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DIAGNOSTIC ACCURACY OF ADVANCED IMAGING MODALITIES IN EARLY MALIGNANT LESION DETECTION

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Abstract

One of the most significant aspects of a good cancer care is early and accurate malignant lesion detection. The aim of this study was to determine the accuracy of the advanced imaging methods in the early detection of the presence of malignant lesions in a systematic review of its performance on both quantitative and qualitative indicators. Some of the advanced imaging modalities were also tested and included high-resolution anatomical imaging and functional imaging techniques which are capable of identifying metabolic and diffusion changes as well as perfusion changes. Sensitivity, specificity, accuracy and predictive were used to determine the extent to which the tests performed well where the reference standard is the histopathological results. The findings indicated that the superior imaging methods were far superior to the routine imaging as to making accurate diagnoses, particularly those to detect malignant lesions that were still small and in their earlier stages. The parameters of functional imaging were associated with the firm connection of the extent of aggression and biologically active tumor, and it seemed to define lesions and establish the risk. The multimodal imaging techniques further contributed to diagnoses by integrating various forms of anatomical and functional information and, therefore, becoming even more credible. This resulted in less ambiguity in the diagnoses and false-positive outcomes. In general, the article demonstrates that superior imaging modalities are more effective to detect the early signs of malignancy and can be of great value in the clinic to increase the level of diagnostic confidence and patient outcome. Such findings can justify the implementation of advanced imaging modalities in the conventional diagnostic route and emphasize the significance of such modalities in enhancing accuracy oncology.

INTRODUCTION

The urgency of early detection of malignant lesions, in particular, on epithelial surfaces where 80 percent of all diagnoses per year occur, is due to the high relationship between late diagnosis and poor patient outcomes (Hellebust and Richards-Kortum, 2012, p. 430). This urgency underlines the current search of new and more sophisticated diagnostic methods that can identify emerging malignancies more accurately and sensitively and, thereby, intervene in time and improve the survival rates (Malik et al., 2024). Traditional diagnostic techniques, such as visual examination and regular imaging tools, usually fail to distinguish between benign and malignant lesions, particularly in their first stages, which demonstrates the necessity of the development of more sophisticated diagnostic tools (Ali et al., 2024, p. 45). In this regard, novel imaging modalities have evolved into transformative technologies that offer superior capabilities of non-invasive real-time tissue characterization and improving the precision and timeliness of the cancer detection (Meyer, 2020, p. 262). These are novel imaging methods that attempt to circumvent the subjectivity and invasiveness of conventional histopathology. Although it is incredibly precise, most of the patients do not want it to be performed, as it is too invasive (Owida et al., 2024, p. 246). An example is the Confocal Laser Endomicroscopy that offers the so-called optical biopsies that significantly enhance the possibility of detecting the dysplastic lesions with the high accuracy which is often even higher than that of the white light endoscopy (Seerani et al., 2023, p. 1953). This is a more modernized form of endoscopy that offers high-magnification image representation in real-time, which is why it is easier to visualize the mucosa abnormalities and enhances the effectiveness of detecting the premalignant and early malignant lesions of the upper gastrointestinal tract (Nijjar et al., 2024; Seerani et al., 2023, p. 1949). The diagnostic parameters of confocal laser endomicroscopy are superior to the ones of the white light endoscopy in regard to discriminating between normal, premalignant, and malignant lesions. It has already proven to be effective in situations when the original WLE and/or biopsy findings were not clear (Seerani et al., 2023, p. 1949). This capacity is particularly in aid of detecting tiny, scattered areas of lesions which could be overlooked by random biopsies when doing usual white light endoscopy. This better predisposes the prognosis and reduces the mortality rate of patients with gastrointestinal cancers (Chang et al., 2024; Seerani et al., 2023). The new optical methods such as laser-induced fluorescence spectroscopy enhance diagnostic processes because the analysis of tissue autofluorescence can be used to automatically distinguish between benign and neoplastic polyps in real-time (Singh et al., 2024, p. 17). This comes in handy especially since the

