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Surgical Safety Reimagined: AI-Powered Detection of Retained Surgical Items

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INTRODUCTION

Counting surgical instruments during surgical procedures is critical for ensuring patient safety. Traditionally, instrument counting is performed manually by nurses and other surgical team members. However, this process is prone to human error and can increase procedure time and associated costs. It was estimated the incidence of retained surgical items (RSIs) to be approximately 1.3 cases per 10,000 surgeries. Failure to identify and retrieve missing instruments is a serious medical incident, requiring reoperation. Our goal is to develop a machine learning-based computer vision algorithm to create a reliable, automated surgical instrument counting support system. With the rapid progress of artificial intelligence (AI), especially in deep learning–based visual recognition, we can design systems capable of detecting and counting surgical instruments on open surgery condition. It has potential to enhance surgical safety protocols, reduce burden of surgeon.

MATERIALS AND METHODS

YOLO is a real-time object detection algorithm built on a convolutional neural network (CNN), known for its efficiency in identifying and localizing objects within images and videos.

To train the model, we record 200 minutes of open surgery video in simulation. These videos captured approximately 2,000 instrument transfer events between a patient (mannequin) and a surgical instrument panel. Additionally, we collected 500 images of 10 different surgical instruments and obtained another 500 images from online surgeries. All images were annotated by a human expert to mark the name and locations of instruments.

Of 2,000 images, 80% were allocated for model training and 20% for validation. After training, the AI model was tested by detecting, tracking and counting surgical instruments from the instrument panel (defined as the Region of Interest (ROI)) from another 2000 frames video.

RESULTS AND DISCUSSION

The model achieved a 90% accuracy rate for recognized tools and consistently tracked the surgery instruments. In a validation session of 2,000 video frames the model demonstrated an 88.5% success rate by correctly tracking and counting instruments in 1,770 of 2,000 frames. In addition, the model correctly classified instruments in 92% of cases and misclassified the remaining 8% primarily confusing small haemostats and needle drivers within the defined ROI.

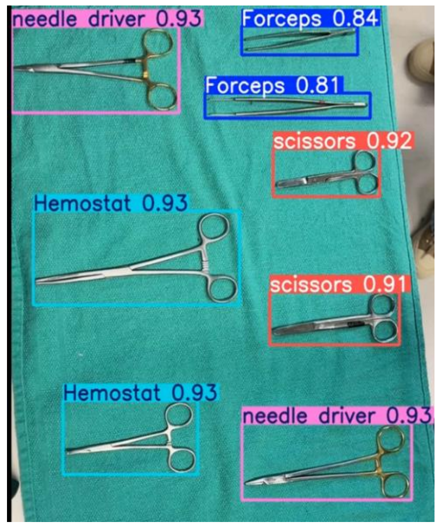

Fig 1 surgical tools detection.

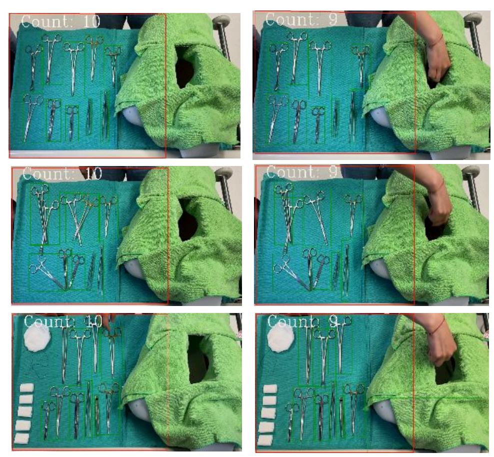

Fig 2 *Counting number of* surgical tools.

CONCLUSIONS

The YOLO-based computer vision model yields a satisfactory outcome in detecting and tracking surgical instruments during open surgery. The model performed more reliably on tracking part. Increasing the sample size and diversity of the training dataset is necessary to further enhance the model's detection and tracking capabilities.