Stepwise Training in Laparoscopic Surgery for Complex Ileocolonic Crohn's Disease: Analysis of 127 Training Episodes

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INTRODUCTION: The inflammation encountered in Crohn's disease makes a minimally invasive approach challenging due to a thickened mesentery, fistulas, abscesses, and large phlegmons with high reported rates of conversion and septic complications. Aim of this study was to evaluate the feasibility of a stepwise approach to training in laparoscopic surgery for complex Crohn's disease.

METHODS: Every surgical procedure was divided in 4 different training tasks: access and exposure, bowel mobilization, division of the mesentery, anastomosis. Extensive adhesiolysis and division and repair of fistulae were considered as additional tasks when present. The laparoscopic competence assessment tool was used to evaluate the safety and proficiency of the surgical performance. The primary outcome was the rate of training tasks successfully completed by surgical trainees.

RESULTS: One hundred and twenty seven training episodes were included and 86 were performed by trainees (67.7%). Fistula division was the less commonly performed training task (25%), while mobilisation and anastomosis were performed by the supervised trainee in 90% and 85% of the cases. Safety and proficiency scores were significantly higher for senior trainees compared to junior trainees.

CONCLUSIONS: Laparoscopic surgery for complex Crohn's disease can be safely performed in a supervised setting with acceptable operating time, postoperative length of hospital stay, and 30 day morbidity. (J Surg Ed 76:1364–1369. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Colorectal surgery, Crohn's disease, Laparoscopy, Surgical training, Inflammtory bowel disease

COMPETENCIES: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement, Patient Care

INTRODUCTION

The advent of laparoscopic surgery has dramatically changed the landscape of colorectal surgery for both benign and malignant disease. Laparoscopy offers well-described benefits[1] such as decreased pain, lower wound complication rates, improved pulmonary function, earlier resumption of diet and bowel function, better cosmesis and shorter hospital stay[2] when compared to open surgery.

However, widespread use of laparoscopy in Crohn's disease (CD) has been more limited due to technical constraints: the inflammation encountered in CD is often multifocal and makes a minimally invasive approach challenging due to a thickened mesentery, as well as the potential for fistulas, abscesses, and large phlegmons[3-4]; moreover, the lack of tactile feedback potentially limits the identification of occult disease.[5] High conversion rates have been reported in surgery for penetrating and recurrent CD with abscesses and adhesions representing the main reasons for conversion.[6] Relatively high rates of morbidity and septic complications have been reported in patients who undergo resections for CD, with reported rates of intra-abdominal sepsis and anastomotic leak as high as 14% and 17% respectively.[7]These challenges explain the concerns on feasibility and safety of training in laparoscopic surgery for complex CD and aim of this study

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https://doi.org/10.1016/j.jsurg.2019.03.009

was to evaluate the feasibility of a stepwise approach to training in laparoscopic surgery for complex CD.

METHODS

Study Settings

All patients undergoing laparoscopic surgery for penetrating or recurrent ileocolonic CD from January 2017 to December 2018 were included in this prospective observational study. Patients undergoing open, single-incision, robotic or hand-assisted surgery were excluded as were patients undergoing emergency operations. The indication for surgical resection was discussed at a dedicated inflammatory bowel disease multidisciplinary team meeting involving gastroenterologists, colorectal surgeons, radiologists, and pathologists. Preoperative assessment included colonoscopy, magnetic resonance imaging enterography, and intestinal ultrasound.

Stepwise Training Evaluation

In our unit, which had been one of the major contributing centres for the national laparoscopic surgery training program in Great Britain[8] the ileocolic resection is performed according to a standardized technique,[9] with extracorporeal division of the small bowel mesentery and anastomosis.

For the purposes of this study every surgical procedure was divided in 4 different training tasks: access and exposure, bowel mobilisation, division of the mesentery, anastomosis. Extensive adhesiolysis, strictureplasties and division and repair of sigmoid and bladder fistulae were considered as additional tasks when present.[10] All procedures were video-recorded and it was annotated which tasks of the procedure were performed by the surgical trainee, considering as trainee-completed tasks with minimal active help from the trainer and mainly led by the surgical trainee with the trainer assisting and supervising.[11] All surgeries were performed under direct supervision of a consultant surgeon specialized in inflammatory bowel disease surgery, present and scrubbed in theatre during the entire case.

After completion of a 2-year postgraduate Foundation programme, the UK surgical training pathway is structured with a 2-year "Core Surgical Training" programme, followed by 6-year "Specialist Training" programme.[12] Only procedures performed by trainees currently enrolled in the Specialist Training programme were included in the study and trainees in the first 3 years of the programme were defined as "junior trainees", while trainees in the final 3 years of the programme were defined as "senior trainees". Procedures performed by surgical fellows undertaking an additional training period at the end of their formal training were added to the senior trainees group.