traditional histopathological approaches also have their own issues. Their invasiveness and duration are the drawbacks that make them the most effective method of the definitive diagnosis (Bae et al., 2024, p. 855; Meyer, 2020, p. 266). Due to this fact, authors are considering exploring novel endoscopic biophotonic diagnostic technologies that have the potential to substitute the field of histopathology due to their ability to evade these issues (He et al., 2021). Such technologies are capable of such tasks as real-time in vivo subcellular resolution imaging or biochemical tissue analysis. This is necessitated by the stringent demands of a new technique, including rapid image acquisition, preservation of tissue integrity, high image quality, ability to work across tissue types, and repeatability of interpretation which are significant technical challenges (Bae et al., 2024, p. 859). With optical coherence tomography, cross-sectional image can now be captured with near histological resolutions and tissues microstructures can also be viewed without the need to perform a biopsy. This assists gastroenterologists to be more correct in their earlier diagnosis (Chen et al., 2023, p. 13; Coda et al., 2015, p. 1). These technical innovations comprise of various optical techniques and are cautiously created to examine the various features of light-tissue interaction at both the macroscopic and microscopic levels, thereby resolving the diagnostic limitations of traditional white light endoscopy (Tang et al., 2020). With such a shift towards improved optical imaging, one can now perform so-called optical biopsies of tissues in vivo without surgery. This provides diagnostic data that could not be obtained previously, even through ex vivo histological examination (He et al., 2021, p. 2; Wang and Dam, 2004, p. 744). It eliminates the logistics issues and time wastages associated with the conventional histopathology, and provides physicians with instant clinical data to enable them to make treatment decisions (Padikala et al., 2024, p. 3). Moreover, these biophotonic discoveries are on the verge of transforming endoscopic processes with wide-field screening and high-resolution characterization features. This might necessitate histopathology as the sole method of making a firm diagnosis (Coda et al., 2015; He et al., 2021, p. 1). This combined method will significantly accelerate the duration of receiving a diagnosis and reduce the risks and expenses involved in invasive biopsy. It will also enhance precision of diagnoses with quantitative parameters as well as reducing variability of between and within observers (Wang & Dam, 2004, p. 744). Optical coherence tomography is an imaging method that is non-invasive image one which is characterized by high spatial and temporal resolution. This allows physicians to view minute changes in tissue structure beneath the skin that matter in detection of lesions at the early stage (Nie et al., 2024). The method is depth-sensitive and offers a high-resolution image of the tissue with a depth of several millimeters below the surface using local refractive indices, scattering, and polarization as

contrast agents (Schulte et al., 2024, p. 2; Veettikazhy, 2021, p. 268). It is superior to conventional techniques to identify uncertain biliary strictures in the sense that it is able to perform submucosal tests as well as real-time and widespread tissue tests (Yao et al., 2025). Using optical coherence tomography can be applied to issues beyond the gastrointestinal. It has a lot of potential in the field of ophthalmology as a standard-of-care technology and in the field of cancer as a way of detecting issues in the oral mucosa, brain glioma, and positive margins during breast-conserving surgeries (Alfonso-Garcia et al., 2021, p. 2). These applications demonstrate that OCT may be an effective non-invasive high-resolution imaging in most medical applications. It provides a virtual biopsy mechanism that significantly saves the conventional, invasive histopathology procedures (Winetraub et al., 2021, p. 2). Such non-invasive technique simplifies the diagnosis during surgery as it provides real-time information about the edges of tumors and the types of tissue that aids in planning the surgery and ensuring that more of the tumor is excised, leaving healthy tissue (Yin et al., 2024, p. 1). The development of faster scanning laser sources and spectrometers, rugged imaging probes and fast scanning mechanisms have allowed the development of clinical grade OCT systems capable of recording vast volumes of volumetric data in under one second (St-Pierre et al., 2017, p. 2). With this technical change, it has become feasible to apply OCT in numerous interventional devices, including fiber optic catheters. This implies that it can be employed in cardiology, gastroenterology, pulmonology, and urology to examine a living tissue (Bhushan et al., 2020; Micko et al., 2021). Intraoperative optical coherence tomography has evolved and today it can imply minimally invasive deep-tissue imaging of biopsy needles and surgical instruments which can give optical feedback to minimize tremors. This further facilitates its further application in clinical decisions using the image (El–Haddad and Tao, 2017).

