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MODERN PRINCIPLES OF EARLY DIAGNOSIS OF HEPATOCELLULAR CARCINOMA IN PATIENTS WITH CHRONIC HEPATITIS B AND C

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Abstract
Hepatocellular carcinoma (HCC) remains one of the most aggressive malignancies, frequently developing in the context of chronic hepatitis B and C. Over the past 15 years, diagnostic approaches have undergone significant transformations. In addition to traditional methods such as ultrasound and AFP testing, modern strategies incorporate multiparametric MRI and CT, PET-CT, LI-RADS classifications, and artificial intelligence (AI). This paper reviews current approaches to early HCC detection, introduces a regional monitoring model from Uzbekistan, and underscores the integration of digital technologies into routine care.

Keywords: Hepatocellular carcinoma, hepatitis B, hepatitis C, early diagnosis, LI-RADS, ultrasound, MRI, AFP, artificial intelligence, dispensary surveillance, Uzbekistan

Introduction

Hepatocellular carcinoma (HCC) is among the most lethal malignancies globally, ranking fifth in overall incidence and third in cancer-related mortality. Its strong etiological link with chronic hepatitis B (HBV) and C (HCV) infections makes it a major health concern in regions with high prevalence of viral hepatitis, including many Central Asian countries. According to the World Health Organization, approximately 250 million individuals are chronically infected with HBV, and an additional 60 million live with HCV. The burden in Uzbekistan

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is particularly significant due to historically low vaccination coverage, inconsistent antiviral treatment availability, and a general lack of structured early detection programs.

In most cases, HCC develops silently, only becoming symptomatic at advanced stages when treatment options are limited and prognosis poor. The global five-year survival rate for HCC remains below 15%. Therefore, early detection remains a cornerstone of effective management. Screening of high-risk populations, especially individuals with cirrhosis or chronic viral hepatitis, is vital. The established international standard recommends ultrasound examination every six months, combined with alpha-fetoprotein (AFP) testing. However, adherence to this protocol remains a challenge, particularly in rural or underserved populations.

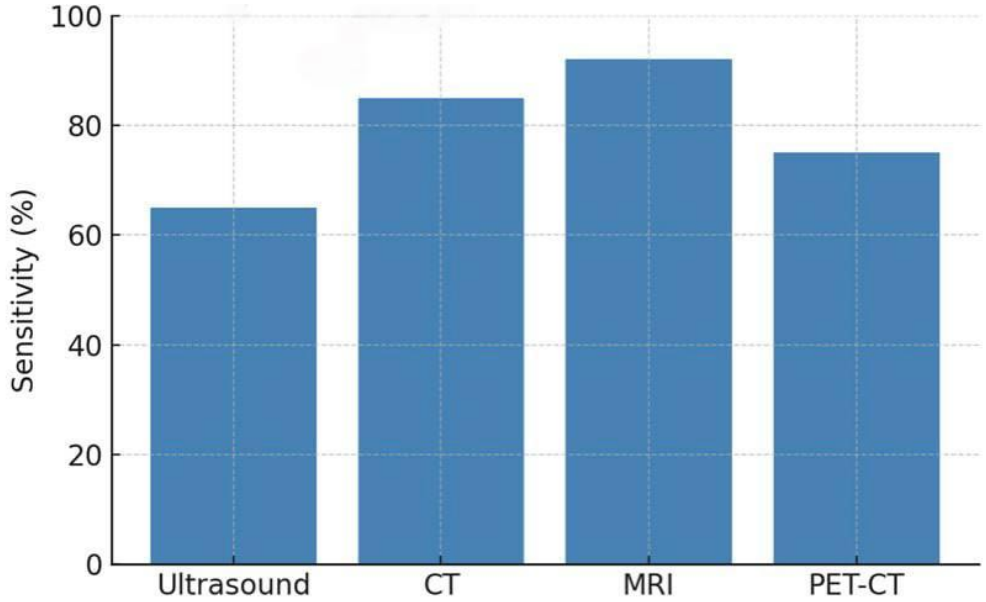

Figure 1. Sensitivity of Different Imaging Modalities in Detecting Hepatocellular Carcinoma

