



Clinical Utility of Liquid Biopsy after Liver Surgery

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DESCRIPTION

Colorectal cancer is one of the most common malignancies worldwide and liver metastases represent a significant cause of morbidity and mortality in affected patients. Surgical resection, or hepatectomy, remains the most effective treatment for isolated liver metastases, offering potential long-term survival benefits. Despite advances in surgical techniques and perioperative management, recurrence rates remain high, highlighting the need for reliable tools to monitor residual disease, assess recurrence risk, and guide postoperative therapy. Traditional follow-up methods rely on imaging and serum tumor markers, which may not detect minimal residual disease or early molecular changes preceding radiological progression.

Extracellular vesicles, including exosomes, carry nucleic acids, proteins and lipids that reflect the tumor microenvironment. Postoperative monitoring of exosomal content may provide insights into changes in tumor signaling pathways, immune responses and angiogenic activity following resection. While these approaches are still under investigation, early evidence suggests that integrating multiple circulating biomarkers could improve sensitivity for detecting minimal residual disease and predicting recurrence.

Several factors influence the interpretation of liquid biopsy results after hepatectomy. Surgical trauma itself can transiently increase circulating DNA levels, potentially confounding early postoperative measurements. Standardization of blood collection timing, processing protocols and assay platforms is necessary to distinguish tumor-specific signals from background noise. Moreover, the heterogeneity of primary and metastatic tumors means that not all relevant mutations may be captured in the circulating pool, emphasizing the need for comprehensive panels and sensitive detection methods.

Cost-effectiveness is another consideration. While sequencing and molecular analyses have become more affordable, comprehensive liquid biopsy panels can still be resource-intensive. Demonstrating that liquid biopsy improves patient

outcomes, reduces unnecessary imaging or invasive procedures and supports more effective therapy selection will support adoption in routine practice. Education of healthcare providers on interpretation and integration of liquid biopsy results is equally important to ensure informed decision-making.

In addition to technical considerations, ethical and logistical issues must be addressed. Patients should be informed about the implications of molecular findings, including the potential detection of minimal residual disease or emerging mutations associated with therapy resistance. Repeated blood sampling for longitudinal monitoring may impose practical burdens and strategies to minimize patient inconvenience should be considered. Data privacy, storage and sharing policies must comply with regulatory requirements to protect patient information.

Future directions include combining liquid biopsy with imaging and traditional serum markers to create a more comprehensive monitoring strategy. Integrating ctDNA dynamics with radiological assessments could improve early detection of recurrence and support individualized follow-up schedules. Multicenter prospective studies are needed to determine the optimal combination of biomarkers, sampling intervals and analytical platforms to maximize predictive accuracy and clinical relevance.

In conclusion, liquid biopsy after hepatectomy for colorectal liver metastases represents a promising approach for monitoring residual disease, assessing recurrence risk and guiding postoperative management. Analysis of circulating tumor DNA, circulating tumor cells and exosomes provides real-time insights into tumor dynamics that are not accessible through conventional imaging or tissue biopsy alone. While technical, clinical and logistical challenges remain, ongoing research and technological advances are expanding the potential applications of liquid biopsy in this setting. Integration into clinical practice could improve early detection of recurrence, inform treatment decisions and ultimately enhance outcomes for patients undergoing resection for colorectal liver metastases

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