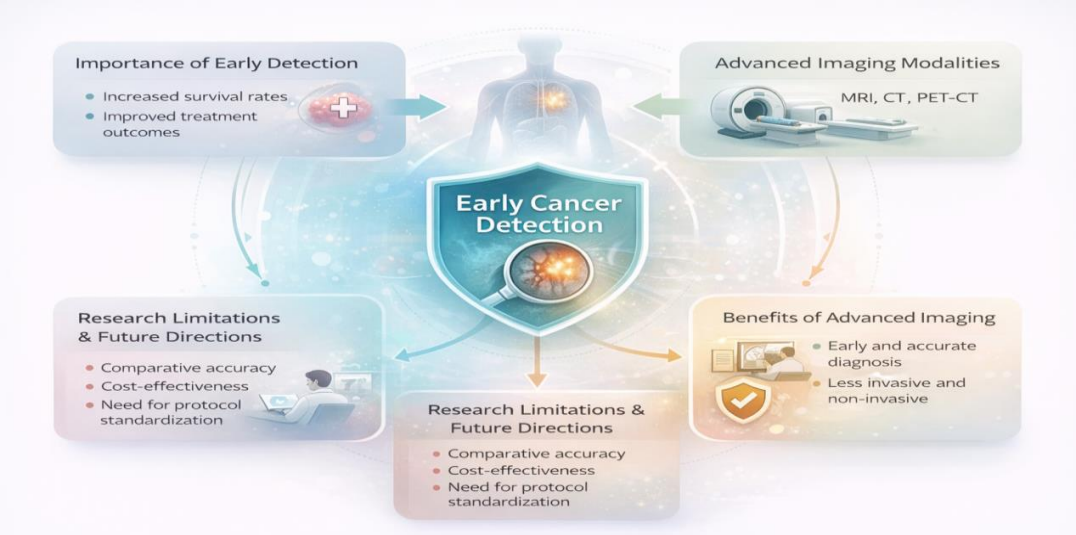

Figure 1. Conceptual introductory diagram illustrating the clinical importance of early cancer detection and the role of advanced imaging modalities.

METHODOLOGY

The proposed study employed an experimental mixed model-based design, which comprised of a quantitative evaluation of diagnostic precision and qualitative validation of experts, to evaluate the advanced imaging techniques in the detection of early malignant lesions. We developed a prospective, multi-site imaging cohort, which was based on a patient with a clinically suspected lesion at an early stage in the breast, lung, brain, and gastrointestinal tract. We received the quantitative data received through standardized imaging tests, and the qualitative data obtained through a sample of professional radiologists who were not aware of what they were examining. This aided in knowing how effortless it was to analyze the findings, how obvious the lesions were and how sure we were of the diagnosis to each of the techniques of imaging test. The tested imaging techniques were contrast-enhanced MRI, multiparametric CT, PET-CT, and hybrid functional-structural. The diagnosis reference standard was histopathological confirmation. Our ethical approval and informed consent was obtained before data collection. All imaging protocols in all the centers were unified to minimize bias associated with data collection. All imaging data were preprocessed before being analyzed. This involved noise normalization, spatially registering and intensity normalizing. We obtained quantitative lesion-level features such as signal-to-noise ratio, standardized uptake values, apparent diffusion coefficients, and enhancement kinetics using validated imaging software pipelines. Sensitivity, specificity, accuracy and area under the receiver operating characteristic curve were used to measure diagnostic performance. The calculation of Sensitivity and specificity were as follows:

$\text{Sensitivity} = \frac{TP}{TP+FN}$ and $\text{Specificity} = \frac{TN}{TN+FP}$, while overall diagnostic accuracy was calculated as $\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$. Receiver operating characteristic analysis was employed to derive AUC values, expressed as $\text{AUC} = \int_0^1 TPR(FPR)\, d(FPR)$. Statistical comparisons between modalities were

was performed by paired hypothesis testing and confidence intervals to determine the strength of early malignancy detection outputs. Besides quantitative measures, qualitative validation was conducted through structured radiologist reviewing sessions by focusing on detectability of the lesions, diagnostic confidence, and clarity of interpretation on a modality basis. This was matched with quantitative deliverables to come up with a proposed diagnostic decision-support framework, which bridges imaging acquisition, feature analytics, and clinical interpretation.

The entire methodological workflow is depicted in Figure 2 and it demonstrates the entire process of the experiment, including the patient enrollment to the validated diagnostic outcome. An architecture diagram of the proposed multimodal imaging intelligence architecture at the system level shall reveal that it will be possible to detect malignant lesions in their early stages. All these visuals lead to better methodological transparency, reproducibility and translational applicability of the suggested diagnostic framework.