Ultrasound continues to serve as the first-line screening tool due to its non-invasiveness, affordability, and portability. Yet, its diagnostic accuracy is highly operator-dependent. To overcome this limitation, advanced imaging techniques such as multiphasic computed tomography (CT) and magnetic resonance imaging (MRI) have become increasingly utilized for confirmation and staging of

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suspicious lesions. MRI, in particular, offers excellent soft tissue contrast and, when used with hepatobiliary-specific contrast agents and functional sequences such as diffusion-weighted imaging (DWI) and MR elastography, can identify even small or atypical lesions. The Liver Imaging Reporting and Data System (LI-RADS) provides a standardized framework for assessing liver nodules, helping radiologists categorize findings and guide management.

While AFP has long been used as a serum biomarker for HCC, its diagnostic performance is limited, particularly in the early stages of the disease. Newer markers such as AFP-L3 and des-gamma-carboxy prothrombin (DCP), when used in combination—such as in the GALAD score—can significantly enhance early detection capabilities. Additionally, advances in molecular diagnostics, including liquid biopsy and cell-free DNA analysis, are under investigation and may play a greater role in the near future.

Artificial intelligence (AI) is emerging as a transformative tool in oncologic imaging. Radiomics, which involves extraction of large amounts of quantitative imaging features, along with machine learning algorithms, enables refined lesion characterization, risk stratification, and outcome prediction. Deep learning models trained on thousands of annotated images can support radiologists in identifying subtle patterns that may be missed by the human eye. Early studies suggest improved sensitivity and specificity when AI is integrated into liver cancer workflows, although widespread adoption is still hindered by technical, ethical, and infrastructural challenges.

Table 1. Comparative Characteristics of Imaging Modalities for HCC Diagnosis.

Modality	Sensitivity (%)	Availability	Strengths	Limitations
Ultrasound	65–75	High	Low cost, safe	Operator dependent, low specificity
CT	80–85	Moderate	Good resolution	Radiation exposure, contrast risk
MRI	90–95	Moderate	Excellent soft tissue contrast	Expensive, time-consuming
PET-CT	70–80	Low	Metabolic assessment	Limited use in HCC, high cost

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A notable example of an effective surveillance model comes from the Fergana region in Uzbekistan. Between 2005 and 2008, a structured four-level model was implemented to monitor patients with chronic HBV and HCV. This program included annual screening using ultrasound and AFP, risk stratification, specialist referral, and periodic follow-up. Among 102 patients followed, five early-stage HCC cases were diagnosed and treated appropriately, demonstrating the feasibility and impact of targeted regional programs in early cancer detection.

Despite these advancements, numerous barriers remain. There is a critical shortage of trained radiologists and hepatologists in many regions, particularly outside urban centers. Access to high-quality imaging equipment is limited, and financial barriers persist. There is also a gap between research findings and clinical implementation, as well as a potential risk of overdiagnosis and unnecessary interventions driven by imaging advances. Furthermore, digital disparities affect rural access to telemedicine and cloud-based diagnostic tools.

To bridge these gaps, integrated health strategies are necessary. These should include public awareness campaigns, continuous medical education, investment in infrastructure, and the gradual implementation of AI-powered diagnostic systems. Telemedicine, cloud-based PACS (Picture Archiving and Communication Systems), and mobile outreach units can help expand the reach of liver cancer screening and care.

In conclusion, modern principles of early HCC diagnosis rely on the synergy of radiological, serological, and computational tools. Uzbekistan's experience demonstrates that locally adapted programs, when well-coordinated, can yield meaningful improvements in early detection and survival outcomes. Looking forward, it is essential to ensure equitable access to innovation and to maintain investment in research, training, and system-wide modernization.

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