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ARTIFICIAL INTELLIGENCE–BASED PREDICTIVE MODELING FOR SURGICAL PLANNING IN DECOMPENSATED COLOSTASIS

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Abstract

Decompensated colostasis is a life-threatening condition characterized by severe intestinal obstruction, ischemic changes, and risk of perforation. Determining the appropriate extent of colon resection remains a major surgical challenge. Artificial intelligence (AI) has emerged as a powerful tool for improving preoperative planning through predictive modeling and large-scale clinical data analysis. This study explores the application of AI-based systems in predicting tissue viability, defining resection margins, and estimating postoperative complication risks in patients with decompensated colostasis. The integration of AI into surgical decision-making may enhance operative precision, reduce unnecessary resections, and improve patient outcomes.

Keywords: artificial intelligence, predictive modeling, colon resection, decompensated colostasis, surgical planning, machine learning.

Introduction

Decompensated colostasis represents an advanced stage of colonic obstruction associated with impaired motility, progressive bowel dilation, ischemia, and systemic inflammatory response. Emergency surgical intervention is often required to prevent perforation, sepsis, and multi-organ failure. One of the critical aspects of operative management is accurate determination of the resection volume.

Conventional diagnostic tools such as computed tomography (CT), laboratory inflammatory markers, and intraoperative visual assessment provide important information but may not fully capture the complexity of tissue viability and microvascular perfusion. Inaccurate estimation of resection margins may lead either to insufficient removal of compromised bowel segments or excessive resection, resulting in increased morbidity.

Artificial intelligence offers advanced analytical capabilities through machine learning and deep learning technologies. By integrating imaging, laboratory, and clinical data, AI systems can support objective and data-driven surgical planning.

Objective

The objective of this study is to evaluate the effectiveness of artificial intelligence–based predictive modeling in determining the optimal volume of colon resection in patients with decompensated colostasis and to assess its impact on surgical accuracy and postoperative outcomes.

Methods

This research was conducted as a retrospective analytical study combined with computational modeling. Clinical and radiological data from patients diagnosed with decompensated colostasis were analyzed. Parameters included CT imaging findings, colon wall thickness, bowel diameter, perfusion patterns, inflammatory markers, duration of obstruction, and comorbidities.

Machine learning algorithms were developed to analyze structured datasets and identify predictive variables associated with bowel necrosis, ischemia progression, and postoperative complications. Deep learning models were applied to contrast-enhanced CT scans to perform automated segmentation and detection of compromised tissue zones.

Predictive models were trained using supervised learning techniques and validated through cross-validation methods. Performance metrics included sensitivity, specificity, predictive accuracy, and area under the receiver operating characteristic curve (AUC). Comparative evaluation was performed between AI-supported planning and conventional surgical assessment.

Results

The analysis demonstrated that AI-based predictive modeling improved the accuracy of preoperative estimation of resection margins. Deep learning image segmentation identified ischemic zones with high precision, allowing for more accurate boundary determination compared to visual radiological interpretation alone.

Predictive algorithms effectively stratified patients according to complication risk, including anastomotic leakage and postoperative infection. AI-assisted planning reduced intraoperative adjustments of resection margins and decreased operative time in simulated evaluations.

Furthermore, AI systems identified complex data correlations between inflammatory markers, perfusion deficits, and structural bowel changes, which were not consistently recognized using standard diagnostic methods. These findings highlight the ability of AI to detect subtle pathological patterns through large-scale data processing.

Discussion

Artificial intelligence introduces a novel paradigm in surgical planning for decompensated colostasis by transforming heterogeneous clinical data into actionable predictive insights. The ability to analyze multidimensional datasets enhances diagnostic precision and supports evidence-based surgical decision-making.

AI-driven prediction of tissue viability and complication risk may reduce both under-resection and over-resection. By providing objective calculations of resection boundaries, AI contributes to improved safety and individualized operative strategies.

However, successful clinical implementation requires robust validation, standardized data collection protocols, and integration with hospital information systems. Ethical considerations and transparency of algorithm decision-making processes must also be addressed to ensure clinician trust and patient safety.

Conclusion

Artificial intelligence–based predictive modeling represents a promising advancement in the surgical management of decompensated colostasis. By enabling precise assessment of tissue viability and optimal resection volume, AI enhances preoperative planning and supports safer, more individualized surgical interventions.

Future prospective clinical studies are required to validate these findings and establish AI as a routine tool in colorectal surgical practice. The integration of artificial intelligence into surgical workflows may significantly improve outcomes and reduce complications in patients with severe colonic obstruction.

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