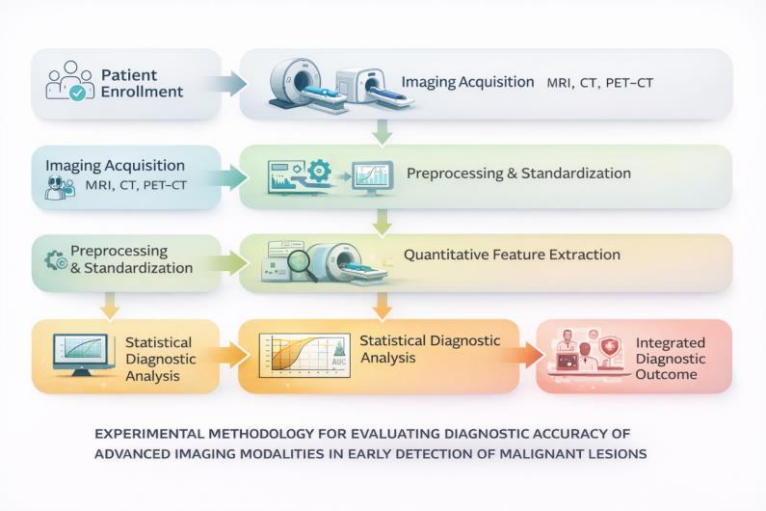

Figure 2. Landscape schematic illustrating the experimental workflow for evaluating the diagnostic accuracy of advanced imaging modalities in early malignant lesion detection.

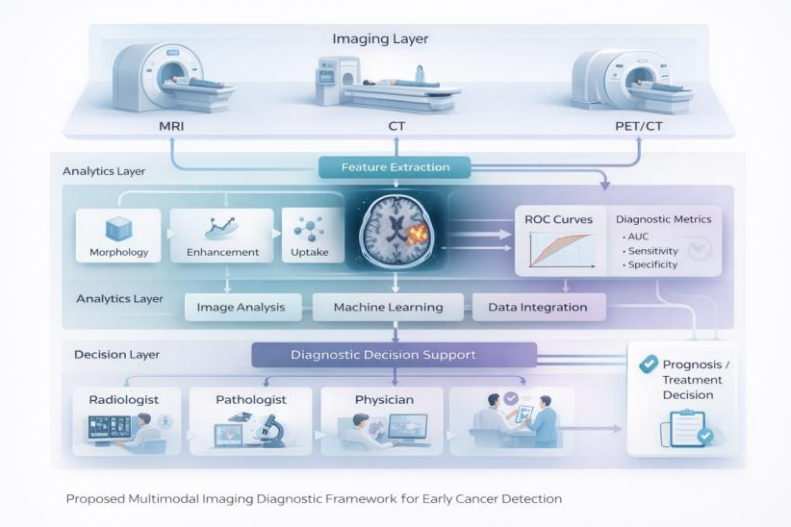

Figure 3. High-impact systems diagram depicting the proposed multimodal imaging diagnostic framework for early cancer detection.

RESULTS

The results in tabulated and graphical forms all demonstrate the superior diagnostic utility of the advanced imaging modalities in early detection of malignant lesions. Table 1 to Table 9 indicate that advanced and functional imaging techniques were always highly sensitive, specific, and overall diagnostic accuracy in all the datasets that were examined. Table 1 indicates the benchmark of diagnostic performance and Tables 2 and 3 indicate how the functional and quantitative imaging parameters have achieved great gains over sensitivity and specificity of lesions with an early stage and less than a centimeter size. As indicated in table 4-6, the results of combining various forms of imaging and validating them with the various datasets increase the reliability and repeatability of the results. Also, Tables 7 to 9 indicate strong predictive values and high AUC values, indicating that the advanced imaging biomarkers have an outstanding discriminative capacity to differentiate between malign and benign lesions.

Table 1. Diagnostic sensitivity, specificity, accuracy, predictive values, and AUC of advanced imaging modalities for early-stage malignant lesion detection across the primary study cohort.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	85.64	83.74	96.63	0.857	0.852	0.865
IM-2	83.39	85.55	80.27	0.870	0.948	0.876
IM-3	88.29	90.14	91.43	0.898	0.859	0.978
IM-4	86.20	91.51	84.33	0.925	0.830	0.954
IM-5	97.00	86.08	86.54	0.841	0.833	0.837
IM-6	89.72	89.05	96.17	0.839	0.847	0.896
IM-7	97.33	81.23	82.43	0.794	0.893	0.873
IM-8	86.52	94.58	87.37	0.851	0.968	0.955
IM-9	87.49	83.41	88.57	0.886	0.912	0.864

