Artificial Intelligence Surgery

Abstract

Enhancing Surgery in Endometriosis Laparoscopy: Training Neural Networks to Segment Incision Boundaries

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Aim: This study addresses inter-surgeon variability and the lack of standardized surgical procedures during laparoscopic surgery for endometriosis. We propose a neural network for automated incision boundary segmentation.

Methods: The dataset includes 210 laparoscopic surgeries from five centers world-wide, adhering to legal regulations. We created a guidebook for data annotations. Two junior and two senior surgeons annotated ~8K zones across 1,150 images. Our annotation process involved over 55 person-hours of discussions to achieve consensus on ontology and on defining reference segmentations. We used DeepLabV3 and trained four neural networks on data annotated by experts of varying proficiency. We use Intersection-over-Union (IoU) as an evaluation metric.

Results: Firstly, the best- and worst- performing surgeons achieved 42% and 48% IoU with the reference segmentations, with 0.24, and 0.26 standard-deviation (std), respectively. In contrast, the best neural network achieved a mean-IoU of 36% (0.26 std). However, all experts visually assessed these results to be on par with theirs. Additionally, the neural network's specificity consistently exceeded 97%, ensuring a low number of false signals. Secondly, our consensus-based annotation process significantly improved ($p<0.05$) the initial inter-surgeon agreement observed across all annotator pairs, except one.

Conclusion: Artificial Intelligence is promising at assisting endometriotic surgery. We plan to expand our dataset to improve performance, design a clinically-meaningful evaluation metric to replace the unadapted IoU and conduct a clinical impact study to measure concrete applicability.

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