

Outcomes of large colorectal polyp endoscopic resections during small audience live endoscopy events with endoscopist at their home endoscopy unit



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ABSTRACT

Background and study aims Live endoscopy courses are popular. The safety of performing live endoscopy has been questioned. In this study, we compared outcomes of large colorectal polyp resections during live endoscopy events (LEEs) (with a small audience of 2 to 5 physicians) to those removed during standard procedure days (SPDs) (without an audience). All procedures were performed at the endoscopist's home unit.

Methods Retrospective assessment of the adverse event (AE) and recurrence rates for large (≥ 20 mm) non-pedunculated colorectal lesions removed during LEEs. Logistic regression was used to assess whether presence of an audience predicted worse outcomes.

Results From January 2017 to May 2021, 317 lesions were removed with a live audience and 866 were removed on SPDs. Polyp pathology and procedure length were similar in both groups. There were 16 (5.0%) total adverse events in the LEE group and 30 (3.4%) in the SPD group ($P=0.224$). The majority in both groups were delayed hemorrhage. There were 2 (0.6%) perforations in the LEE and 3 (0.3%) in the SPD group. Increasing polyp size was associated with more AEs and higher recurrence. Increasing patient age predicted higher recurrence, and thermal injury of the resection margin predicted lower recurrence. There were no other predictors of AEs or recurrence, including presence of a live audience.

Conclusions Removing large colorectal polyps with a small live audience did not increase adverse outcomes.

Introduction

Live endoscopy courses are increasingly common and popular with learners. Live endoscopy courses raise concerns about whether endoscopists in this setting make best decisions for patient outcomes. These concerns led to recommendations by professional societies for performance of live endoscopy [1–3].

Live endoscopy courses could place patients at risk for several reasons. First, the environment of an audience is different from daily practice and might lead endoscopists to attempt

procedures they would normally feel are too high risk or have a low likelihood of success. Second, endoscopists might demonstrate techniques that the lesion does not warrant, e.g. endoscopic submucosal dissection for a lesion with very low risk of cancer that could be easily removed by standard polypectomy or endoscopic mucosal resection (EMR). Third, endoscopists participating in live courses may feel pressured by organizers or attending industry representatives to use endoscopes or accessories they have not previously used or do not use routinely. Fourth, endoscopists are often assisted by technicians that are

not familiar with idiosyncrasies of their endoscopic technique, or who have language barriers that could impede a clear understanding of the endoscopist's direction. The endoscopist may feel less in control of the procedure in a live setting at another institution than they do in their home setting.

Available evidence on the outcomes of live endoscopy transmitted cases compared to non-transmitted cases is mixed [4–7]. One study showed that success rates for endoscopic retrograde cholangiopancreatography (ERCP) were lower in live cases [4]. It is possible that this reflects the selection of extremely complex cases for live transmission. Other studies have shown no difference in outcomes for live ERCP [7, 8] and endoscopic submucosal dissection (ESD) [9].

One potential mechanism to enhance patient safety in live courses is to have endoscopists perform at their home endoscopy unit, with either outside learners visiting the home center, or transmitting the cases electronically from the endoscopist's home center to the learners. Electronic transmission from the endoscopist's home center has increased in feasibility with development and improvement in electronic transmission platforms.

In this report, we describe the results of colonoscopic EMR performed to small live audiences (typically 2–5 physicians) at the endoscopist's home endoscopy unit. Learners either traveled to the center and were present in the endoscopy room for the entire colonoscopy or, during the COVID era, observed the entire colonoscopy procedure via web transmission.

Methods

We performed a retrospective review of a prospectively maintained database of large polyps (size ≥ 20 mm) resected by the senior author, DKR, between January 2017 and May 2021. All live sessions were sponsored by Boston Scientific Inc. (Marlborough, Massachusetts, United States). During a regular, monthly-held live endoscopic event attended by colonoscopists, DKR performed large polyp resections. The polyp cases for these sessions are typically selected from an array of large polyps referred to the senior author's practice. Polyps described with larger size in records from referring physicians were chosen preferentially for resection on course days. Pre-pandemic, physicians traveled to Indiana University Hospital and stood in the procedure room for the duration of all cases. There were typically eight to 12 cases scheduled in a single all-day session. During the pandemic, cases were broadcast on the web typically for a half day, with four to six cases scheduled. Patients undergoing colonoscopy in live sessions gave consent for the presence of learners. Both cases performed with visiting physicians present in the endoscopy room and those broadcast on the web were considered live endoscopy cases. Patients were sedated by an anesthesiologist without endotracheal intubation or general anesthesia (i.e. Monitored Anesthesia Care). Propofol was the primary sedation agent. Colonoscope insertion was usually performed by a gastroenterology fellow, but all resections were performed by a single attending (DKR). Physicians attending as learners were encouraged to ask questions at any time during the procedure. Otherwise, the attending endoscopist