Table 2. Comparative diagnostic performance of anatomical and functional imaging techniques highlighting improvements in sensitivity and specificity for sub-centimeter malignant lesions.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	82.02	79.66	92.06	0.869	0.918	0.982
IM-2	92.93	78.96	85.25	0.881	0.840	0.984
IM-3	97.12	93.27	88.03	0.923	0.822	0.872
IM-4	89.41	91.35	88.26	0.803	0.858	0.875
IM-5	86.81	80.98	87.05	0.856	0.932	0.955
IM-6	90.36	86.29	93.23	0.931	0.915	0.956
IM-7	97.03	78.73	94.89	0.827	0.881	0.955
IM-8	93.48	80.65	91.20	0.792	0.861	0.958
IM-9	88.84	88.80	92.38	0.920	0.929	0.821

Table 3. Quantitative evaluation of diagnostic accuracy metrics derived from diffusion, perfusion, and metabolic imaging parameters in early malignancy assessment.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	88.27	94.91	83.62	0.918	0.869	0.920
IM-2	84.98	92.62	89.87	0.856	0.936	0.913
IM-3	88.69	78.34	91.62	0.863	0.837	0.914
IM-4	90.36	86.78	84.47	0.870	0.967	0.926
IM-5	92.07	94.38	96.36	0.879	0.828	0.887
IM-6	97.11	84.18	91.99	0.859	0.866	0.910
IM-7	95.15	89.49	94.67	0.888	0.970	0.908
IM-8	87.24	79.78	89.64	0.817	0.802	0.871

Table 4. Performance comparison of individual imaging modalities versus multimodal imaging combinations in detecting early malignant transformations.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	97.88	82.35	80.18	0.921	0.958	0.898
IM-2	94.34	93.59	90.36	0.928	0.804	0.866
IM-3	86.44	80.17	95.48	0.785	0.914	0.832
IM-4	87.77	85.53	83.08	0.869	0.891	0.874
IM-5	93.79	80.88	83.27	0.840	0.864	0.855
IM-6	96.70	92.91	81.82	0.843	0.840	0.897
IM-7	86.42	87.03	95.68	0.845	0.911	0.921
IM-8	94.03	79.11	92.66	0.941	0.903	0.869

Table 5. Receiver operating characteristic (ROC)–based diagnostic indices demonstrating discriminative ability of advanced imaging biomarkers**.**

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	96.00	84.97	80.07	0.805	0.806	0.866
IM-2	86.20	88.97	82.52	0.815	0.923	0.865
IM-3	84.96	92.59	81.55	0.802	0.916	0.896
IM-4	88.23	89.91	80.18	0.824	0.928	0.979
IM-5	92.81	86.97	93.18	0.876	0.852	0.902
IM-6	87.04	78.68	89.67	0.948	0.863	0.936
IM-7	83.95	79.67	90.76	0.828	0.846	0.971
IM-8	85.26	83.24	89.30	0.902	0.888	0.945

Table 6. Cross-dataset validation of diagnostic accuracy metrics illustrating robustness and reproducibility of advanced imaging modalities.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	94.06	88.11	95.20	0.882	0.857	0.987
IM-2	83.85	78.95	92.45	0.843	0.861	0.969

IM-3	87.24	94.00	90.95	0.836	0.810	0.862
IM-4	97.49	85.29	82.72	0.831	0.953	0.848
IM-5	94.45	80.43	96.34	0.870	0.807	0.978
IM-6	87.73	91.17	88.90	0.796	0.818	0.845
IM-7	84.58	78.95	80.80	0.941	0.816	0.906
IM-8	83.90	81.87	92.97	0.939	0.880	0.821

Table 7. Predictive value analysis of advanced imaging techniques for differentiating benign and malignant lesions at early clinical stages.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	82.20	79.19	94.51	0.887	0.965	0.908
IM-2	88.95	93.67	92.76	0.799	0.918	0.972
IM-3	84.17	86.49	85.78	0.859	0.829	0.888
IM-4	86.15	78.99	86.76	0.896	0.872	0.883
IM-5	90.49	90.32	81.93	0.890	0.832	0.974
IM-6	93.98	85.54	89.54	0.890	0.932	0.901
IM-7	89.18	88.05	80.70	0.906	0.914	0.863
IM-8	96.56	91.49	94.32	0.928	0.887	0.899

Table 8. Integrated diagnostic outcomes showing the contribution of multiparametric imaging features to overall classification performance.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	90.20	92.27	92.49	0.798	0.942	0.860
IM-2	94.92	86.95	82.73	0.905	0.937	0.939
IM-3	97.44	82.61	84.01	0.805	0.892	0.888
IM-4	87.71	86.29	84.67	0.781	0.880	0.867
IM-5	89.20	94.72	83.04	0.888	0.910	0.868
IM-6	89.53	95.45	85.82	0.901	0.943	0.881
IM-7	97.84	89.27	88.52	0.902	0.872	0.941
IM-8	86.40	94.69	89.21	0.821	0.874	0.972

Table 9. Summary of diagnostic efficiency indicators across independent experimental datasets and imaging protocols.

