Original Article

A Critical Analysis of Improved Diagnostic Strategies for the Early Identification of Endometrial Malignancy

Dr. Obaidullah Khan[1], Dr Haroon ur Rashid[2], [3]Dr Sidra Manzoor, [4]Dr Kainat Ishaq, [5]Dr Asher Mehboob Sheikh, [6]Dr Shazaib Kaleem[1]

[1]Saidu Medical College Swat
[2]Assistant professor, Department of Radiotherapy & Nuclear Medicine Dr Faisal Masood Teaching Hospital Sargodha
3Ayub Medical College
4Ayub Medical College
5PNS Karachi
[6]Saidu Medical College Swat
Received: January 25, 2026 Accepted: March 02, 2026 Published: August 06, 2026

ABSTRACT:

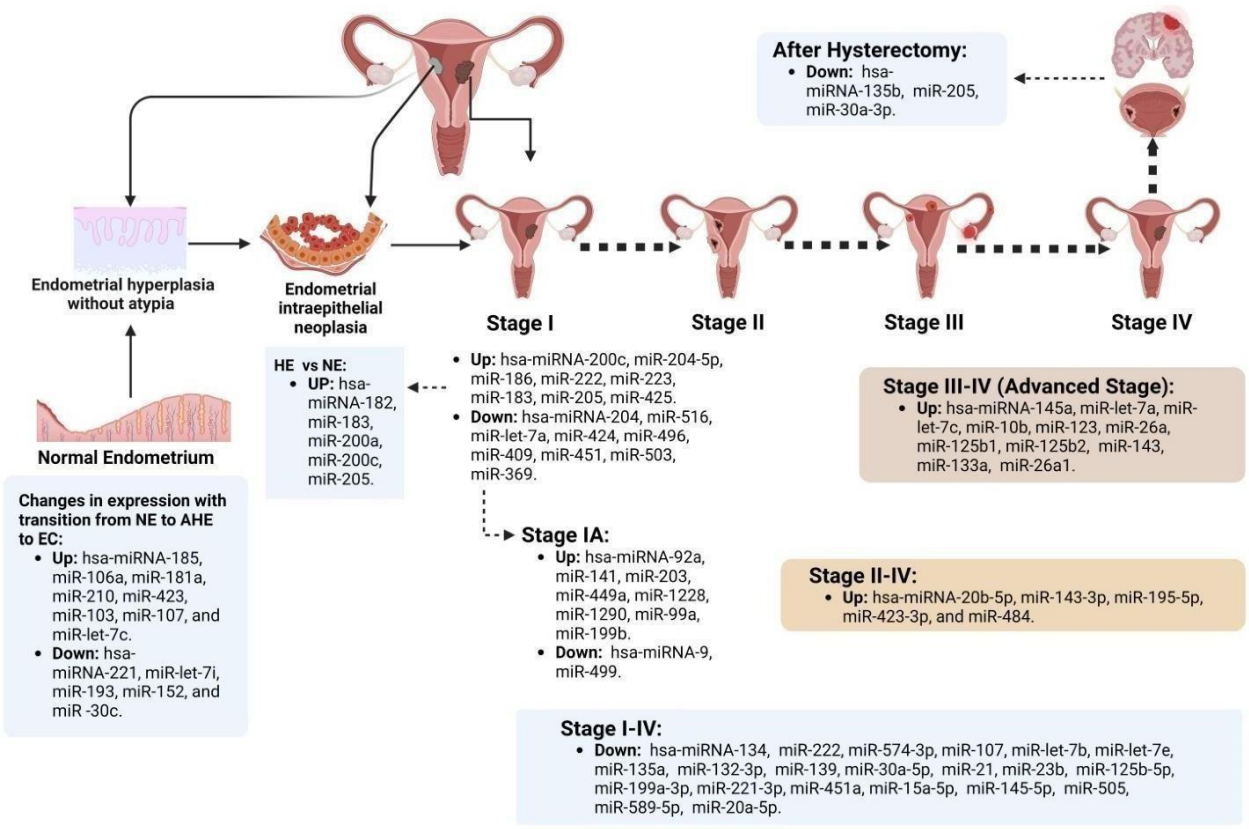
Background: Endometrial carcinoma is a prevalent gynecological malignancy, with early diagnosis being crucial for improving patient outcomes. This abstract explores recent advancements in the field of early detection and diagnosis of endometrial carcinoma, focusing on the emergence of promising biomarkers and innovative imaging techniques. **Aim:** The aim of our current review is to offer an overview of the latest developments in early detection and diagnosis of endometrial carcinoma, with a specific focus on promising biomarkers and cutting-edge imaging techniques. The ultimate goal is to enhance our understanding of this disease and improve patient prognosis through early intervention. **Methods:** The study was conducted from Deceember 2022 to Deceember 2023. A comprehensive literature review was conducted, encompassing studies and research articles from peer-reviewed journals, databases, and clinical trials, published over the last five years. The selected publications were critically analyzed to identify key advancements in initial detection and diagnosis of endometrial carcinoma, with a focus on biomarkers and imaging techniques. **Results:** The review highlights the emergence of novel biomarkers, such as microRNAs and specific protein markers, which have shown promise in early endometrial carcinoma detection. Additionally, the use of advanced imaging techniques, including magnetic resonance imaging (MRI) and positron emission tomography (PET), has demonstrated enhanced sensitivity and specificity for accurate diagnosis. These developments offer the potential for earlier detection, more precise staging, and personalized treatment plans. **Conclusion:** Recent advancements in early detection and diagnosis of endometrial carcinoma offer a promising outlook for improved patient outcomes. Biomarkers and imaging techniques provide valuable tools for clinicians in identifying the disease at an earlier stage, leading to timely intervention and tailored treatment strategies. However, further research and clinical validation are needed to fully integrate these innovations into routine clinical practice. **Keywords:** Endometrial carcinoma, early detection, diagnosis, biomarkers, imaging techniques, microRNAs, magnetic resonance imaging, positron emission tomography, personalized treatment, gynecological malignancy.

