

ANATOMICAL-GROUNDED AND GUIDELINE-DRIVEN NAVIGATION FOR LAPAROSCOPIC CHOLECYSTECTOMY USING ARTIFICIAL INTELLIGENCE

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Background : The Tokyo Guideline 2018 advocates for "Safe Steps" for laparoscopic cholecystectomy (LC), recommending "starting dissection from the posterior leaf of the peritoneum covering the neck of the gallbladder (GB) and exposing the GB surface above Rouviere's sulcus (RS)" and "maintaining the plane of dissection on the GB surface throughout LC." However, LC is frequently performed by less experienced surgeons in emergency settings, which may lead to deviations from adherence to these safe steps. We developed an artificial intelligence (AI) navigation system designed to assist surgeons in adhering to these safe steps.

Methods : We analyzed the cases of LC performed at our institution between 2022 and 2024. The GB surface and Alert Zone (AZ), which we defined as the hepatoduodenal ligament area below a line connecting the roof of RS, the base of Segment 4, and the infundibulum-cystic duct junction, were annotated as target anatomical structures, and two surgeons independently annotated the extracted images. Using this annotated data, an AI model was developed.

Results : A total of 83 LC cases were included, with 31 male patients (37.3%) and a mean age of 60.0 ± 15.0 years. Diagnoses were gallstones, acute cholecystitis, and chronic cholecystitis in 47, 23, and 13 cases, respectively. A total of 1321 images were annotated. The mean IoU was 0.645 for the GB surface and 0.613 for AZ.

Conclusions : Our AI system provides an anatomically grounded and guideline-driven navigation approach, emphasizing critical safety zones and facilitating adherence to recommended dissection planes, thereby potentially enhancing LC safety and clinical outcomes.

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