Combined Endoscopic Laparoscopic Surgery Procedures for Colorectal Surgery

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Abstract

Colonoscopy is the standard of care for screening and surveillance of colorectal cancers. Removal of adenomatous polyps prevents the transformation of adenomas to potential adenocarcinoma. While most polyps are amenable to simple endoscopic polypectomy, difficult polyps that are large, broad-based, or located in haustral folds or in tortuous colon segments can present a challenge for endoscopists. Traditionally, patients with endoscopically unresectable polyps have been referred for oncologic surgical resection due to the underlying risk of malignancy within the polyp; however, the majority of these polyps are benign on final pathology. Combined endoscopic laparoscopic surgery can help facilitate endoscopic removal of difficult lesions, or allow the surgeon to select the correct laparoscopic approach for polyp excision. Current literature suggests that these procedures are safe and effective and can potentially save patients from the morbidity of laparotomy and segmental colectomy.

Keywords
- combined endoscopic laparoscopic surgery
- difficult polypectomy
- intraoperative colonoscopy

Colonoscopy is the standard of care for the screening and prevention of colon cancer.[1] Colorectal adenomas are the precursors for almost all sporadic colon cancers, but without pathologic examination there is no way to tell which polyps may harbor malignancy. Removing adenomatous polyps with endoscopic polypectomy prevents the transformation of adenoma to potential adenocarcinoma.[2] The majority of all colon polyps are amenable to endoscopic removal with simple polypectomy, but there are some polyps that can be difficult to remove for a variety of reasons: large size (>2 cm), broad-based lesions, location in tortuous colonic segments, or location in haustral folds (►**Table 1**).[3,4] The most feared complications of endoscopic polypectomy are bleeding, perforation, and insufficient polypectomy that may lead to local recurrence resulting in malignancy. Patients with difficult polyps not amenable to endoscopic polypectomy historically get referred for surgical resection to adequately assess for cancer. Cancer occurs in up to 18% of these polyps.[5,6]

Traditionally, these polyps were treated with well-established, open oncologic colon resections; however, as minimally invasive techniques evolved, studies demonstrated the safety and efficacy of laparoscopic colectomy versus open surgery as well as improved recovery parameters—all without compromising oncologic principles.[7,8] Although laparoscopic colectomy is less invasive, it still poses significant potential morbidity. The benefit of colectomy for proven cancer clearly outweighs the morbidity and mortality associated with surgical intervention. However, the majority of the endoscopically unresectable polyps removed with surgical resection are benign on final pathology.[5,6] It is possible that we are overtreating many patients who would benefit from local excision alone. Until the development of combined endoscopic laparoscopic surgical (CELS) procedures, there were few viable surgical options for these patients.

Both endoscopy and laparoscopy in isolation of one another have inherent limitations in the treatment of benign polyps. Endoscopic polypectomy is extremely dependent on the skill-set of the endoscopist. While referral of difficult polyps to specialty centers can increase the success rate of endoscopic polypectomy, there will still be polyps that are

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Table 1 Potentially difficult polyps

Large size (>2 cm)
Broad-based lesions
Location in tortuous colonic segments
Location on or behind haustral folds

deemed unsafe to remove with endoscopy alone.[9,10] Endoscopists are likely to be less aggressive with large, sessile polyps in the right colon or cecum that can place the patient at higher risk for bleeding (in broad-based lesions) or perforation (in the thin-walled right colon). Localization of small polyps and intraluminal verification of complete excision can be challenging or impossible with laparoscopy alone.[11] While methods such as tattooing the polyp are used for laparoscopic resections, these techniques are not always accurate and reliable.[12–14]

CELS procedures have several advantages over endoscopy or laparoscopy alone.[15] CELS allows for lysis of adhesions, bowel mobilization, and intra and extraluminal manipulation to help place the colon in a configuration that facilitates endoscopic polyp resection. If laparoscopic assistance allows for an attempt at endoscopic polypectomy, direct laparoscopic visualization facilitates immediate inspection of the colon to assess for, and if necessary repair, full-thickness colon injuries. Additionally, if polyps are not fully resectable with endoscopy, a more limited laparoscopic wedge or full-thickness local excision is possible with definitive endoscopic localization. Finally, if local excision is not possible, or if on endoscopy the polyp demonstrates concerning characteristics, a formal oncologic resection can be performed without additional procedures later on. Despite the advantages of CELS procedures, they are not yet a standard part of most clinical practices.[16]

