Symposium | Surgery

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Symposium 5 Recent advances in surgery for colorectal diseases

Moderator: Kay Uehara (Department of Coloproctological Surgery, Juntendo University, Japan), Mina Shen (China Medical University Hsinchu Hospital, Taiwan)

# [SY5-5] Surgical Workflow Analysis Using AI-Based Object Recognition in Laparoscopic Colorectal Surgery

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Background: Recent advances in artificial intelligence (AI)-based surgical video analysis have enabled automatic recognition of surgical instruments and anatomical structures, allowing visualization of surgical workflow in a time-series manner. This study investigated whether AI-driven workflow analysis based on object recognition could contribute to the standardization of minimally invasive colorectal cancer surgery. Methods: A total of 11,225 frames extracted from intraoperative videos of 57 laparoscopic colorectal resections were used as training data. An instance segmentation model based on Mask R-CNN was developed using 34,455 annotations across 26 categories, including 13 surgical instruments and 13 anatomical or physiological structures. Model validation was performed using 600 frames from seven independent surgeries. Surgical workflow analysis was then conducted in another seven cases using time-series object recognition results. Six operative phases were predefined: dissection initiation, vascular management initiation, clipping initiation, bowel transection, anastomosis, and extracorporeal manipulation. Workflow transitions were automatically identified according to temporal changes in object detection. Results: The object recognition model achieved a mean recall of 85.3% and a mean precision of 90.7%. Time-series analysis successfully identified all six operative phases in all seven analyzed cases, enabling objective visualization of surgical progression. Quantitative workflow analysis enabled objective comparison of surgical progression and facilitated identification of technically difficult phases. Conclusions: AI-based surgical workflow analysis enabled objective evaluation of operative progression in minimally invasive colorectal cancer surgery and may contribute to procedural standardization, surgical education, and skill assessment. Integration with robotic surgical logs and preoperative imaging may support development of real-time intraoperative navigation systems.

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