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Video-laparoscopic assessment of the small bowel in Crohn's disease: a comparative study to evaluate surgeons' inter-observer variability

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Abstract

Background Assessment of the entire small bowel is advocated during Crohn's disease (CD) surgery, as intraoperative detection of new lesions may lead to change in the planned procedure. The aim of this study was to evaluate the inter-observer variability in the assessment of extent and severity of CD at the small bowel laparoscopic "walkthrough".

Methods A survey on laparoscopic assessment of the small bowel in patients with CD, including items adapted from the MREnterography or ultrasound in Crohn's disease (METRIC) study and from the classification of severity of mesenteric disease was developed by an invited committee of colorectal surgeons. Anonymous laparoscopic videos demonstrating the small bowel "walkthrough" in ileocolonic resection for primary and recurrent CD were distributed to the committee members together with the anonymous survey. The primary outcome was the rate of inter-observer variability on assessment of strictures, dilatations, complications and severity of mesenteric inflammation.

Results 12 assessors completed the survey on 8 small bowel walkthrough videos. The evaluation of the small bowel thickening and of the mesenteric fat wrapping were the most reliable assessments with an overall agreement of 87.1% ($k=0.31$; 95% CI − 0.22, 0.84) and 82.7% ($k=0.35$; 95% CI − 0.04, 0.73), respectively. The presence of strictures and pre-stenotic dilatation demonstrated agreement of 75.2% ($k=0.06$: 95% CI − 0.33, 0.45) and 71.2% ($k=0.33$; 95% CI 0.15, 0.51), respectively. Evaluation of fistulae had an overall agreement of 75.3%, while there was a significant variation in the evaluation of mild, moderate and severe mesenteric disease with overall agreement ranging from 33.3 to 100%.

Conclusion Laparoscopic assessment of the small bowel thickening and of the presence of mesenteric fat wrapping is reliable for the intraoperative evaluation of CD with high inter-rater agreement. There is significant heterogeneity in the assessment of the severity of the mesenteric disease involvement.

Keywords Crohn's disease · Laparoscopic surgery · Colorectal surgery · Ileocaecal resection · Inflammatory bowel disease

Crohn's Disease (CD) is a chronic inflammatory disorder that can present in any part of the alimentary tract with the most commonly affected areas being the terminal ileum and cecum (55%). Other areas include small bowel disease only (11–48%), colon disease only (19–51%), and combined small and large intestine (26–48%) [1].

Although advances in the multidisciplinary treatment have reduced the need for surgery in Inflammatory Bowel Disease (IBD) over the past 60 years [1, 2], there is still a significant risk of needing to perform surgical resection in CD for lack of response to medical management or complications during the lifetime of a patient. This risk further increases with time to reach 50% of patients at 10 years [1]. Patients with CD rely on a multidisciplinary team (MDT) approach [3] for essential close and structured integration of medical and surgical management. Key to the MDT approach is to identify the right time for surgery with the aim of improving patient outcomes by avoiding emergency surgery, reducing postoperative complications and attempting to mitigate recurrence.

The perioperative decision-making on when to operate and whether to fashion an anastomosis or to create a stoma, require highly trained surgeons [4] and it is recommended

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that surgeons performing CD resection must be an integral part of the IBD MDT. Additionally, the association between procedural volume and surgical outcomes is well-described throughout all specialities of surgery, including those for IBD [5] with up to a twofold in-hospital mortality increase in low-volume hospitals [6].

The surgical strategy on length and number of bowel resections is guided by the preoperative imaging [7]; however, a repeat assessment of the entire small bowel is advocated during the procedure, as intraoperative detection of new lesions may lead to change in the planned surgery [7] and is key to enhancing patient outcomes. The small bowel "walkthrough" enables the surgeon to visually assess the entire small bowel via a minimally invasive approach but intra and inter-observer variability may result due to the limited tactile feedback and two-dimensional vision.

Therefore, the aim of this study was to evaluate the inter-observer variability in the assessment of extent and severity of CD at the small bowel laparoscopic "walkthrough" and to correlate the intraoperative assessment of the small bowel at laparoscopy with the preoperative imaging.