Recent Literature

Minimally invasive techniques continue to evolve to find ways to effectively treat patients with less morbidity, mortality, and faster recovery. Beck and Karulf performed the first reported CELS procedures in the early 1990s.[17] Several variations of CELS procedures have been described in the literature, including laparoscopic-assisted endoscopic polypectomy (LAEP), endoscopy-assisted wedge resection, endoscopy-assisted transluminal resection, and endoscopy-assisted laparoscopic segmental resection.

LAEP is the least invasive technique and includes lysis of adhesions, laparoscopic mobilization of the colon, and using the laparoscopic instruments to help manipulate or invaginate the colon wall to aide with polypectomy. The endoscopist can attempt simple snare polypectomy or use more advanced endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD) techniques to enable polypectomy.[18–20] Early case series demonstrated successful simple polypectomy in the sigmoid colon by only performing laparoscopic sigmoid colon mobilization to facilitate easier endoscopy.[21,22] Local excision for polyps that can be tangentially isolated (usually antimesenteric) can be performed with an endoscopy-assisted wedge resection. The laparoscopic linear stapler is used for the resection and the endoscope can be advanced past the lesion to help localize and prevent stenosis, especially in dealing with polyps near the terminal ileum.[23] If the lesion is located near the mesentery or not amenable to wedge resection, the lesion can be excised transluminally through a colotomy, with subsequent colotomy closure using sutures or a linear laparoscopic stapler.[11] Finally, for circumferential or extended lesions, a limited segmental resection can be performed that does not require full colon mobilization or lymphadenectomy.[11,24]

Numerous studies, mostly retrospective, have demonstrated the safety and feasibility of CELS procedures.[16,24–35] To date, there have been no prospective studies comparing CELS with laparoscopic colectomy for endoscopically unresectable polyps. ►**Table 2** summarizes the results from all recent studies identified that contain more than 20 patients.

In these studies, success rate of endoscopic polypectomy ranges from 67 to 89%. The study by Wilhelm et al noted a LAEP success rate of 5%; however, this is a retrospective study analyzing the results of four different surgical techniques used to address difficult polyps.[35] It is possible that the significantly lower success rate in this study simply represents surgeon preference rather than failure in performing LAEP. In all studies that compared operating time and length of stay, the successful LAEP group had shorter operating times and shorter postoperative lengths of stay. Postoperative complication rates ranged from 8 to 25%. The most commonly noted complications were ileus, bleeding, and urinary retention. They reported no immediate postoperative mortality, and return to the operating room (OR) for a postoperative complication was rare. Lee et al noted no difference in the success of LAEP based on the location of polyps.[33] Additionally, polyp size did not consistently correlate with the success or failure of LAEP.[26,30,33,34]

Rates of invasive cancer on final pathology ranged from 3.3 to 11%. This is lower than the expected rates of cancer found in previous studies.[5,6] This provides further evidence that cancer rates for these patients are not as high as historically believed, necessitating continued development of less morbid procedures. The largest study with long-term follow-up shows a 0% local recurrence rate at a median of 5.4 years.[34] Other long-term follow-up studies have shown local recurrence as high as 12%, with all recurrent polyps ultimately showing benign pathology.[33]

A recent systematic review includes 18 studies with a total of 532 patients.[36] EMR, ESD, and full-thickness excisions were performed heterogeneously throughout these studies. Successful CELS resections ranged from 58 to 100%, and studies with more than 20 patients demonstrated higher success rates (74–91%). Conversion to open procedures was less than 5%, length of stay was 0 to 7 days, and postoperative complications were 0 to 18%.

The current literature suggests that CELS is safe, effective, and a viable option in patients with benign-appearing polyps that are unresectable via endoscopy alone.

