A novel, artificial-intelligence driven method to study variations in surgical stapler technique and load color choices.

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INTRODUCTION

- Stapler related complications remain a significant source of morbidity and mortality[1]
- Annotating stapler related data is laborious, requiring human review of operative reports or videos
- Video Based Analysis (VBA) and machine learning can uncover previously inaccessible data at scale on variable intraoperative events[2]
- Through VBA/ML we can identify outcome-optimizing techniques.
- Here we present a deep multi-stage temporal convolutional network (MSTCN)[3] with an EfficientNetV2 featurizer[4] which detects the sequence of stapler load colors and time of use from video of bariatric procedures

METHODS

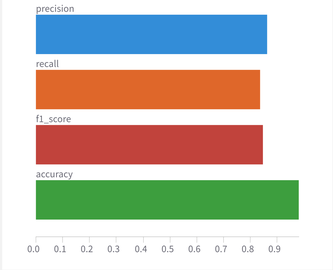
- Videos were annotated by trained non-clinicians for time of stapler presence, load color, buttress type, and anvil positioning (up, down, or other)
- Model trained and tested on the following data from endoscopic cases:

METHODS (cont.)

Procedure	Training (58+ surgeons)	Testing (38+ surgeons)
Sleeve Gastrectomy	643	96
Roux-en-Y Gastric Bypass	257	86
Radical Retropubic Prostatectomy	8	15
Mini Gastric Bypass	2	2
Low Anterior Resection	0	1

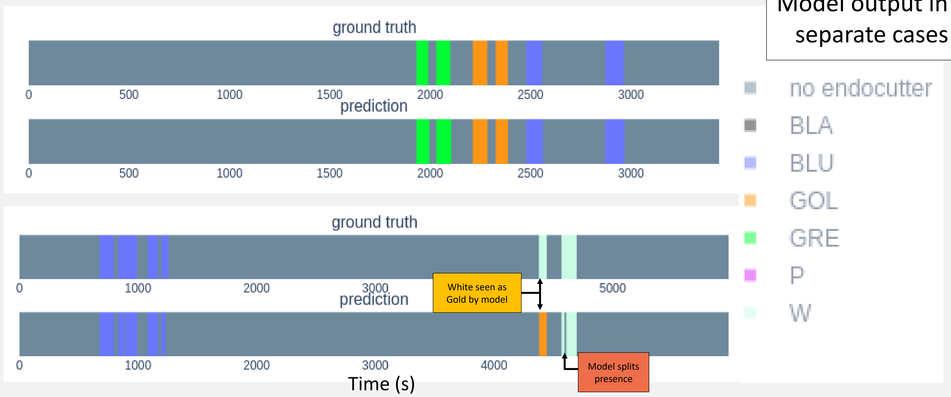
RESULTS

Overall Model Performance



- Levenshtein distance was calculated to measure color sequencing performance, where the model achieved an average error of 1.47
  - Distance increases by 1 for every inaccurate addition or deletion of a data point in the stapler sequence
- Predicted time spent stapling was within 15 seconds of ground truth in 50% of cases, within 45s in 75% of cases, and within 90s in 90% of cases, where the mean time spent stapling was 8 +/- 4.5 minutes.

Model output in 2 separate cases

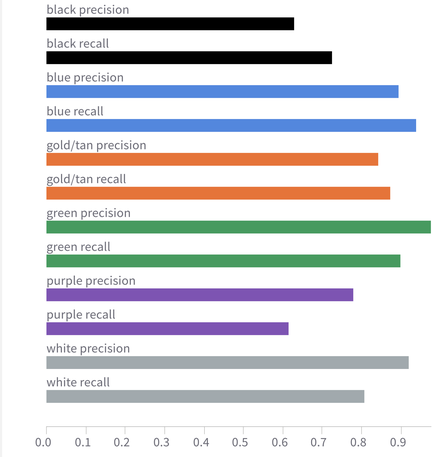


- These metrics allowed the rapid and scalable analyses of stapler choices differences across a large set of bariatric operations, with about 5% of stapler load colors misidentified

CONCLUSIONS

- CV and AI can be used to detect sequences of stapler load color choices from surgical video recordings with reasonable accuracy, at a much faster rate and larger scale than is currently possible with human review
- These results provide a basis upon which to further study the potential impact of stapler choices on patient outcomes, which remains an open question
- Future directions include developing the model further to detect data points such as buttress presence, buttress type, and stapler manufacturer
- Ultimately, the model outputs will be analyzed in correlation with complications such as bleeding, leaks, and stenosis. This analysis is necessary in order to understand the impact on patient care.

Model Performance by Load Color



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DISCLOSURES

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