provided continuous discussion as the case proceeded. During the web-based broadcast, the physician learners could speak directly to the endoscopist via a headset and microphone worn by the endoscopist. Neither live presentation with an in-person physician audience nor livestream with a web-based audience were interrupted for complications. Lesions that proved to be < 20 mm in diameter, were pedunculated, proved to not be adenomatous or serrated by histology, or had overt endoscopic evidence of deep submucosally invasive cancer and were not endoscopically resected, were excluded from the analysis. Permission to review the deidentified database for this study was granted by our Institutional Review Board on September 8, 2021.

Outcomes and definitions

Adverse events

Patients were followed by telephone at 30 days to assess post-resection events. Post-procedure pain, bleeding, emergency visits, transfusion, repeat procedures, hospitalization and surgeries were recorded.

Follow-up

After 6 months, patients presented for follow-up surveillance colonoscopies to assess the EMR scar defects for residual lesion. Endoscopically normal scar defects are biopsied [10], and either endoscopically visible polyp or polyp detected histologically by biopsy were counted as residual polyp.

Statistical analysis

Bivariate analysis We compared the patient demographics, polyp characteristics, adverse event rates, and recurrence rates (rates of residual lesion at follow-up) between large polyps resected during live endoscopy events (LEEs) and those resected during standard procedure days (SPDs) with no live audience. Categorical variables were displayed as counts and percentages and continuous variables were presented as mean \pm standard deviation (SD). Student's t-test was used to compare continuous unadjusted variables, and chi square test was used to compare categorical unadjusted variables.

Multivariate regression analysis We performed a logistic regression analysis to adjust for possible effect of size and possible factors affecting adverse event rates. We built a regression model for adverse event rate using backward stepwise method to detect any independent variable with a statistically significant effect on the outcome. A two-tailed $P < 0.05$ was considered to be statistically significant. All statistical analyses were computed using IBM SPSS statistical package (version 27, IBM Corp, Armonk New York, United States).

Results

During the period from January 2017 to May 2021, 1183 non-pedunculated colorectal lesions ≥ 20 mm in diameter were completely removed from 971 patients. There were 317 lesions removed from 282 patients during a LEE (polyps and patients),

► **Table 1** Comparison between large polyps removed in the presence or absence of an audience for unadjusted variables.

	Standard procedure day	Live endoscopy event	P value
Demographics			
No. patients, N	689	282	N/A
Age in years (SD)	66.2 ± 10.1	65.8 ± 9.1	0.565
Females, N (%)	333/689 (48.3%)	135/282 (47.9%)	0.910
Polyp characteristics			
Polyp count, N	866	317	N/A
Mean polyp size in mm (SD)	31.0 ± 13.8	34.0 ± 14.2	0.001
Distribution of polyp location			0.011
▪ Right colon (%)	499 (57.6%)	204 (64.4%)	
▪ Transverse ¹ (%)	217 (25.1%)	62 (19.6%)	
▪ Descending (%)	36 (4.2%)	23 (7.3%)	
▪ Sigmoid (%)	42 (4.8%)	11 (3.5%)	
▪ Rectum (%)	72 (8.4%)	17 (5.4%)	
Distribution of shape			
▪ Sessile (%)	381 (45.6%)	166 (54.2%)	0.010
▪ Flat (%)	454 (54.4%)	140 (45.8%)	
Procedure length in min (SD)	46.6 ± 21.3	48.4 ± 19.9	0.224
Hot removal technique (%)	589/858 (68.6%)	275/317 (86.8%)	<0.001
En bloc resection (%)	47/866 (5.4%)	7/317 (2.2%)	0.02
STSC treatment of EMR defect (%)	412/854 (48.2%)	180/313 (57.5%)	0.005
All-cause adverse event rate (%)	30 (3.4%)	16 (5.0%)	0.222
Post-polypectomy bleed rate (%)	22 (2.5%)	13 (4.1%)	0.164
Number of polyp scars clipped (%)	530 (61.2%)	231 (72.9%)	<0.001
Mean number of clips placed per clipped polyp, N (SD)	5.0 ± 2.4	5.5 ± 2.5	0.009

SD, standard deviation; STSC, snare tip soft coagulation; EMR, endoscopic mucosal resection.
¹ Includes hepatic and splenic flexures.

while the remaining 866 polyps (689 patients) were removed with no live audience on SPDs. Among the patients and polyps in the live endoscopy arm, there were no significant differences in patient demographics or polyp features between the in-person physician audience days versus the web-based audience days (data not shown).