In order to assess the safety and proficiency of the trainees' surgical performance a validated competency assessment tool specifically designed for laparoscopic colorectal surgery was used.[13] The laparoscopic competency assessment tool (LCAT) is a task-specific marking sheet for the assessment of technical surgical skills in laparoscopic colorectal surgery (Table 1). It is designed to assess the surgeon's performance by watching a live, live-streamed or recorded operation. The procedure is divided into 4 different tasks: each task has 4 different items which are scored based on the safety and effectiveness of the procedure. The overall mean score for each case ranges from 1 to 4, and the pass mark was set at 2.7 as validated in a previous study.[14] This pass mark was the score above which expert assessors rated the operations as "safe performance", defined by receiver operating characteristic curve analysis. Extensive adhesiolysis, strictureplasties, and division and repair of sigmoid and bladder fistulae were considered as additional tasks when present and in order to obtain scores comparable to the LCAT marking sheet, every step of these additional tasks was ranked from 1 to 4 (hazardous, imprecise, safe, and efficient) with regards to bowel manipulation, use of graspers, use of dissection tools, and suturing/anastomosis. The evaluation of the trainees' performance was undertaken during the theatre de-briefing in a face-to-face session between the trainer and the trainee and only the tasks performed by the trainee were assessed.

TABLE 1. Laparoscopic Competence Assessment Tool (LCAT)

Task Step 1 "Exposure"	Operating ports insertion and complete exposure of the operating field to commence dissection. Low scores are assigned in case of forceful and potentially dangerous port insertion as for ineffective grasping of the bowel and mesentery and exposure of the operative field.
Task Step 2 "Vascular pedicle"	Starts with the retraction of the vascular pedicle and ends with the complete division of the mesocolon, focusing on the assessment of appropriate level of section of the vascular pedicle and avoiding blind application of clips/stapler.
Task Step 3: "Mobilization"	Includes the separation of tissue planes with full mobilisation of the bowel for resection. The procedure is scored against the adequacy of tissue planes maintained and length of mobilized bowel.
Task Step 4: "Resection/anastomosis"	Complete dissection of the bowel and the creation of the anastomosis.

Data Collection

Preoperative, operative, and postoperative data were prospectively recorded for each patient. Preoperative parameters included age, sex, body mass index, comorbidities, American Society of Anaesthesiologists status, albumin and haemoglobin concentration, previous abdominal surgery, smoking status, weight loss, indication for surgery, and preoperative medical therapy.

Operative data included duration of surgery, intraoperative complications, estimated operative blood loss, reasons for conversion and use of temporary ileostomy. Postoperative data included postoperative length of hospital stay, time to tolerate oral fluids and oral diet, time to resolution of ileus and postoperative complications according to the Dindo–Clavien classification.[15]

Study Objectives

The primary outcome was the rate of training tasks successfully completed by surgical trainees. Secondary outcomes were operating time and safety of the procedure according to the LCAT scores.

Statistical Analysis

Categorical variables are presented as frequency or percentage and were compared with the use of the chi-square test or Fisher's exact test, as appropriate. Continuous variables are presented as mean (±standard deviation) or median (range) and were compared with the use of Student's *t* test. The Mann–Whitney *U* test was used for continuous, not normally distributed outcomes. Statistical analysis was performed by using the Statistical Package for Social Sciences (SPSS version 16.0; SPSS, Chicago, IL). All reported p values were two-tailed, and p values of less than 0.05 were considered to indicate statistical significance.

Ethics

The study is conducted in accordance with the principles of the Declaration of Helsinki and "good clinical practice" guidelines. Informed consent has been obtained from the patients.

RESULTS

One hundred and twenty-seven training episodes were included and 86 were performed by trainees (67.7%). 48 tasks (37.8%) involved penetrating CD with fistula formation, while the remaining 79 included redo surgery for recurrent CD (62.2%). Junior trainees only performed 41 of the 72 tasks they were involved in (56.9%), while senior trainees performed 46 out of 55 tasks (83.6%) $p < 0.0001$.

Fistula division was the less commonly performed training episode (25%), while mobilisation and anastomosis were performed by the supervised trainee in 90% and 85% of the cases. The adhesiolysis was performed by trainees in 67% of the cases, while access and exposure in 52%. LCAT scores were significantly higher for senior trainees compared to junior trainees, with a mean score of 3.4 and 2.5 respectively ($p < 0.0001$). In none of the included patients all the steps of the procedure were performed entirely by the trainer.

Data on individual tasks operating time was retrospectively retrieved from the video analysis. No differences were found in the median operating time needed for individual tasks completion amongst the tasks performed by the trainer and the junior and senior trainees (34.1 ± 27.6, 28.4 ± 25.8, 32.7 ± 30.1 minutes respectively), which could be explained by the different complexity of the tasks performed.

Postoperative outcomes are presented in Table 2; there were 4 readmissions and 1 reoperation for washout of intra-abdominal haematoma.