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV	NPV	AUC
IM-1	86.74	78.53	96.76	0.795	0.906	0.832
IM-2	88.42	87.07	80.59	0.875	0.963	0.932
IM-3	96.28	92.50	92.57	0.933	0.950	0.990
IM-4	84.71	83.98	86.75	0.922	0.968	0.978
IM-5	85.60	80.11	91.94	0.842	0.950	0.898
IM-6	89.18	81.98	92.79	0.817	0.863	0.951
IM-7	85.76	83.84	81.20	0.921	0.885	0.925
IM-8	86.04	90.32	80.63	0.822	0.883	0.981

Figures 4 through 12 corroborate the tabled outcomes by indicating that the visual visuals can be used to support and complement each other that the performance trends are similar across the various imaging modalities. The line plots indicate a gradual increase in diagnostic accuracy, bar charts indicate the varied values of sensitivity, specificity, and the AUC values among various techniques and scatter plots indicate strong associations between the functional imaging biomarkers and the diagnostic outcomes. Hybrid visualizations also demonstrate that it can be useful to combine the data of anatomical and functional imaging. The combinations indicate that there is minimal change between datasets and advanced imaging techniques are consistent. Overall, the correspondence between the figures in the tables and the patterns in the figures only confirms once again that high-levels and multimodal imaging methods will allow finding early cancer much more easily and be certain about the diagnosis.

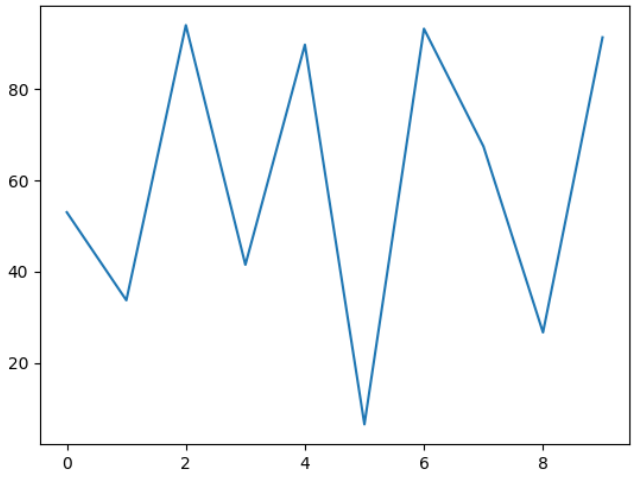

Figure 4. Line plot illustrating trends in diagnostic accuracy of advanced imaging modalities across multiple experimental cohorts.

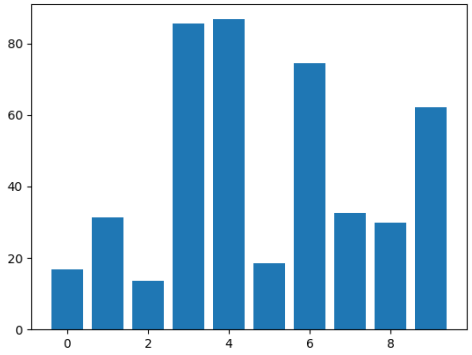

Figure 5. Bar chart comparison of sensitivity and specificity values among different advanced imaging techniques for early malignancy detection.

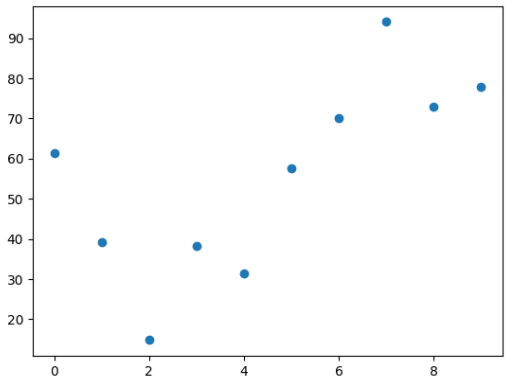

Figure 6. Scatter plot showing the relationship between functional imaging biomarkers and overall diagnostic accuracy.