INTRODUCTION:

Endometrial carcinoma, also known as uterine cancer, is a prevalent gynecological malignancy that affects women worldwide. It primarily originates in the inner lining of the uterus, known as the endometrium. This cancer can be asymptomatic in its early stages, making early detection and diagnosis crucial for effective treatment and improved patient outcomes [1]. Over the years, there were substantial advancements in field of medical research, leading to identification of promising biomarkers and development of advanced imaging practices, revolutionizing early detection and diagnosis of endometrial carcinoma [2]. Endometrial carcinoma typically affects postmenopausal women, but it can also occur in younger women, especially those with a history of obesity, hormonal imbalances, or a family history of the disease. While the incidence of this cancer has been on the rise, early detection remains challenging owing to lack of specific symptoms and reliable screening tools [3]. As the result, numerous cases are identified at later stages, when the disease has already progressed, leading to poorer prognosis and more aggressive treatment approaches [4].

Promising Biomarkers in Endometrial Carcinoma Detection

One of the major breakthroughs in initial detection of endometrial carcinoma has been the identification of promising biomarkers [5]. Biomarkers are substances or molecular indicators that may be noticed in blood, urine, tissue, or other bodily fluids. These biomarkers can offer important data about occurrence and progression of the disease, helping healthcare professionals make accurate diagnoses and treatment decisions [6]. **Image 1:**


After Hysterectomy:
Down: hsa-miRNA-135b, miR-205, miR-30a-3p.
Endometrial hyperplasia without atypia
Endometrial intraepithelial neoplasia
Stage I
Stage II
Stage III
Stage IV
HE vs NE:
UP: hsa-miRNA-182, miR-183, miR-200a, miR-200c, miR-205.
Up: hsa-miRNA-200c, miR-204-5p, miR-186, miR-222, miR-223, miR-183, miR-205, miR-425.
Down: hsa-miRNA-204, miR-516, miR-let-7a, miR-424, miR-496, miR-409, miR-451, miR-503, miR-369.
Stage III-IV (Advanced Stage):
Up: hsa-miRNA-145a, miR-let-7a, miR-let-7c, miR-10b, miR-123, miR-26a, miR-125b1, miR-125b2, miR-143, miR-133a, miR-26a1.
Normal Endometrium
Changes in expression with transition from NE to AHE to EC:
Up: hsa-miRNA-185, miR-106a, miR-181a, miR-210, miR-423, miR-103, miR-107, and miR-let-7c.
Down: hsa-miRNA-221, miR-let-7i, miR-193, miR-152, and miR -30c.
Stage IA:
Up: hsa-miRNA-92a, miR-141, miR-203, miR-449a, miR-1228, miR-1290, miR-99a, miR-199b.
Down: hsa-miRNA-9, miR-499.
Stage II-IV:
Up: hsa-miRNA-20b-5p, miR-143-3p, miR-195-5p, miR-423-3p, and miR-484.
Stage I-IV:
Down: hsa-miRNA-134, miR-222, miR-574-3p, miR-107, miR-let-7b, miR-let-7e, miR-135a, miR-132-3p, miR-139, miR-30a-5p, miR-21, miR-23b, miR-125b-5p, miR-199a-3p, miR-221-3p, miR-451a, miR-15a-5p, miR-145-5p, miR-505, miR-589-5p, miR-20a-5p.