Methods

Study setting

Anonymous laparoscopic videos were recorded and edited at Queen Alexandra Hospital (Portsmouth, UK) to demonstrate the small bowel "walkthrough" in patients undergoing laparoscopic ileocolonic resection for primary and recurrent CD during the three months study period from March to May 2019. The small bowel walkthrough consisted of the entire exploration of the small bowel from the Treitz ligament to the ileocaecal valve or neo-terminal ileum, using a "hand over hand" technique with atraumatic forceps [8]. The laparoscopic graspers were marked every 10 cm for length evaluation (Fig. 1). All procedures were performed by a single surgeon with expertise in IBD surgery in an attempt to mitigate the confounding factors of approach variation. The indication for surgical resection was discussed at dedicated IBD MDT involving gastroenterologists, colorectal surgeons, radiologists and pathologists to ensure consistency. Preoperative assessment included colonoscopy, MRI enterography and intestinal ultrasound.

Study design

Colorectal surgeons with expertise in minimally invasive surgery and IBD were selected as committee members to develop a survey on laparoscopic assessment of the small bowel in patients with CD.

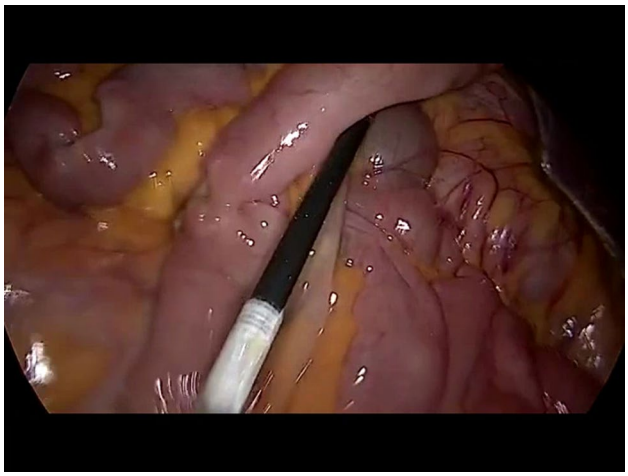

Fig. 1 "hand over hand" technique with atraumatic forceps for small bowel walkthrough

Inclusion criteria for the committee members included evidence of previously published experience in CD surgery guideline development [9], distance learning in surgery [10], minimally invasive surgery training programme development [11] and dissemination of online surgical videos [12]. 12 experts made up this committee.

The committee communicated regularly and identified items for inclusion in the survey on laparoscopic assessment were finalized by discussion through e-mails, videoconferences, and face-to-face meetings. Survey items and the protocol for video recording of the small bowel walkthrough were reviewed and agreed upon by all committee members. The final survey (Online Appendix 1) included items suggested by committee members as well as items adapted from the MREnterography or ultrasound in Crohn's disease (METRIC) study protocol [13] and from the classification of severity of mesenteric involvement described by Coffey et al. [14]. The study protocol was developed according to the STROBE checklist [15].

Survey distribution

The anonymous videos demonstrating the small bowel walkthrough were distributed to the committee members together with the anonymous survey using an electronic tool (Enalyzer, Denmark, www.enalyzer.com). Committee members were blinded to patient clinical data, imaging and pathological findings.

Primary and secondary outcomes

The primary outcome was the rate of inter-observer variability in laparoscopic assessment of the small bowel concerning different findings, such as the presence of strictures and

dilatations, complications (abscesses, fistulae) and presence and severity of mesenteric inflammation. The secondary outcomes were concordance between laparoscopic assessment and surgical findings and preoperative imaging.

Statistical analysis

Data from the survey were collated, checked and subjected to 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.

Inter-rater reliability was estimated by overall percent agreement and by Fleiss' kappa (κ) [16] along with its 95% confidence interval. κ values from 0.21 to 0.4 were considered as indicating fair agreement, while values from 0.41–0.6 and > 0.61 were considered as indicating moderate and substantial agreement, respectively.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS version 16.0; SPSS, Chicago, IL, USA). 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 was obtained from the patients.