DISCUSSION

Despite the benefits of laparoscopic surgery,[16] a considerable number of CD patients may be a formidable challenge even for the most experienced laparoscopic surgeon,[17] who also has to be prepared to deal with unexpected findings that may require additional surgery, such as proximal strictures, fistulas, abscesses, or phlegmons, which can be identified in about 20% of patients.[18] Surgery for CD is technically challenging and the perioperative decision making of when to operate and whether to fashion an anastomosis or to create a stoma, require highly trained surgeons.[19] Despite this, our study found that up to 83% of these operations can be safely performed in a supervised setting when the surgery is performed by a senior surgical trainee, with postoperative outcomes such as

TABLE 2. Patients Characteristics and Surgical Outcomes

Number of patients	27
Age (years)	39.3 ± 14.2
Sex (M:F)	11:16
BMI	24.6 ± 5.3
ASA	
– I	6
– II	18
– III	3
Conversion to open	1 (3.7%)
Ileostomy	1 (3.7%)
Operating time (minutes)	156.2 ± 39.4
Blood Loss (ml)	68.4 ± 52.9
LOS (days)	6 (2-35)
Readmissions	4 (14.8%)
Reoperations	1 (3.7%)
Overall 30 day morbidity	5 (18.5%)

LOS: length of hospital stay.

operating time, length of hospital stay and 30-day morbidity comparable with the data reported in the literature. More junior trainees may benefit from exposure to these procedures; however they are less likely to perform some of the most difficult training tasks such as division and repair of fistulising disease. In order to maximise training opportunities colorectal surgery training units should aim to allocate trainees with appropriate level of prior exposure to these complex laparoscopic CD cases. We used the LCAT, an objective assessment tool, to critically appraise the performance of the surgical trainees across the different training episodes. Given that feedback has been demonstrated to improve performance,[20] this should be a fundamental part of training in advanced laparoscopic surgery, despite it being a shift from the more traditional method of surgical teaching.[21] Technical competency is dependent on supervised training volume,[13] which is consistent with the theory of deliberate practice, indicating that expertise is not related exclusively to the volume of experience but to time spent practising with constructive feedback.[22] Therefore, technical competence should be based on objective assessment of the quality of performance rather than solely relying on the number of procedures performed. In our unit we encourage video-based review of the trainees' own performance and this study highlights the advantages of advocating routine video-recording of the surgical procedure which can then be reviewed with peers and trainers.[23] The LCAT score may also be valuable in assessing over a period of time the proficiency gain of the same cohort of surgical trainees indicating the appropriate timing for exposure to more complex surgeries. Feedback on the training episode is ideally delivered at the end of the training session in a face-to-face debriefing, but we must acknowledge that this happens only in 41% of the theatre lists, according to a recent survey of UK trainees,[24] with time constrictions probably accounting as the main limiting factor.[25] The time needed for constructive feedback and structured LCAT assessment has not been directly measured as a study end-point, mainly due to the trainer/assessor being scrubbed in theatre for the whole procedure. Median operating time of 152 minutes represents a surrogate of video length for review and assessment; however, further studies are needed to explore the role of e-feedback for procedural skills acquisition in surgery.[26]

Increased rates of adverse clinical outcomes at the early stage of the learning curve raise ethical questions and highlight the need for mechanisms to reduce complications and conversions during the initial stage of independent practice. A number of studies have reported on the length of the learning curve for laparoscopic colorectal resections by using different methods and end-points resulting in suggested numbers between 11 and 110 cases.[27] This heterogeneity is easily explained by the different parameters used for evaluating the learning curve such as conversion rate, operating time, blood loss, and rate of postoperative complications.[28] The average length of the proficiency gain curve in laparoscopic colorectal surgery for self-taught senior surgeons is estimated between 100 and 150 procedures.[29] Supervised training programs have demonstrated to significantly decrease the length of the learning curve,[30] and an autodidactic approach to acquire the necessary skills for laparoscopic surgery should be considered obsolete and unacceptable.

The patients' population of this study is heavily selected, potentially resulting in the trainers performing the most complex cases and taking over procedures that were too difficult for the trainees. It is important to consider that patient safety must never be compromised; therefore, it is hard to imagine a surgeon watching a trainee getting into trouble without intervening. The presence in theatre or at the operating table of the trainer makes obviously a significant difference, and this is what we exactly aim in a laparoscopic training unit. It is important to consider that also the trainees' population of this study is heavily selected, as only procedures involving trainees enrolled in a higher surgical training programme were included. The validity of our results may be specific to the UK training programme and stratifying the different experience of the trainees accordingly to previously performed procedures rather than seniority would have resulted in more robust data.

CONCLUSIONS

A stepwise training approach can be applied to laparoscopic surgery for complex Crohn's disease with a high rate of tasks successfully performed by supervised trainees and an acceptable profile of postoperative outcomes.

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SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.jsurg.2019.03.009.