Feasibility of Automatic Verification of the Critical View of the Inferior Mesenteric Artery (IMA) Ligation with Artificial Intelligence (AI)

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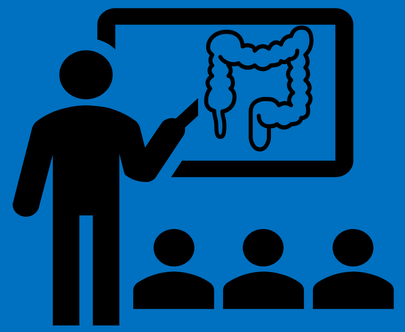
Introduction: Standardizing a critical step in surgery has inherent challenges. For automation and development of AI algorithms, an objective view of the step with measurable performance metrics is required. Video-based assessment may reduce contextual variability and improve the machine learning process. But expert agreement is first needed for the feasibility, annotation, and use of explainable AI. Our goal was to assess the clinical need and feasibility for automating a critical view of safety in left-sided colorectal resections..

Methods: A mixed-methods approach was employed, with a quantitative survey administered to international key colorectal surgery opinion leaders. The critical step definition was reviewed, then the distinct critical step of Inferior Mesenteric Artery (IMA) ligation evaluated. In stepwise fashion, the clinical need for a critical view of safety around this step, then the ability to recognize, reproduce, and teach the step were surveyed. Consensus was defined as 70% or greater agreement (Yes/No). Then, qualitative analysis was performed by a panel of data scientists and engineers on the proposed critical view illustration and video-based assessment (10 videos sequences of 5 laparoscopic and 5 robotic left-sided colorectal resections) for the feasibility, challenges, and insights into AI automation

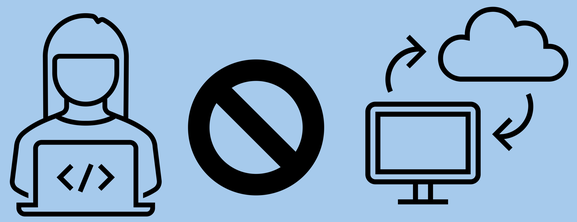
Results: Twenty-one surgical experts participated. Initial survey consensus was reached on the following: a) IMA ligation was a distinct and critical step b) there was a need to standardize this critical view, and c) the critical view was reproducible and teachable. Key features of the critical view included the IMA takeoff from the aorta, the ureter down, and a clear mesenteric window around the IMA. After qualitative analysis by the technical team, there was understanding of the view and structures from the illustration. The view and distinct structures were not recognized in the laparoscopic videos (0/5). The view and distinct structures were recognizable in 3 of the 5 robotic videos (60%).

The surgical leaders affirmed: There is a need for a critical view of safety in left-sided colorectal resections to improve the surgical quality and patient outcome

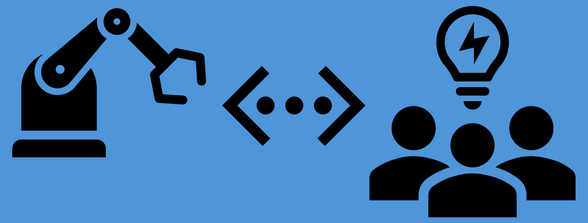
Consensus was reached for the IMA ligation as the step with 8 individual components. The step was agreed to be easily recognizable, reproducible and teachable



After qualitative teaching by the clinical team using illustrations, the engineering team was not able to recognize the steps or critical views structures in segmented videos (0%laparoscopic, 60% robotic)



AI could not work autonomously to reliably recognize the structures in video-based assessment



AI accelerates data acquisition and analysis, but a better method for universal learning could improve the quality of AI algorithms

Improving surgical vision, segmentation of steps, and annotation in advance of training algorithms can help ensure quality and explainable AI in clinical surgery

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