

Artificial Intelligence in Colon Cancer: Advances, Challenges, and Future Perspectives

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Abstract

Colorectal cancer (CRC) remains a significant global health challenge, with rising incidence in younger populations and high mortality. Artificial intelligence (AI) is transforming CRC care, enhancing accuracy and efficiency across diagnostic, therapeutic, and follow-up stages. In endoscopy, computer-aided detection (CADE) systems increase adenoma detection rates by 25–50%, while computer-aided diagnosis (CADx) supports real-time lesion characterization. In pathology, AI applied to whole-slide imaging enables automated triage, *in silico* microsatellite instability prediction, and prognostic risk stratification, often outperforming TNM staging. Radiology benefits from AI-driven lesion detection, staging, and radiomic “virtual biopsy” for molecular profiling (e.g., KRAS, MSI). AI-based treatment planning integrates histopathology, imaging, and multi-omics to refine chemotherapy indications, predict neoadjuvant response, and identify novel therapeutic targets. In surgery, AI-enhanced robotic platforms enable real-time anatomical recognition, perfusion assessment, and complication risk prediction, improving intraoperative safety. Prognostic modeling using multimodal datasets offers superior survival and recurrence predictions, while AI-driven quality-of-life forecasting and patient-reported outcome monitoring facilitate personalized survivorship care. Challenges to widespread adoption include data heterogeneity, external validation gaps, interpretability, and regulatory compliance. Advances in multimodal AI and federated learning may overcome these barriers. With rigorous evaluation, AI is poised to become a cornerstone of precision oncology in CRC, improving outcomes and optimizing care delivery.

Keywords: artificial intelligence, colon cancer, screening, digital pathology, precision oncology, minimal invasive surgery