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Epigenetics Research: Open Access

Short Communication

Liquid Biopsies for Epigenetic Biomarker Detection in Ovarian Cancer

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DESCRIPTION

Liquid biopsy technologies are revolutionizing ovarian cancer management by enabling non-invasive detection of epigenetic biomarkers, improving early diagnosis, and monitoring treatment response. Ovarian cancer is often diagnosed at advanced stages due to the lack of effective screening methods and the non-specific nature of early symptoms [1]. The five-year survival rate for advanced ovarian cancer remains below 50%, highlighting the urgent need for improved diagnostic and monitoring strategies [2]. Liquid biopsies, which analyze circulating tumor-derived material in blood and other body fluids, offer a promising approach for addressing these challenges.

Circulating tumor DNA (ctDNA) carries the same epigenetic modifications as the primary tumor, making it an ideal source for biomarker discovery. Methylation patterns in ctDNA can be detected with high sensitivity using techniques such as methylation-specific PCR and bisulfite sequencing. The methylation status of genes like *BRCA1*, *RASSF1A*, and *APC* in ctDNA correlates with tissue-based findings and provides valuable prognostic information [3]. The detection of methylated ctDNA has shown particular promise for monitoring treatment response in ovarian cancer. Patients receiving platinum-based chemotherapy show changes in ctDNA methylation patterns that precede conventional imaging-based response assessment. This early detection of treatment efficacy allows for timely treatment modifications and improved patient outcomes [4].

Circulating microRNAs (miRNAs) represent another important class of epigenetic biomarkers accessible through liquid biopsy. Several miRNAs, including miR-200 family members, miR-21, and miR-92, are dysregulated in ovarian cancer and can be detected in plasma and serum samples. These miRNAs are stable in circulation and resistant to degradation, making them reliable biomarkers for disease monitoring [5]. The miR-200 family, consisting of miR-200a, miR-200b, miR-200c, miR-141, and miR-429, plays crucial roles in Epithelial-Mesenchymal Transition (EMT) and is frequently silenced in ovarian cancer through promoter hypermethylation. Circulating levels of miR-200 family members correlate with tumor burden and can distinguish ovarian cancer patients from healthy controls with high accuracy.

Long non-coding RNAs (lncRNAs) are emerging as valuable liquid biopsy targets in ovarian cancer. The lncRNA HOTAIR is elevated in the plasma of ovarian cancer patients and correlates with tumor stage and chemotherapy resistance [6]. Similarly, circulating levels of lncRNA are associated with poor prognosis and can be used to monitor treatment response. The technical challenges of liquid biopsy implementation include the low abundance of circulating tumor-derived material, especially in early-stage disease, and the need for highly sensitive detection methods. Recent advances in digital PCR, next-generation sequencing, and nanotechnology-based approaches have improved the sensitivity and specificity of liquid biopsy assays [7].

Extracellular Vesicles (EVs), including exosomes and microvesicles, represent another source of epigenetic biomarkers in liquid biopsies. EVs released by ovarian cancer cells carry DNA, RNA, and proteins that reflect the molecular characteristics of the parent tumor [8]. The analysis of EV-derived miRNAs and methylated DNA has shown promise for early detection and monitoring of ovarian cancer. The clinical validation of liquid biopsy-based epigenetic biomarkers requires large-scale prospective studies. Several ongoing clinical trials are evaluating the utility of circulating biomarkers for ovarian cancer screening, diagnosis, and monitoring [9,10]. The promise study, for example, is assessing the performance of a multi-analyte liquid biopsy test for ovarian cancer detection. The integration of liquid biopsy results with other clinical parameters, including imaging findings and serum tumor markers like CA-125, may improve diagnostic accuracy. Machine learning algorithms are being developed to combine multiple biomarker types and create comprehensive risk assessment models.

CONCLUSION

Future developments in liquid biopsy technology include the analysis of Circulating Tumor Cells (CTCs) and Tumor-Educated Platelets (TEPs). These approaches may provide additional molecular information and complement existing liquid biopsy methods. The standardization of sample collection, processing, and analysis protocols will be essential for

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Received: 03-Mar-2025, Manuscript No. EROA-25-38319; **Editor assigned:** 05-Mar-2025, PreQC No. EROA-25-38319 (PQ); **Reviewed:** 19-Mar-2025, QC No. EROA-25-38319; **Revised:** 26-Mar-2025, Manuscript No. EROA-25-38319 (R); **Published:** 02-Apr-2025, DOI: 10.35248/EROA.25.7.211

Citation: Gilani R (2025). Liquid Biopsies for Epigenetic Biomarker Detection in Ovarian Cancer. J Epigenetics Res. 7:211.

widespread clinical adoption. The potential applications of liquid biopsy in ovarian cancer extend beyond biomarker detection to include monitoring of minimal residual disease, early detection of recurrence, and assessment of treatment resistance mechanisms. As these technologies continue to mature, they will likely become integral components of ovarian cancer management strategies.

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