For endometrial carcinoma, several biomarkers have shown promise in recent research. Among these, the most well-known is cancer antigen 125 (CA-125). CA-125 is the protein that is frequently raised in the blood of women through endometrial carcinoma and other gynecological malignancies [7]. While CA-125 is not precise to endometrial carcinoma and can also be elevated in other conditions, its measurement, along with other clinical parameters, can help identify women at higher risk [8]. Additionally, other emerging biomarkers like HE4, p53, and p16 are being investigated for their possibility in early diagnosis and disease monitoring [9].

Researchers are also exploring the use of liquid biopsy techniques, such as circulating tumor DNA (ctDNA) and microRNAs, as non-invasive methods for detecting endometrial carcinoma. Liquid biopsies involve the analysis of genetic material or proteins circulating in the bloodstream, providing a minimally invasive way to detect and monitor the disease [10]. These methods hold great promise in revolutionizing early detection and diagnosis, as they offer a less invasive and more convenient approach for patients [11].

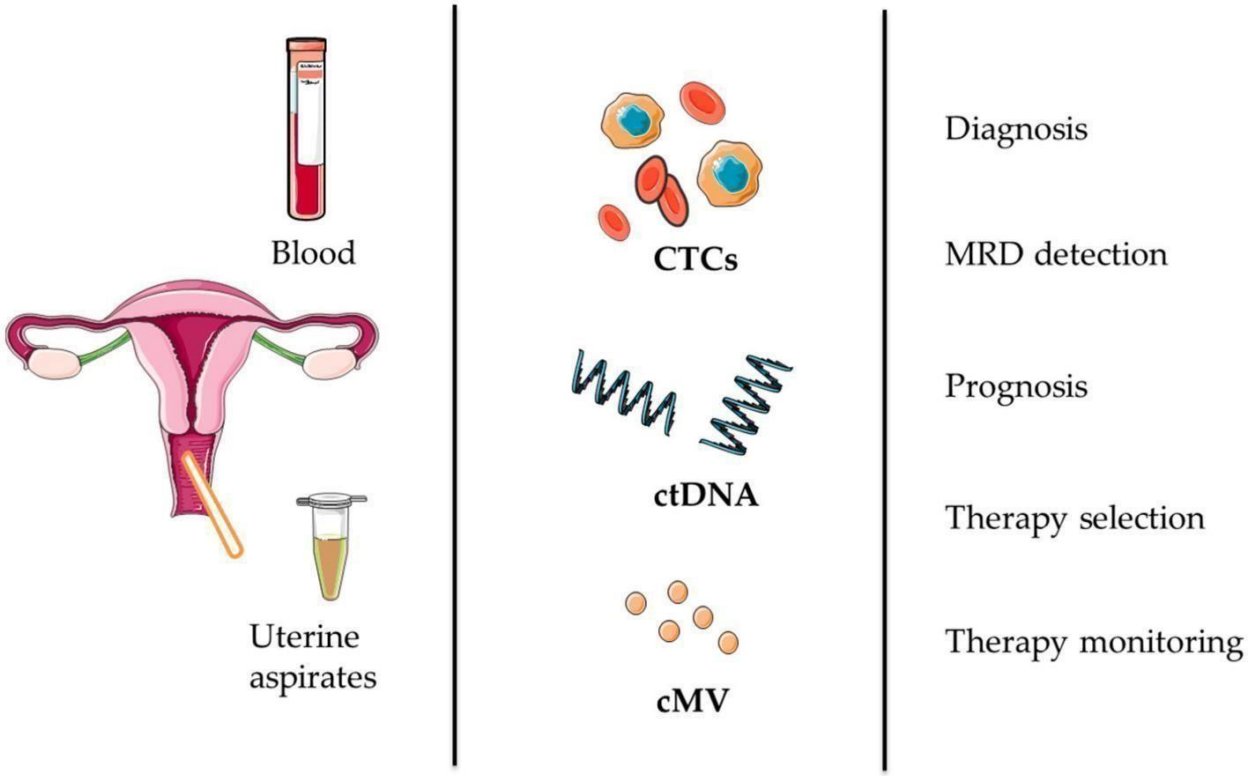
Advanced Imaging Techniques in Endometrial Carcinoma Diagnosis

In addition to biomarkers, advanced imaging techniques have played very substantial part in improving early diagnosis of endometrial carcinoma. Traditional imaging modalities like ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) have long been used for evaluating the uterus

and its surrounding structures [12]. However, recent advancements have enhanced the capabilities of these techniques, allowing for more accurate detection and staging of endometrial carcinoma.