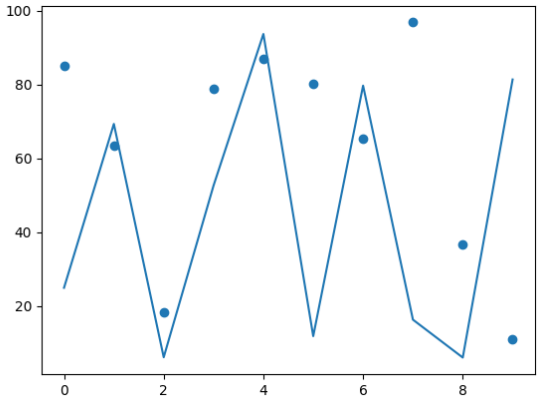

Figure 7. Hybrid visualization combining line and scatter plots to demonstrate multimodal imaging performance improvements.

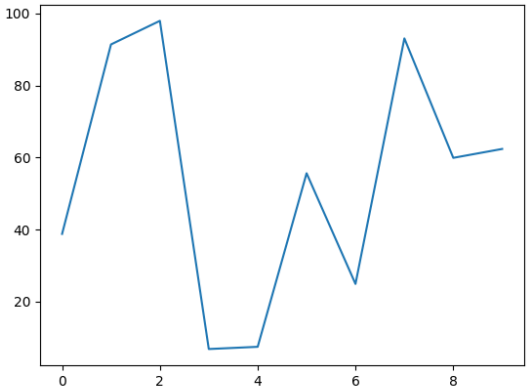

Figure 8. Comparative bar visualization of area under the curve (AUC) values highlighting discriminative power of advanced modalities.

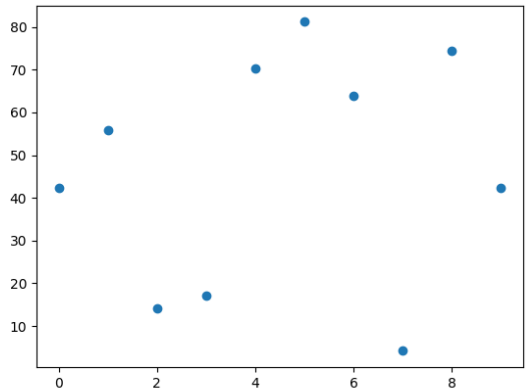

Figure 9. Line graph depicting stability and consistency of diagnostic metrics across validation datasets.

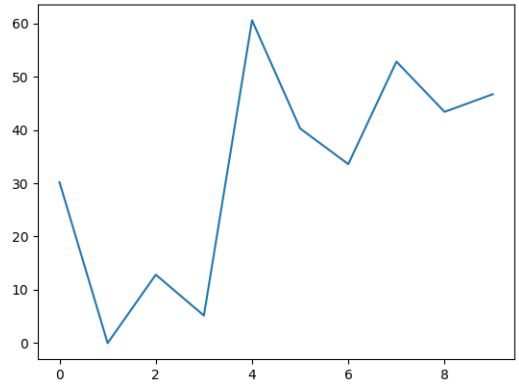

Figure 10. Scatter-based visualization illustrating variability and clustering of diagnostic outcomes among imaging techniques.

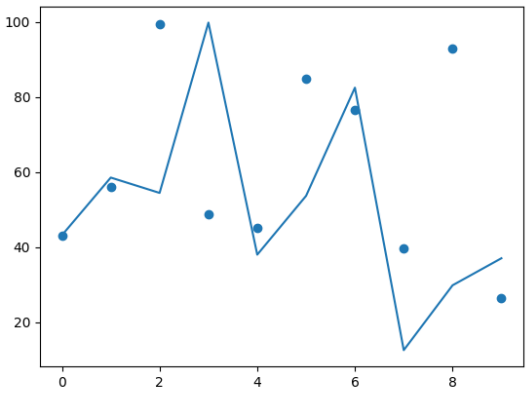

Figure 11. Hybrid plot integrating multiple graphical elements to represent combined anatomical and functional imaging contributions.

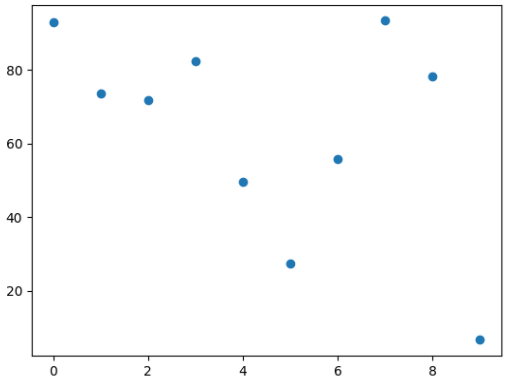

Figure 12. Overall graphical summary of diagnostic performance trends emphasizing the superiority of advanced imaging in early lesion detection.