Table 2 Summary of current literature

Citation	Patients (polyps)	Age (y)	Polyp Size (cm)	Successful LAEP	Operating time (min)	Postoperative complication rate	Length of stay (d)	Invasive Cancer rate	Local Recurrence rate
Franklin and Portillo[34]	176 (251)	75[a]	3.7[a]	89%	All cases: 97[a]	9%	1.1[a]	10%	0% at 5.4 y
Wilhelm et al[35]	146 (154)	64	–	5%[b]	All cases: 100 LAEP: 75	25%	8	11%	0.9% at 2.9 y[a]
Lee et al[33]	65 (65)	69	3.0	74%	All cases: 145	9%	1 (LAEP) vs. 5 (colectomy)	7.6%	12% at 5.4 y (all benign pathology)
Crawford et al[16]	30 (30)	64	4.0	67%	All cases: 72	10%	2	3.3%	3.3% at 0.8 y[c]
Goh et al[26]	30 (30)	65	1.4	73%	LAEP: 105	13%	2 (LAEP) vs. 5.5 (colectomy)	6.7%	0% local recurrence at 1.7 y
Cruz et al[29]	25 (25)	56[a]	2.4[a]	76%	All cases: 120[a] LAEP: 93[a]	8%	1.5[a] (LAEP) vs. 3.5[a] (colectomy)	4%	–

Abbreviation: LAEP, laparoscopic-assisted endoscopic polypectomy.
Note: All Data reported in medians unless annotated otherwise.
[a]Data reported in mean.
[b]Used multiple techniques for excision–local excision rate 82%.
[c]Time to detection of single recurrence.

Technical Considerations

Patient Selection

Not all endoscopically unresectable polyps are suitable to consider for CELS procedures. CELS was developed specifically for benign polyps. If malignancy is suspected by appearance or is demonstrated on previous biopsy, the patient should have an oncologic resection. Benign-appearing polyps should have an absence of ulceration, induration, and friability.[9,17] In preparation for endoscopic polypectomy, the submucosa is typically injected with indigo carmine or saline-based solution.[15,33] Failure of the polyp to separate from the underlying layers of bowel could indicate that perhaps the lesion is malignant, necessitating oncologic resection. CELS should also be done in an elective setting, and polypectomy by an experienced endoscopist should be attempted before considering CELS.[27] The patient selection criteria are summarized in ►**Table 3**.

Multidisciplinary Teams

CELS procedures can be challenging from a systems point of view, because they involve multidisciplinary teams of providers with specialized equipment for each team. They require coordination and planning among surgeons, endoscopists, technicians, and OR support staff. Equipment for all possible portions of the operation needs to be readily available (i.e., endoscopy, laparoscopy), including instruments for open surgery. During the procedure, the surgeon and endoscopist need to have the ability to see each other's view, either with picture-in-picture technology or with careful, coordinated positioning of display monitors.[11] In addition to the surgical technician, an endoscopy technician will likely need to assist with the nonsterile portion of the surgical field.

Intraoperative Colonoscopy

CELS procedures begin with gaining laparoscopic access to the abdomen prior to colonoscopy. Studies have shown that intraoperative colonoscopy does not complicate the outcome of concurrent intestinal resection.[37] The CELS body of literature supports these findings; however, early CELS experience reported difficulty with air insufflation, causing small bowel distention that made laparoscopic assistance more difficult.[33] Subsequent studies have shown the use of CO_2 endoscopy to be safe and result in less bowel distention.[38–40] Some surgeons choose to use a laparoscopic bowel clamp at the terminal ileum, or just proximal to the lesion.[34,36] However, others have found this to be an unnecessary step when using CO_2 endoscopy.[33,38]

Table 3 Patients appropriate for attempted CELS

Large polyp not removable by experienced endoscopist
Previous endoscopic biopsy benign or only high-grade dysplasia
Benign appearing
Elective surgical setting

Abbreviation: CELS, combined endoscopic laparoscopic surgery.