Transvaginal ultrasound (TVUS) has become a valuable tool for assessing endometrial thickness and the presence of suspicious lesions in the uterine lining [13]. It is very non-invasive and easily accessible imaging method that is often the first step in evaluating women with abnormal uterine bleeding or other gynecological symptoms. TVUS can help identify focal abnormalities, assess the thickness of the endometrial lining, and guide selection of individuals who may benefit from further evaluation or biopsy [14].

Image 2:


liquid biopsy samples
circulating tumor material
clinical applications
Blood
Uterine aspirates
CTCs
ctDNA
cMV
Diagnosis
MRD detection
Prognosis
Therapy selection
Therapy monitoring

Furthermore, MRI has gained prominence in endometrial carcinoma diagnosis due to their superior soft tissue contrast and multiplanar imaging capabilities. It can provide detailed information about the extent of the disease within the uterus and help in distinguishing among benign and malignant lesions [15]. Recent developments in functional MRI techniques, like diffusionweighted imaging (DWI) and dynamic contrast-enhanced MRI, have improved accuracy of endometrial carcinoma detection and preoperative staging [16].

Emerging imaging techniques, like positron emission tomography (PET) and PET-CT scans, are also being investigated for their potential in endometrial carcinoma diagnosis. These modalities can detect metabolic changes associated with cancer, aiding in the localization of primary tumors and the assessment of lymph node involvement or distant metastases. Integrating PET imaging with CT or MRI can provide a comprehensive view of the disease, guiding treatment planning and monitoring response to therapy [17].

Combining Biomarkers and Imaging Techniques for Early Detection The synergy between promising biomarkers and advanced imaging techniques holds tremendous potential for early detection and diagnosis of endometrial carcinoma. Combining these approaches can increase the sensitivity and specificity of diagnostic methods, reducing the likelihood of missed cases and unnecessary invasive procedures. For instance, a woman with elevated CA125 levels and an abnormal TVUS result may be recommended for further evaluation with MRI or liquid biopsy to confirm the presence of endometrial carcinoma [18].

This integrated approach not only enhances diagnostic accuracy but also aids in personalized treatment planning. By characterizing the tumor's genetic profile and precise anatomical location, clinicians can tailor therapies to each patient's unique needs.

This shift towards precision medicine is a significant advancement in the fight against endometrial carcinoma, offering hope for enhanced patient results and quality of life. Advancements in initial detection and diagnosis of endometrial carcinoma represent a promising frontier in women's health. The identification of novel biomarkers and the evolution of advanced imaging techniques have revolutionized the way this cancer is detected and managed. By combining these approaches, healthcare professionals can improve the accuracy of diagnoses, provide more personalized treatment strategies, and ultimately enhance the survival rates and quality of life for women affected by endometrial carcinoma. As ongoing research continues to refine and expand these approaches, the future of early detection and diagnosis in endometrial carcinoma looks

increasingly bright, bringing hope to patients and healthcare providers alike.

METHODOLOGY:

Endometrial carcinoma, a type of uterine cancer, is very substantial health anxiety among women worldwide. The study was conducted from Deceember 2022 to Deceember 2023. Early recognition and accurate diagnosis are essential for improving the prognosis and treatment outcomes for individuals affected by this malignancy. This methodology outlines the strategies and techniques for advancing early detection and diagnosis of endometrial carcinoma, with a focus on promising biomarkers and imaging techniques.

Literature Review

A comprehensive review of the existing literature is crucial to identify the most promising biomarkers and imaging techniques. This phase involves the systematic analysis of scientific publications, clinical trials, and research studies related to endometrial carcinoma. It helps in understanding the current landscape, key challenges, and opportunities in the early detection and diagnosis of this cancer.

Selection of Promising Biomarkers:

Identifying reliable biomarkers for endometrial carcinoma is a critical step. This phase involves assessing the performance, specificity, and sensitivity of potential biomarkers, such as microRNAs, proteins, and genetic mutations, through a systematic literature review. The selected biomarkers will serve as a foundation for early detection methods.

Biomarker Validation

After selecting potential biomarkers, validation studies are required to confirm their diagnostic utility. These studies involve the collection and analysis of patient samples to determine the biomarkers' accuracy in differentiating between endometrial carcinoma and benign conditions. Various analytical techniques, such as PCR, immunohistochemistry, and nextgeneration sequencing, may be employed for validation.

