TITLE: ARTIFICIAL INTELLIGENCE GUIDANCE FOR SAFE DISSECTION IN PER ORAL ENDOSCOPIC MYOTOMY

Authors + Affiliations: Vasisht, Shubha[5]; Sharma, Riya M[3]; Singh, Vivek K.[5, 4]; Liao, Guiqiu[5]; Jogan, Matjaz[5]; Eaton, Eric[1]; Marks, Jeffrey M.[2]; Ginsberg, Gregory G.[5]; Leung, Galen[5]; Hashimoto, Daniel A.[5, 1]
1. University of Pennsylvania School of Engineering and Applied Science, Philadelphia, PA, United States.
2. University Hospitals, Cleveland, OH, United States.
3. Royal College of Surgeons in Ireland, Dublin, Ireland.
4. Boston University, Boston, MA, United States.
5. University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, United States.

Background: Peroral endoscopic myotomy (POEM) offers a less invasive treatment for achalasia but carries a risk of complications, including perforation and bleeding in up to 10% of cases. Limited depth perception and narrow visual fields in POEM can lead to errors, such as thermal injuries and leaks. Advances in artificial intelligence (AI) and computer vision may enable automated detection of safe and unsafe dissection areas. This study aimed to develop AI algorithms for guiding submucosal dissection by identifying mucosa, muscle, and dissection areas.

Methods: 24 POEM videos from two institutions yielded 6658 image frames labeled by three annotators and reviewed by an experienced endoscopist. Labels included electrosurgical knife, mucosa, muscle, safe ("Go"), and unsafe ("NoGo") dissection zones as determined by a consensus of experienced endoscopists. Visual transformer (Segformer) and convolutional neural network (Res-Unet) models were developed using a 90:10 train-test split, with performance evaluated using Dice score and Hausdorff distance. Model performance was also tested with a smaller subset of 122 frames.

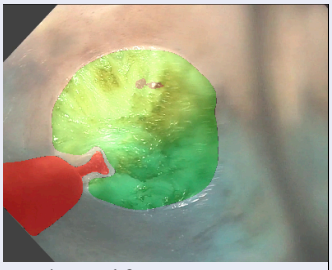
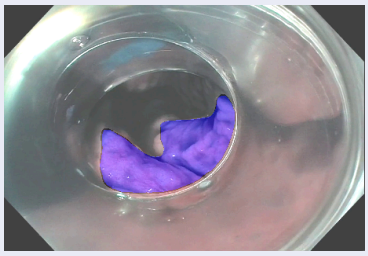
Results: Segformer achieved a Dice score of 0.87, outperforming Res-Unet (0.84) in identifying mucosa, muscle, and dissection zones. Models trained on the larger dataset performed better than those trained on the subset. Figure 1 illustrates guidance qualitative overlays during submucosal dissection.

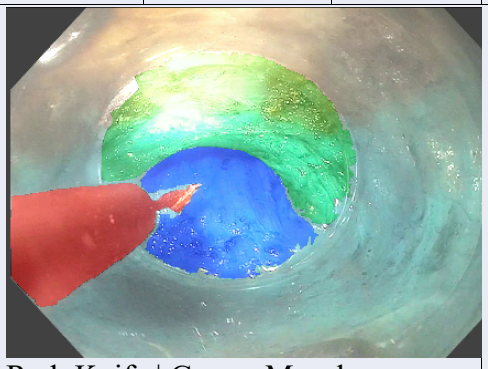
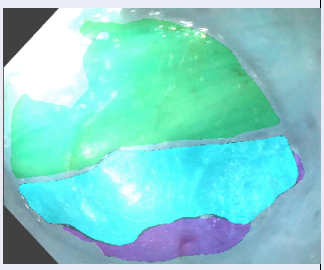
Conclusion: AI models show promise in identifying endoscopic tools and anatomical structures during POEM. Ongoing work incorporates additional institutional data to enhance model generalizability and performance, including detecting blood vessels, thermal injuries, and mucosal perforations.

Word Count: 237/250

(Figure on next page)

Table 1. Comparison of algorithm performance between transformer (Segformer) and convolutional neural network (Res-Unet) models in identifying different objects or anatomic features in POEM videos. Background includes the distal attachment cap area. Go=safe; NoGo=unsafe dissection areas. Dice score is a metric of overlap between the human label and AI identification (max=1.0); Hausdorff distance (HD) measures the maximum distance in pixels of the AI prediction from the human label (lower is better).

Large Dataset (n=6658 frames)						
	Metrics	**Knife**	**Muscle**	**Mucosa**	**Background**	**Avg**
Res-Unet	Dice	0.9172	0.7281	0.7386	0.9620	0.8365
	HD (pixels)	5.5920	26.3575	27.1098	19.5074	19.6417
Segformer	Dice	0.9193	0.7891	0.7918	0.9688	0.8672
	HD (pixels)	5.2562	19.8862	21.1778	15.9613	15.5704
Example Images Labeled by AI		 Red: Knife Green: Muscle		 Purple: Mucosa		

Data Subset (n=122 frames)							
	Metrics	**Knife**	**Muscle**	**Mucosa**	**Go**	**NoGo**	**Avg**
Res-Unet	Dice	0.8605	0.7294	0.5323	0.60	0.3018	0.6539
Segformer	Dice	0.8710	0.7284	0.5679	0.66	0.3429	0.6786
Example Images Labeled by AI		 Red: Knife | Green: Muscle Blue: Mucosa			 Green: Muscle Sky Blue: Go Purple: NoGo		

Incidence of and Risk Factors for Radiographically Occult Nodal Metastases in Colon Cancer: Is It Time for a New Lymphadenectomy Standard?

Chatani PD, Fredette J, Porpiglia AS, Greco S, Reddy SS, Farma JM, Villano AM

Introduction

Adequate lymphadenectomy in non-metastatic colon cancer is a critical component of oncologic colectomy. Proper identification of clinically-occult positive nodes after resection is essential for best oncologic outcomes as it informs adjuvant chemotherapy use. The incidence of and risk factors for node-positivity, as well as the optimal lymph node yield to accurately stage patients, are poorly characterized.

Methods

The National Cancer Database was queried for patients with clinically node-negative colon adenocarcinoma undergoing curative-intent resection between 2010 and 2021. Demographic, clinical, and pathologic variables were analyzed using descriptive statistics; multivariate logistic regression analysis was employed to identify variables independently associated with pathologic upgrade to nodal-positivity.

Results

Clinically node-negative patients who underwent curative resection of colon adenocarcinoma (n = 195,213) were upstaged to node-positive in 26.3% of cases. Characteristics most strongly associated with upgrade to nodal positivity on multivariate logistic regression (Table 1) were age <50, Black or Asian race, sigmoid primary, poorly-differentiated histology, lymphovascular or perineural invasion. With every 1cm increase in tumor size, odds of pathologic upgrade increased by 1.2%. Nodal harvest also correlated with increased odds of pathologic upgrade at a rate of 0.6% per node excised; patients with ≥18 nodes excised were more likely to demonstrate nodal-positivity than those with 12-17 (OR 1.12; $p<0.05$).

Discussion

Our study demonstrates numerous risk factors associated with radiographically occult nodal metastases; a risk calculator (https://tinyurl.com/4yey2ru5) has been built to assist with assessment in the pre-operative setting. Resection of at least 18 nodes increases the risk of pathologic upgrade, suggesting modification of operative standards in colon surgery.