Patients in the LEE and SPD groups had similar ages of 65.8 ± 9.1 years and 66.2 ± 10.1 years and similar female gender proportions of 135/282 (47.9%) and 333/689 (48.3%), respectively.

Polyps in the LEE group were larger than the SPD group with mean polyp sizes of 34.0 ± 14.2 mm vs 31.0 ± 13.8 mm ($p = 0.001$), more likely to be located in the right colon ($p = 0.011$), and more likely to be sessile rather than flat ($P = 0.01$) (► **Table 1**). En bloc resection rates were lower in the LEE group (2.2%) than the SPD group (5.4%; $P = 0.02$). Polyp pathology and procedure lengths were similar between groups (► **Table 1** and

► **Table 2**). Snare tip soft coagulation treatment [11] of the resection margin was more common in the LEE group (► **Table 1**).

Most EMR defects were clipped post-resection [12–14] but more often in the LEE group (72.9% vs 61.2%) and the mean number of clips placed was higher for clipped polyps in the LEE group (5.5 vs 5.0 clips placed; $P = 0.009$).

Recurrence at follow-up

Lesions in the LEE and SPD groups had similar recurrence rates at the first surveillance follow-up, 16.1% and 14.2% as well as at the second follow-up, 5.3% and 8.6% (► **Table 3**).

Adverse event rates

Sixteen patients in the LEE group had AEs including 13 cases of delayed hemorrhage (4.1%), two perforations (0.6%), and one post-polypectomy coagulation syndrome. Eight of the 13

► **Table 2** Pathology of large polyps in patients with lesion removed on standard procedure day (no live audience) and live endoscopy events (with live audience).

Pathology	Standard procedure day	Live endoscopy event	P value
Conventional adenoma	671 (77.5%)	255 (80.4%)	0.723
Sessile serrated lesion	160 (18.5%)	50 (15.8%)	
Hyperplastic	13 (1.5%)	5 (1.6%)	
Cancer	22 (2.5%)	7 (2.2%)	

► **Table 3** Recurrence rates at first two follow-ups after lesion resection on standard procedure days (without a live audience) and live endoscopy event (with live audience).

	Standard procedure day	Live endoscopy event	P value
Lesions with recurrence at first F/U (%)	84/522 (16.1%)	33/233 (14.2%)	0.506
Lesions with recurrence at second F/U (%)	11/209 (5.3%)	11/128 (8.6%)	0.236
F/U, follow-up.			

bleeding patients underwent repeat colonoscopy for bleeding treatment.

One of the perforated lesions in the LEE group underwent closure with an over the scope clip and did not require surgery. The other patient developed fever without abdominal pain after returning to his home. He did not have abdominal pain, but a computed tomography (CT) scan showed perirectal stranding and a minute amount of perirectal gas. He was treated by diverting colostomy at his local hospital, though the fever was later attributed to pneumonia. No deaths were associated with the procedures in either group.

Thirty patients had AEs in the SPD group, including 22 cases of delayed hemorrhage (2.5%), three perforations (0.3%), two post-polypectomy coagulation syndromes, three abdominal pain and one with severe nausea/vomiting. Fourteen of the 22 bleeding patients underwent repeat colonoscopy to evaluate resection sites and add clips if necessary. Two patients had immediate perforations that were closed with hemostatic clips. The third had post-procedure pain and a CT showed extraluminal gas. All three patients were hospitalized for 1 to 3 days on antibiotics and released without surgery.

A logistic regression model for the all-cause AE rate after large polyp removal adjusted for polyp size and shape, en bloc resection, age, gender, polyp location, snare tip soft coagulation treatment of the EMR defect margin, as well as presence of an audience was made and showed that AEs were only associated with lesion size. A 1-mm increase in polyp size above 20 mm had a 5.2% (CI: 3.5%-6.9%; $P < 0.001$) increase in AE rate adjusted for the other variables. The presence of an audience did not show any association with AEs.