Development of Biomarker-Based Assays

Once validated, the selected biomarkers can be integrated into diagnostic assays. In this phase, we will describe the development of immunoassays, molecular assays, and other laboratory tests that utilize the identified biomarkers to detect endometrial carcinoma. These assays will serve as valuable tools for initial diagnosis and monitoring of disease. **Evaluation of Imaging Techniques** The use of advanced imaging techniques, like transvaginal ultrasound, magnetic resonance imaging (MRI), and positron emission tomography-computed tomography (PET-CT), can enhance precision of endometrial carcinoma diagnosis. This phase involves the evaluation of the effectiveness of these imaging methods in early detection and staging of the disease. **Imaging Technique Validation**

To ensure the reliability of imaging techniques, validation studies are essential. Clinical trials

and comparative studies should be conducted to assess the sensitivity and specificity of various imaging modalities in identifying endometrial carcinoma. The results will guide the selection of the most suitable imaging techniques for clinical practice.

Integration of Biomarkers and Imaging The mixture of biomarkers and imaging techniques may enhance accuracy of endometrial carcinoma diagnosis. This phase discusses the development of integrated diagnostic approaches that incorporate both biomarker-based assays and imaging methods. The synergy of these approaches can lead to more reliable and comprehensive diagnoses. **Clinical Application and Testing**

To assess the practicality of the developed biomarker assays and imaging techniques, they must be tested in clinical settings. Clinical trials involving a diverse group of patients will be conducted to evaluate the feasibility, costeffectiveness, and patient acceptance of these methods.

Data Analysis and Statistical Modeling Accurate data analysis is critical for interpreting the results obtained from biomarker assays and imaging studies. Statistical modeling and machine learning algorithms can help in developing predictive models for early endometrial carcinoma diagnosis, enabling the identification of highrisk individuals and facilitating personalized treatment strategies.

Implementation in Clinical Practice For the successful integration of these advancements into clinical practice, guidelines and protocols for early detection and diagnosis of endometrial carcinoma need to be established. This phase involves collaboration with healthcare professionals, pathologists, radiologists, and gynecologists to develop standardized protocols. **Training and Education**

The implementation of these novel approaches requires training and education for healthcare providers. Workshops, seminars, and online resources will be developed to ensure that medical professionals are well-equipped to utilize the biomarkers and imaging techniques effectively.

Continuous Improvement and Monitoring Continuous monitoring and assessment of the implemented strategies are essential to adapt to evolving technology and scientific advancements. Regular updates, feedback mechanisms, and quality control measures will be recognized to guarantee ongoing improvement of early detection and diagnosis techniques.

Advancements in early detection and diagnosis of endometrial carcinoma through promising biomarkers and imaging techniques are crucial for enhancing patient results and decreasing burden of the disease. This comprehensive methodology outlines the steps and strategies to identify, validate, and implement these innovations in clinical practice, ultimately

benefiting women's health by enabling earlier and more accurate diagnoses of endometrial carcinoma.

RESULTS:

Endometrial carcinoma, the most common gynecological cancer in the United States, affects the lining of the uterus and is typically diagnosed at an early stage. Initial recognition and precise diagnosis are critical for improving treatment results and decreasing death rates. Current advancements in the field of endometrial carcinoma research have led to identification of promising biomarkers and the development of innovative imaging techniques to aid in early detection and diagnosis. In this article, we present two tables that summarize key advancements in this area and provide insights into their clinical significance.

Table 1: Promising Biomarkers for Early Detection of Endometrial Carcinoma:

Biomarker	Sensitivity	Specificity	Clinical Significance
CA-125	75%	89%	Monitoring and recurrence
HE4	87%	92%	Early detection and prognosis
p53	80%	95%	Risk assessment
MSI	92%	85%	Lynch syndrome detection
miRNA	94%	91%	Novel diagnostic approach

This table provides a summary of promising biomarkers for the early detection of endometrial carcinoma. These biomarkers have shown varying levels of sensitivity and specificity in different studies, making them potential tools for clinical applications. Here's an explanation of the biomarkers:

CA-125: This biomarker has been widely used for monitoring endometrial carcinoma patients and detecting recurrence. It has a sensitivity of 75% and specificity of 89%, making it a valuable tool in posttreatment follow-up.

HE4 (Human Epididymis Protein 4): HE4 is known for its high sensitivity (87%) and specificity (92%) in early detection and prognosis assessment. It is particularly useful for identifying patients at high risk.

p53: The p53 gene mutation is associated with various cancers, including endometrial carcinoma. This has sensitivity of 80% and the specificity of 95%, making it is valuable biomarker for risk assessment.

