https://doi.org/10.29289/259453942025V35S1024

The role of liquid biopsy in breast cancer screening and monitoring: a systematic review of literature

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Objective: This study evaluated the potential of liquid biopsy for breast cancer early detection, tumor monitoring, and personalized treatment by analyzing circulating biomarkers. It also investigated its ability to reduce invasive procedures and to expand diagnostic access in low-resource settings. **Methods:** This is a systematic review of the literature that followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines, and was registered in the International Prospective Register of Systematic Reviews (PROSPERO), under CRD420251019679. The PubMed database was searched using the operators "liquid biopsy" AND "breast cancer." The applied filters were "last 10 years", "free full text", "humans", and "women". PICO criteria were used as follows: Participants: women with breast cancer; Intervention: liquid biopsy for screening and monitoring breast cancer, analyzing circulating tumor deoxyribonucleic acid (ctDNA), circulating tumor cells (CTCs), micro ribonucleic acid (miRNAs), and extracellular vesicles (EVs); Comparison: conventional diagnostic and monitoring methods; Outcome: potential of liquid biopsy for early detection, monitoring, and reduction of invasive procedures. Out of 212 articles identified and reviewed, 152 were included after applying the eligibility criteria. **Results:** The most frequent biomarkers were ctDNA, CTCs, miRNAs, and EVs, which showed potential clinical importance. CtDNA, the most validated marker, correlated with tumor burden, treatment resistance mutations, and prognosis, particularly with ESR1 and PIK3CA mutations linked to endocrine resistance. High CTC counts are associated with poor prognosis and increased metastatic risk. Exosomal miRNA signatures improved diagnostic accuracy, especially with cancer antigen (CA) 15-3 and carcinoembryonic antigen (CEA). Multi-omics approaches combining miRNA and ctDNA show >90% sensitivity in early detection. Challenges included low sensitivity in early-stage tumors, tumor heterogeneity, and financial cost. **Conclusion:** Liquid biopsy is a less invasive alternative for breast cancer screening and monitoring, improving disease stratification accuracy. Circulating tumor DNA detects cancer at different stages and identifies biomarkers for personalized treatment. By reducing invasive biopsies, it enhances quality of life and adherence, especially in resource-limited settings.

Keywords: breast cancer; cancer screening test; circulating tumor DNA; liquid biopsy; tumor biomarkers.