce human error, and simplify the clinical procedure during breast cancer screening.

The analysis of images in the breast has been transformed by AI in the analysis of mammographic and tomosynthesis images in the Integration of AI into breast magic. Careful emphasis by Sechopoulos, Teuwen and Mann (2021) is that AI algorithms, particularly the deep learning models were incredibly sensitive and specific to detect such indicators as microcalcification, asymmetries, and architectural distortions, the hallmarks of carcinoma. Many data are used to train these models, hence allowing them to process thousands of mammograms in a short period of time and mark the areas of suspicion to radiologists. Similarly, Yoen et al. (2024) repeat the idea that the effectiveness of AI in mammography is influenced by the density of the breast, nature of lesion, and quality of the image and in this case, AI can perform very well on the detection of innate cancers, and

the cancer can be missed by human observers. This characteristic does not only enhance the levels of early detection, but also empowers the actions of double-reading, which enhances uniformity of diagnoses in practice.

To further elaborate on the domain of AI application, Nassif et al. (2022) establish a literature review that demonstrates that AI techniques, such as machine learning, deep learning, and ensemble modeling, can be used to categorize breast lesions, define the probability of malignancy, as well as optimize the process of diagnostic decisions. These systems are multimodal information centers that include mammogram, ultrasound and histopathological information to offer comprehensive center of assessment of the tumor characteristics. Moreover, Diaz, Rodriguez-ruiz and Sechopoulos (2024) confirm that AI image analysis has evolved to assume the position of a single-use detection system in terms of diagnostic workflows that are fully automated and capable of segmentation, feature-spoiling, as well as prediction of malignancy. These advances, despite this, bring to light the current challenges of institutional algorithms, data normalization and implementation in the clinical, particularly the delivery of equitable performance with a wide variety of patient populations.

AI is also required in enhancing accuracy in biopsy analysis and digital pathology. Entire automated image sectioning enables the precise definition of the cancerous areas and the pattern recognition system to label histopathological grades, whose classification is very repeatable. Houssami et al. (2019) believe that AI can significantly improve their situation by improving the rate of false positives and false negatives with breast screening programs and that has been of concern in the broad-based screening. They can provide interpretability and transparency, i.e. the radiologists will be able to understand when a lesion was considered malign or benign and hence remain clinically accountable.

Overall, incorporating AI in detecting breast cancer is a novel undertaking that brings on board accuracy in cancer therapy. Becoming a part of the interpretive abilities of deep learning and clinical experience, AI enhances the performance of image analysis, biopsy grading, and risk prediction. These technologies as outlined by the literature by Sechopoulos et al. (2021), Nassif et al. (2022), Diaz et al. (2024), Houssami et al. (2019), Yoen et al. (2024), and Lord et al. (2007) demonstrate that they have a potential to remove diagnostic errors, enhance the efficiency of the workflow and eventually save lives because of the possibility to identify in a more effective and quicker way the presence of the breast carcinoma. The AI and XAI should

be active; otherwise, breast cancer screening will become better in terms of accuracy, transparency, and patient support.

5. AI in Oral Cancer Detection

Oral cancer, the oral squamous cell carcinoma (OSCC) is a significant health issue to the population of the world, particularly the late-onset diagnosis and high mortality rates. The author states that the improved prognosis depends on the early diagnosis, which is very hard because of ignorance or lack of knowledge of early symptoms such as the ones of leukoplakia, erythroplakia or minor changes in mucosa among others (Sciubba, 2001). According to the authors of the study Monteiro et al. (2025), all these preliminary symptoms of oral cancer are not always taken into consideration, that is why it is essential to design the tools that can enhance the accuracy and objectivity of the clinical tests. Artificial Intelligence (AI) is a potential business technological solution that can help clinicians recognize malignancy in the earliest stages and the most amenable ones.

Artificial Intelligence-based diagnostic systems have demonstrated an average performance when it comes to diagnosing oral cancer using non-invasive visualizations, as well as simple computational algorithms. Al-Rawi et al. (2022) state that AI could process photographic and autofluorescence images and automatically recognize precancerous and cancerous lesions, which is more precise in comparison with the traditional visual inspection opportunities than their use necessitates. Such systems work based on the computer vision algorithms capable of distinguishing the normal mucosa and the early stages of the carcinoma based upon the changes of light, changes of texture and morphology of mouth tissues. Along with that, AI in digital cytology can provide the assessment of exfoliated cells in an automatic manner, therefore, which will permit high-speed, reproducible, and cost-effective mass screening, and which will become a necessity in health programs at the community level.

Technologically, they are machine learning and deep learning-based AIs. Convolutional neural networks (CNNs) scrutinized by Kavyashree, Vimala, and Shreyas (2024) have become the most popular technique of analyzing oral images and histopathological tests. These models could identify the presence of aberrations in the cell nucleus such as pleomorphism, abnormality in chromatin and structural deformity that are salient characteristics of malignant alteration. Continuing this point, Hegde et al. (2022) notes that the use of AI algorithms can also pool such clinical data, patient history, and behavioral

variables (e.g., smoking or drinking) so that the diagnosis can be made more accurate and even that the patient has malignancy. These are not only useful in improving the precision of the early diagnosis but also assist in preventive oncology since it can identify persons at high risk when they are yet to show signs or symptoms of the analysis.