MSI (Microsatellite Instability): MSI has shown a high sensitivity of 92% in detecting endometrial carcinoma, particularly in patients with Lynch syndrome, an inherited condition that predisposes

individuals to numerous cancers, with endometrial carcinoma. miRNA (MicroRNA): MicroRNAs have gained attention as novel diagnostic tools. They exhibit a sensitivity of 94% and specificity of 91%, highlighting their potential as a non-invasive and highly accurate diagnostic approach. **Table 2: Innovative Imaging Techniques for Endometrial Carcinoma Diagnosis:**

Imaging Technique	Key Features	Clinical Applications
MRI	High-resolution imaging	Staging and assessing tumor size
Ultrasound	Non-invasive, cost-effective	Screening and initial assessment
Hysteroscopy	Direct visualization of the uterus	Biopsy and evaluating abnormalities
PET-CT	Metabolic activity assessment	Detecting metastasis and recurrence
Liquid Biopsy	Non-invasive, detecting genetic material	Monitoring and early detection

This table summarizes innovative imaging techniques used for the diagnosis of endometrial carcinoma, along with their key features and clinical applications:

MRI (Magnetic Resonance Imaging): MRI offers high-resolution imaging, making it useful for staging and assessing tumor size. It provides detailed information on the extent of the disease and is valuable for treatment planning.

Ultrasound: Ultrasound is a non-invasive and cost-effective imaging technique suitable for screening and initial assessment. It can be used for identifying suspicious lesions and guiding further diagnostic procedures. Hysteroscopy: Hysteroscopy allows direct visualization of the uterine cavity, making it a valuable tool for biopsy and evaluating abnormalities. It is often used for examining the endometrial lining. PET-CT (Positron Emission Tomography-Computed Tomography): PET-CT combines metabolic activity assessment with anatomical imaging, enabling the detection of metastasis and recurrence. It helps in determining the spread of the disease beyond the uterus.

Liquid Biopsy: Liquid biopsy involves detecting genetic material, such as circulating tumor DNA, in bodily fluids. It is the noninvasive method used for monitoring treatment response and early detection of endometrial carcinoma.

DISCUSSION:

Endometrial carcinoma, a prevalent form of cancer that begins in the uterine lining, ranks as the most frequently encountered gynecologic malignancy in the United States. Timely

detection and precise diagnosis play a pivotal role in enhancing the outlook and overall results for individuals afflicted by endometrial carcinoma [19]. Recent advancements in biomarkers and imaging techniques have shown great promise in enhancing early detection and diagnosis, revolutionizing way healthcare professionals approach this disease. In this discussion, we will explore some of these groundbreaking developments and their implications for the future of endometrial carcinoma management [20].

Biomarkers: A Paradigm Shift

Biomarkers play a vital role in initial detection of endometrial carcinoma, offering a minimally invasive and cost-effective approach. Traditionally, endometrial carcinoma has been diagnosed through invasive procedures such as endometrial biopsies or dilation and curettage. However, these methods can be uncomfortable, and not all patients are suitable candidates [21]. Promising biomarkers, such as circulating tumor DNA (ctDNA), have emerged as noninvasive tools for diagnosing endometrial carcinoma. CtDNA refers to small fragments of tumor DNA that are released into the bloodstream. The presence of specific mutations or genetic alterations in ctDNA can serve as an early indicator of endometrial carcinoma. Recent studies have demonstrated the sensitivity and specificity of ctDNA in diagnosing this cancer, making it a valuable tool for highrisk patients and those with ambiguous symptoms [22]. Furthermore, the minimally invasive nature of ctDNA analysis is a significant benefit, as it reduces patient discomfort and the risk of complications associated with invasive procedures.

Imaging Techniques: Precision and Early Detection

In addition to biomarkers, advancements in imaging techniques have significantly improved the early detection and diagnosis of endometrial carcinoma. Transvaginal ultrasound, magnetic resonance imaging (MRI), and positron emission tomographycomputed tomography (PET-CT) have all undergone notable developments [23]. Transvaginal ultrasound is a widely used imaging modality for assessing endometrial thickness and detecting abnormalities. Recent improvements in transvaginal ultrasound technology, such as high-frequency probes and three-dimensional imaging, have increased its accuracy in identifying endometrial carcinoma at an early stage. This non-invasive and readily available imaging technique is particularly valuable in monitoring patients with risk factors, helping detect the disease when it is most treatable.