A logistic regression model for the recurrence rate at first follow-up, adjusted for the above variables also showed a statistically significant increase in residual polyp with increasing polyp size. For each 1-mm increase in polyp size above 20 mm there was a 3.5% (CI: 1.9%-5.1%; $P < 0.001$) increase in the rate of residual lesion at follow-up. An increase in age of 1 year was

associated with a 2.6% (CI: 0.3%-4.9%; $P = 0.026$) increase in recurrence rate. Use of snare tip soft coagulation to treat EMR scar defects had a protective effect for recurrence with an odds ratio of 0.27 (CI: 0.17–0.44; $P < 0.001$). No other risk factors for residual polyp at follow-up were identified, including en bloc resection and presence of a live audience.

Discussion

LEEs are increasingly common. In the past, learners often traveled to a specific city, and endoscopists traveled to a hospital in the same city, where live cases performed by many different endoscopists are transmitted electronically to an auditorium. Many of the potential patient safety factors associated with live endoscopy are in effect in this setting.

An alternative approach is for endoscopists to present from their home endoscopy center, and there are numerous advantages to the endoscopist in this setting, including the potential to work with familiar technicians and nurses, and familiar endoscopes and accessories. In this study, we demonstrated in a large number of cases (the largest report of live endoscopy cases of EMR in the literature) that home endoscopist-based live cases to small audiences at one time are not associated with worse outcomes. This was true despite the clear bias toward selection of lesions that were larger. Potential advantages of this learning format are listed in ► **Table 4**.

A strength of our study is the large number of live endoscopy cases and inclusion of control cases. A single endoscopist should reduce the chance of a difference in AE rates attributed to variable endoscopic technique. On the other hand, performance of the procedures by a single endoscopist limits generalizability for the central conclusion of no difference in outcomes for the groups with and without a live audience. Further, it is not clear if the same outcomes would be achieved with a larger audience. Another strength is complication follow-up on all patients. A weakness is that significant numbers of patients did

► **Table 4** Potential advantages for learners of course format described in this study

- Single focus (endoscopic mucosal resection)
- Multiple cases, allowing demonstration of a wide range of tips and techniques
- Small number of learners, with continuous communication between endoscopist and learners
- Observation of cases from beginning to end without interruption while endoscopist explores challenges, identifies and implements solutions, manages complications

not return to our center for first follow-up, and the majority did not return for second follow-up (► **Table 3**). This likely reflects significant numbers of patients traveling long distances to our center (who underwent follow-up closer to home), and in some cases patient age, comorbidities, or unwillingness to repeat the bowel preparation or the colonoscopy procedure. In some cases, the second follow-up was not due at the time of manuscript preparation. However, the absolute number of patients undergoing first follow-up was sufficient to allow recurrence comparison between the LEE and SPD groups.

The approach used for live endoscopy at our center has certain advantages compared to large live courses with multiple performing endoscopists (► **Table 4**). First, the small number of attending learners at each session allowed constant communication between the endoscopist and learners, and the platform used for electronic transmission in this series allowed the same level of communication. Second, the learners observed all cases from beginning to end of procedure, which provides a greater opportunity to see the endoscopist deal with all aspects of each colonoscopy. In large courses with multiple endoscopists and simultaneous cases occurring in multiple rooms, it is possible for the cameras to move to other cases during repetitive or tedious portions of the procedure, or when adverse events occur. However, in our setting, the endoscopist may feel more comfortable making the best choice for the patient because there are multiple cases scheduled in which the endoscopist can demonstrate skills and techniques. In large courses, endoscopists may feel more pressure to perform because their performance is being compared with other endoscopists, and they may have only one or two cases on their schedule with which to demonstrate their skills. Thus, the results seen in our setting may not translate to large course with multiple endoscopists and each performing one or a few cases.

Conclusions

In summary, our data indicate that endoscopist demonstrations of live endoscopy at or from their home endoscopy base, combined with small audiences observing entire procedures from beginning to end, is associated with patient outcomes equal to performance without a live audience. Our data suggest that this model is a safe approach to live endoscopy for patients and war-

rants additional study by other endoscopists and with other endoscopic procedures, and including other outcomes such as learner satisfaction and knowledge gain and retention.

Competing interests

Dr. Rex is a consultant for Olympus Corporation, Boston Scientific, Medtronic, Aries Pharmaceutical, Braintree Laboratories, and Lumendi, Ltd. He has received Norgine Endokey GI supply research support from EndoAid, Olympus Corporation, Medivators, and Erbe USA Inc. He has an ownership interest in Satisfai Health.

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