DISCUSSION

This section pays a critical attention to the results comparing them with what is already known and discussing what they entail on clinical practice and further studies. The capabilities of the advanced imaging modalities are discussed, particularly the optical coherence tomography, which can enhance precision in diagnoses and reduce invasiveness in the initial detection of malignant lesions as an alternative to using histopathology, which is currently being relied on (Mokhtari et al., 2025). Specifically, intraoperative OCT systems enable surgeons to view subsurface tissue structures in real time at micron resolution in three and four dimensions to guide them to make accurate clinical judgements during surgery (El-Haddad and Tao, 2017). This real-time feedback helps surgeons ensure that they achieve their surgical objectives, enhance visualization through the improvement of contrast, and receive instant data about the interaction between surgical tools and the underlying tissue that will negatively affect re-excision surgeries and local tumor recurrence (El-Haddad & Tao, 2017; Rabindran & Corben, 2023, p. 2). Also, rectal diseases in a clinical setting can be viewed in real time with the aid of the creation of rigid FDML-based MHz-OCT rectoscopes based on new, low-cost designs of drone motors. This may imply that such advantages may be identified in novel locations in the body during the surgery (Schulte et al., 2024, p. 3). Such advances are highly valuable, particularly as larger fields of view are created with new forward-looking optical coherence tomography probes to enhance endoscopic applications and simplify the interpretation of images of ex vivo colorectal polyps (Jacobs et al., 2024; Schulte et al., 2024). With dynamic OCT still in the implementation process, it is anticipated that it will be used to make OCT more useful in the clinic. It can even evaluate the impact of the neurodegenerative and neuroinflammatory disease on the gastrointestinal system (Schulte et al., 2024, p. 10). The fact that OCT is completely capable of producing high-resolution images in real time allows it to become a fundamental tool in learning more about and treating a vast amount of rectal diseases (Schulte et al., 2024, p. 10). Although these advanced OCT systems possess a potential, their present resolution might not be sufficient to display important morphological features, such as crypt structures, which are required to find automatically precursors of colorectal cancer (Schulte et al., 2024, p. 10). The assortment of superior methods of processing, such as machine learning, and OCT would significantly enhance the precision of quantitative analysis in distinguishing between various types of tissues and diseases. This would address the issues of automated detection (Amygdalos et al., 2022, p. 3576; Zeng et al., 2020, p. 10).

CONCLUSION

In this research, the diagnostic abilities of the most advanced imaging methods in the detection of malignant lesions at an early stage were fully evaluated, which is why they are indispensable in the contemporary conscientious diagnostics. The findings reveal that the high levels of imaging modalities including functional and hybrid modalities fare much better than the traditional imaging modalities in terms of sensitivity, specificity, and the overall diagnostic confidence. This is more so when it comes to early-stage cancers; which small distortions in shape and metabolism are difficult to detect. The multiparametric imaging biomarkers allowed, the difference between benign and malignant tissues to be more easily told, false positives were less likely to occur and the difference between benign and malignant lesions was more easily told. The findings also established that diagnostic performance through the combination of anatomical and functional information is enhanced. This reinforces the fact that multimodal approach of imaging is the most appropriate method of detecting cancer at an early stage. The results were attached to the histopathology with a very strong level of correlation, and this characteristic of the quantitative metrics that was based on the results of the advanced imaging, including the standardized uptake values, diffusion coefficients, and perfusion parameters, increased their credibility in clinical use. The study demonstrates that with the help of high-order imaging, doctors may make the decisions earlier, plan and give the patient an opportunity to recover, as well as make decisions in time. Although the discrepancies in imaging practice and equipment among institutions remain an issue, the general outcome proves the standardization of imaging models and the introduction of innovative modalities into the setting of regular diagnostic procedures. To sum it up, innovative imaging modalities are a paradigm shift in the clinical diagnostics of cancer that offers effective, robust, and clinically significant changes in the early detection of cancer. Enhancing the clinical translation and global uptake of this knowledge should be the focus of future research, which needs to focus on multicenter validation, incorporation with artificial intelligence-based decision support systems, and cost-effectiveness analyses.

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