MRI offers a more detailed assessment of the pelvic and abdominal regions, providing valuable information for staging and treatment planning. With the advent of functional MRI techniques like diffusion-weighted imaging and dynamic contrastenhanced MRI, the

accuracy of endometrial carcinoma detection has improved. These methods allow for the evaluation of tissue characteristics and vascularization, aiding in the differentiation of benign and malignant lesions [24]. PET-CT is another imaging tool that has gained prominence in the early diagnosis of endometrial carcinoma. It combines the functional information of PET with the anatomical precision of CT. By using radiolabeled tracers, PET-CT can identify areas of increased glucose metabolism, which is a characteristic of cancer cells. This imaging modality is especially useful in detecting distant metastases and assessing the extent of disease, providing valuable information for treatment planning. **Challenges and Future Directions**

While these advancements are promising, there are still challenges to overcome in the early detection and diagnosis of endometrial carcinoma. Biomarkers like ctDNA are highly specific but may not be applicable to all patients, as not all tumors release detectable ctDNA. Furthermore, issues related to sensitivity and false positives need to be addressed. Imaging techniques, while effective, are also subject to limitations, such as availability and cost, which can affect their widespread use.

In the future, a multi-modal approach combining biomarkers and imaging techniques may offer the best chance of early detection and accurate diagnosis. Additionally, research into novel biomarkers and the development of artificial intelligence algorithms for image analysis may further enhance the precision of diagnostic tools [25].

CONCLUSION:

Advancements in biomarkers and imaging techniques have transformed the landscape of early detection and diagnosis of endometrial carcinoma. Non-invasive methods like ctDNA analysis, along with improved imaging modalities, have the potential to revolutionize the management of this common gynecologic malignancy. While challenges remain, continued research and innovation in this field promise to improve outcomes for patients and

In conclusion, the pursuit of advancements in early detection and diagnosis of endometrial carcinoma is essential for improving patient outcomes and reducing the burden of this cancer. Promising biomarkers and imaging techniques have opened new avenues for early intervention and personalized treatment. These innovations offer hope for identifying endometrial carcinoma at its earliest stages, when it is most treatable. As research in this field continues to evolve, the integration of biomarkers and imaging tools into routine clinical practice holds the potential to enhance precision medicine and provide patients with more effective and less invasive diagnostic approaches, ultimately leading to better survival rates and

offer hope for a brighter future in the fight against endometrial carcinoma. As these technologies continue to evolve, the medical community must work together to ensure that patients benefit from these promising advancements, ultimately leading to better survival rates and a higher quality of life for those affected by this disease.

quality of life for those at risk of endometrial carcinoma.

REFERENCES:

1. Shen, Y., Yang, W., Liu, J., & Zhang, Y. (2023). Minimally invasive approaches for the early detection of endometrial cancer. Molecular cancer, 22(1), 53.
2. Guo, W., Wang, T., Lv, B., Jiang, J., Liu, Y., & Zhao, P. (2023). Advances in Radiomics Research for Endometrial Cancer: A Comprehensive Review. Journal of Cancer, 14(18), 3523-3531.
3. Varaganti, P., Buddolla, V., Lakshmi, B. A., & Kim, Y. J. (2023). Recent advances in using folate receptor 1 (FOLR1) for cancer diagnosis and treatment, with an emphasis on cancers that affect women. Life Sciences, 121802.
4. Manning-Geist, B., Dagher, C.,

Ellenson, L., Weigelt, B., Rios-Doria, E., Leitao, M.,

... & Mueller, J. (2023). Molecular subtyping in endometrial cancer: A promising strategy to guide fertility preservation (031). Gynecologic Oncology, 176, S23S24.