The ability of AI to reduce cases of diagnostic delay in oral cancer has been a marvelous move towards improved clinical outcomes. As emphasized by Ilhan, Guneri, and Wilder-Smith (2021), the phenomenon of diagnostic latency becomes especially important and contributes to reduced survival in oral cancer when specialists and the use of state-of-the-art imaging facilities are inaccessible and such an environment is characterized by a low level of resources. They are seeking a solution to it by means of AI-based mobile and cloud-based diagnostic solutions. Upon the type of such a system, primary care providers will be able to record oral pictures on their smartphones and be analyzed with the assistance of AI, thus providing an immediate referral and intervention. Also, the incorporation of the concepts of Explainable Artificial Intelligence (XAI) offers the clinical trust of the interpretability of AI decisions- the focus on the visual or morphological features that the model considered when reaching the decisions.

Each of these studies proves that AI has evolved to become a significant collaborator in cases of fighting oral carcinoma since it can offer diagnostic accuracy, scalability, and access to existing approaches, which is usually lacking. Because early lesion detection, as well as the historical pathology, classification, are not the only applications of AI in the field of healthcare, the mobile-based screening tools and screening-data-based tools will lead to a more reactive, data-driven, and equitable healthcare stake. The key to the successful treatment, which, as it has been emphasized by Sciubba (2001), is early diagnosis, is closing the gap between the initial detection and prompt intervention; the innovations described by Al-Rawi et al. (2022), Kavyashree et al. (2024), Hegde et al. (2022), Ilhan et al. (2021), and Monteiro et al. (2025) assist in decreasing this distance. This is the merger between technology and medical expertise that will result in diagnosis and improved patient prognosis at an earlier stage and reduce the rate of oral cancer reference in the world.

6. Difficulties and shortcomings of AI in Cancer Detection.

At the same time as the implementation of Artificial Intelligence (AI) as a tool to diagnose cancer can change the current situation, numerous obstacles and constraints are linked to its implementation into the clinical

environment. Diaz, Rodriguez-Ruiz, and Sechopoulos (2024) claim that the quality of AI algorithms, their diversity and representative nature of the training dataset play a crucial role in determining how effective the created algorithms are when it comes to making incorrect predictions and poor generalizability of the predictions made to a group of people. Katta et al. (2023) also emphasizes that the variety of imaging protocol, patient population, and tumor can also cause bias in the algorithm, which can result in unfair care provision or even misdiagnosis. The condition of AI deployment that makes issues more complicated and that the factors to consider cover the area of patient privacy, information security, and informed consent, which must be addressed carefully, should be mentioned by Mohammed and Malhotra (2025).

Interpretability is another significant restriction. There is an overwhelming majority of AI systems, particularly deep learning models that are black boxes and it is difficult that clinicians to understand the basis on which predictions are made. Nouis, Uren and Jariwala (2025) point to the fact that the lack of such transparency can harm the credibility between the healthcare staff, derail clinical rule making, and raise the issue of accountability in case of making an error. Corti et al. (2023) also state that explainable and unbiased AI systems are essential to offer equal healthcare services and professional confidence in the diagnosis with AI. In addition, pragmatic obstacles, including elevated expense of installation, complexity with existing hospital information systems, and capability training needs, stand in the way of large-scale clinical adoption, which Kelly et al. (2019) point out. All these issues imply that despite the immense potential truly vested in AI in cancer detection, such challenges as reliability of postponed information, ethical regulations, explainability, and feasibility should be properly addressed to ensure that technological advances can become harmless, reliable, and equitable patient care.

7. Future Directions

The present state of Artificial Intelligence (AI) in cancer detection and management is the current stage that consists of the integration of power contained by sophisticated computational models with multimodal patient data to offer precision in oncology. Trends are to prioritize inclusion of imaging, histopathology, genomic and clinical information to develop more holistic diagnostic and prognostic models capable of presenting customized treatment options. AI mobile medical and cloud-based diagnosis applications are enhancing equity within the healthcare sector in terms of early cancer

detection in low resource settings. Another area of improvement is the Explainable AI (XAI) that needs enhancement as the predictive models should be provided with interpretive enlightenment that would enable clinical confidence, responsibility, and rational decision-making.

The issue of bias minimization and testing algorithms on large populations and in line with the ethical and regulatory frameworks is emerging as a point of concern and the subject of research that is required to affect the safe and equitable implementation into the clinical context. Moreover, real-time patient management and predictive analytics provided with the help of AI will alter the character of patient management and enable timely intervention and changes to the treatment. Integration with telemedicine, wearable sensors, and automated image analysis will tend to make the procedures much easier and more accurate in the diagnosis. AI is anticipated to facilitate human expertise, and hence with the integration of artificial intelligence, it may ultimately optimize the discovery of the disease at the initial phase, which may contribute to improved treatment results and ultimately diminish the management of breast and oral cancer worldwide, the new age of evidence-based and patient-based interventions of cancer is coming.

Conclusion

AI is now a fresh disruptive technology in cancer diagnostics that improves the early diagnosis of the disease, precision, and consistency of it in both breast and oral patients, through machine learning, deep learning and neural network algorithms. The imaging, histopathological, and clinical data is also analyzed with the help of AI that can identify malignancy patterns, detect the micro calcifications, masses, and precancerous lesions and plan the evaluation of the individual risks as well as the planning of his treatment. Despite having made significant progress so far, the problem of data quality, algorithmic bias, interpretability, ethical considerations and the integration with clinical workflow are still not entirely comprehensive, and this is why Explainable AI (XAI) and regulatory control are relevant. Multimodal information, predictive models, and mobile/cloud-based diagnostic systems will all come together in the future to enhance precision of oncology and can deliver patients the right care at the right time and in an equitable and patient-centered way. By introducing human professionalism and AI computational power, clinicians will have the possibility to facilitate better outcomes of cancer management, reduce the time of diagnosis, and bring a new era of cancer

management based on the data, effective, and accurate management.

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