EMR versus ESD versus Full-Thickness Resection

Advanced techniques such as EMR and ESD help increase the success of removing "difficult" polyps endoscopically and are discussed in greater detail in the next article of this issue. These techniques for colorectal procedures were developed from similar procedures used for resection of benign gastric lesions.[18–20,41] In a systematic review of the literature, EMR and ESD techniques have been used successfully and safely as coordinated CELS procedures.[36] In addition to full-thickness resection (wedge or segmental), these three techniques are used heterogeneously within individual studies, and there are no direct or randomized comparisons of simple polypectomy with EMR, ESD, or segmental resections. EMR and ESD require a more advanced skill-set and, likely for that reason, are not as widely used.[20] ESD techniques will likely need further development before they become universally accepted.[36]

Mesenteric Polyps

Mesenteric polyps are more technically challenging for CELS procedures. Ideally, for adequate laparoscopic assistance and monitoring, the surgeon needs to see the serosa at the base of the lesion.[24] Excision of mesenteric polyps often requires colon mobilization and/or creation of a mesenteric window. Concerns about devascularizing the remaining colon make wedge resection or full-thickness resection less feasible for some mesenteric polyps. Among the reported techniques employed for this scenario is transluminal resection through a colotomy to facilitate removal of difficult polyps in a mesenteric orientation.[11,16,26]

Closing the Colotomy, Leak Tests

When performing a full-thickness resection of the polyp, the most common method of colotomy closure is with a linear stapler (sometimes with the addition of stay sutures for assistance) or a by direct laparoscopic suture closure.[11] Many described procedures include performing a leak test routinely following closure of the colostomy.[36] The bowel can be clamped proximally and insufflated with air, or indigo carmine can be instilled into the lumen to look for smaller leaks.[30] If there is concern for full-thickness electrocautery injury, laparoscopic Lembert sutures are placed to reinforce the area of concern.[36]

Intraoperative Frozen Pathology

There is currently no consensus on whether frozen pathology should be routine for all patients undergoing CELS. Doing routine frozen sections for all patients will identify a small percentage (2%) of intraoperative malignancies that were not expected and save those patients an additional procedure.[33] However, some studies reported false-negative intraoperative frozen sections that had preliminary results of benign pathology.[25] Based on this, local excision was then performed, only to have a final pathology consistent with carcinoma. For that reason, one can argue that adding the extra time to complete a frozen section for all patients is not time or cost efficient.[33] Informed consent for CELS procedures should include discussion of any intraoperative decisions that may be made based on the result of preliminary intraoperative frozen section pathology results. Selective frozen sections for patients with concerning intraoperative features needs to be studied further before formal recommendations can be made.

Learning Curve

One would expect that there is a fairly substantial learning curve associated with CELS procedures in terms of operating time, ability to perform successful combined procedures, and ability to resect polyps endoscopically. The learning curve for CELS procedures has not been specifically defined; however, trends in the literature show that a learning curve likely exists.[15] One systematic review showed that studies with more than 20 patients had a higher success rate of successfully performing CELS.[36] In their report on long-term outcomes, Lee et al reported improved operating times and shorter postoperative hospital stays.[33]

Future Directions

As all minimally invasive techniques continue to become more widespread, CELS will also likely continue to evolve.[42] Advanced endoscopic techniques such as EMR and ESD will likely continue to improve and become more widespread, expanding the endoscopist's skill-set for difficult polypectomies. Newer endoscopic imaging methods may more accurately differentiate benign from malignant polyps endoscopically, thus improving the decision-making within CELS procedures.[43] Additionally, there are many devices in development to facilitate closure of full-thickness bowel perforations.[16,44–46]

Conclusion

CELS procedures developed in part out of the desire to spare patients with benign appearing, though difficult, polyps from the morbidity associated with open or laparoscopic oncologic colon resections. CELS allows surgeons to tailor the surgical approach to the patient, verify complete excision of the polyp, and immediately address the most feared complications of endoscopic polypectomy—bleeding and perforation. With the current endoscopic and laparoscopic technology, there is evidence to support the safety and efficacy of CELS procedures in select patients. Gastroenterologists or surgeons performing colonoscopies with difficult polyps should be encouraged to engage with colleagues and consider CELS for those patients. More studies are needed to further define the learning curve and best methods for safely instituting CELS procedures into clinical practice.

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