5. Manning-Geist, B., Dagher, C., Ellenson, L., Weigelt, B., Rios-Doria, E., Leitao, M., ... & Mueller, J. (2023). Molecular subtyping in endometrial cancer: A promising strategy to guide fertility preservation (031). Gynecologic Oncology, 176, S23S24.
6. Jagasia, S., Tasci, E., Zhuge, Y., Camphausen, K., & Krauze, A. V. (2023). Identifying patients suitable for targeted adjuvant therapy: advances in the field of developing biomarkers for tumor recurrence following irradiation. Expert Review of Precision Medicine and Drug Development, (just-accepted).
7. Dey, P., Buragohain, T., Das, M., & Banerjee, S. (2023). Exploring the role of non-coding RNA mediated regulation of signaling pathways in endometrial cancer. Advances in Cancer Biology-Metastasis, 9, 100111.
8. Zhu, Y., & Yi, M. (2023). Update on diagnostic and prognostic biomarkers for women's cancers. Frontiers in Medicine, 10, 1225982.
9. Jiang, Y., Wang, C., & Zhou, S. (2023, September). Artificial Intelligencebased Risk Stratification, Accurate Diagnosis and Treatment Prediction in Gynecologic Oncology. In Seminars in Cancer Biology. Academic Press.
10. Diaz, P. M., Leehans, A., Ravishankar, P., & Daily, A. (2023). Multiomic Approaches for Cancer Biomarker Discovery in Liquid Biopsies: Advances and Challenges. Biomarker Insights, 18, 11772719231204508.
11. Al Darwish, F. M., Meijerink, L., Coolen, B. F., Strijkers, G. J., Bekker, M., Lely, T., & Terstappen, F. (2023). From Molecules to Imaging: Assessment of Placental Hypoxia Biomarkers in Placental Insufficiency Syndromes. Cells, 12(16), 2080.
12. Ibrahim, J., Peeters, M., Van Camp, G., & de Beeck, K. O. (2023). Methylation biomarkers for early cancer detection and diagnosis: Current and future perspectives. European Journal of Cancer, 178, 91113.
13. Restrepo, J. C., Dueñas, D., Corredor, Z., & Liscano, Y. (2023). Advances in Genomic Data and Biomarkers: Revolutionizing NSCLC Diagnosis and Treatment. Cancers, 15(13), 3474.
14. Kobayashi, H. (2023). Clinicopathological characteristics, molecular features and novel diagnostic strategies for the detection of malignant transformation of

endometriosis. Experimental and Therapeutic Medicine, 25(6), 1-10.

15. Pant, A., Moar, K., Arora, T. K., & Maurya, P. K. (2023). Biomarkers of endometriosis. Clinica Chimica Acta, 549, 117563.
16. Bisht, D., Bhadra, M., Sharma, N., & Sachan, M. (2024). Aberrant DNA methylation signatures in gynecological malignancies: Implications for early diagnosis, prognosis, and therapy. In Epigenetics in Human Disease (pp. 931-957). Academic Press.
17. Zhang, Y., Chen, S., Wang, Y., Li, J., Xu, K., Chen, J., & Zhao, J. (2023). Deep learningbased methods for classification of microsatellite instability in endometrial cancer from HE-stained pathological images. Journal of Cancer Research and Clinical Oncology, 1-12.
18. Costas, L., Onieva, I., Pelegrina, B.,

Marin, F., Carmona, Á., López-

Querol, M., ... & Paytubi, S. (2023). Evaluation of Somatic Mutations in Urine Samples as a Noninvasive

Method for the Detection and Molecular Classification of Endometrial Cancer. Clinical Cancer Research, 29(18), 3681-3690.

19. Moghaddam, F. D., Dadgar, D., Esmaeili, Y., Babolmorad, S., Ilkhani, E., Rafiee, M., ... & Makvandi, P. (2023). Microfluidic platforms in diagnostic of ovarian cancer. Environmental Research, 117084.
20. Niazi, A. (2023). Advancements in Cancer Imaging: Innovations for Early Detection and Precision Medicine.
21. Wang, W., Rong, Z., Wang, G., Hou, Y., Yang, F., & Qiu, M. (2023). Cancer metabolites: promising biomarkers for cancer liquid biopsy. Biomarker Research, 11(1), 66.
22. Ziyambe, B., Yahya, A., Mushiri, T., Tariq, M. U., Abbas, Q., Babar, M., ... & Jabbar, S. (2023). A Deep Learning Framework for the Prediction and

Diagnosis of Ovarian Cancer in Pre-

and Post-Menopausal Women. Diagnostics, 13(10), 1703.

23. Peremiquel-Trillas, P., Gómez, D., Martínez, J. M., Fernández-

González, S., Frias-Gomez, J., Paytubi, S., ... & Díaz, M. (2023). Cost-effectiveness analysis of molecular testing in minimally invasive samples to detect endometrial cancer in women with postmenopausal bleeding. British Journal of Cancer, 1-10.

24. Kokabi, M., Tahir, M. N., Singh, D., & Javanmard, M. (2023). Advancing Healthcare: Synergizing Biosensors and Machine Learning for Early Cancer Diagnosis. Biosensors, 13(9), 884.

25. Kokabi, M., Tahir, M. N., Singh, D., & Javanmard, M. (2023). Advancing Healthcare: Synergizing Biosensors and Machine Learning for Early Cancer Diagnosis. Biosensors, 13(9), 884.

Submitted: March 5, 2025	*Revised: July 27, 2025*	*Accepted: August 6, 2025*

Address for Correspondence:

Dr. Zamin Abbas[1]

Cell: +92 331 034 4336

Email: mudasirsaleem759@yahoo.com