Results

Eight small bowel walkthrough videos (Table 1) were distributed and 12 assessors completed the survey. Out of the 672 expected answers, 588 were returned, with a questionnaire completion rate of 87.5%. The quality of the small bowel walkthrough was widely considered acceptable, with assessors being unable to comment on the case only in 18

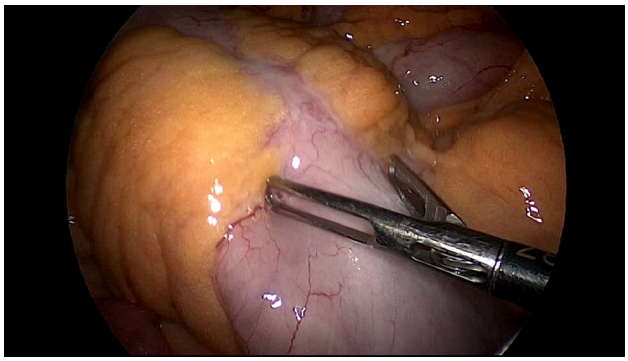

Fig. 2 Creeping fat and short small bowel stricture

Table 1 Imaging and surgical findings of the 8 video-recorded cases

Case (*N*)	Preoperative imaging	Surgical findings
1	Short stricture of the terminal ileum over 5 cm with mild upstream small bowel dilatation	5 cm stricture at terminal ileum with mild pre-stenotic dilatation. No fat wrapping
2	20 cm of active inflammation at the terminal ileum which is in close proximity with the sigmoid colon	15 cm of terminal ileitis with ileo-sigmoid fistula and psoas abscess
3	10 cm stricture at the neo-terminal ileum. Fat hypertrophy with upstream bowel dilatation	Recurrent crohn's disease with stricture at the anastomosis (10 cm of neo-terminal ileum) and upstream small bowel dilatation
4	20 cm of distal ileum thickening with evidence of stricturing. Pre-stenotic dilatation of the ileum. Fistula to the sigmoid colon	Penetrating crohn's disease of the terminal ileum (20 cm) with ileo-sigmoid fistula
5	Active Crohn's disease involving the distal 30 cm of terminal ileum with a concomitant para-caecal abscess of 5 cm	Perforated terminal ileum (35 cm) with abscess in the terminal ileum mesentery
6	Transmural inflammation of the terminal ileum. Abdominal wall collection measuring 4.6 cm abutting the inflamed ileum and containing a gas bleb suggesting fistulation to the bowel	Penetrating crohn's disease of the terminal ileum (with severe fat wrapping) with fistula to the abdominal wall and abdominal wall abscess
7	Two short strictures in the distal ileum (35 cm from the ileocaecal junction). Also another mid ileum stricture of 3 cm. Moderate pre-stenotic dilatation of the small bowel	Several strictures in the proximal ileum over 30 cm with moderate fat wrapping Another 15 cm stricture in the distal ileum with mild fat wrapping
8	5 cm segment of active inflammatory disease involving the ileocaecal junction. Separate 20 cm segment of active disease within the distal jejunal/proximal ileum. Mild pre-stenotic dilatation	40 cm of inflamed distal jejunum/proximal ileum. No distal ileum disease

out of 588 questions (3%). Examples of laparoscopic findings are showed in screenshots from the videos (Figs. 2, 3).

Laparoscopic small bowel assessment

The evaluation of the small bowel thickening and of the mesenteric fat wrapping were the most reliable assessments with an overall agreement of 87.1% ($k=0.31$; 95% CI − 0.22, 0.84) and 82.7% ($k=0.35$; 95% CI − 0.04, 0.73), respectively.

The presence of strictures and pre-stenotic dilatation data demonstrated overall agreement of participants 75.2% ($k=0.06$: 95% CI − 0.33, 0.45) and 71.2% ($k=0.33$; 95% CI 0.15, 0.51), respectively.

Evaluation of fistulae had an overall agreement of 75.3% ($k=0.47$; 95% CI 0.34, 0.61), while the assessment of abscesses of 70.4% ($k=0.25$; 95% CI 0.03, 0.48).

The answers with the highest number of assessors agreeing were recorded for the evaluation of bowel thickening (range 50–100%) and fat wrapping (range 66.7–100%).

The full results of the survey are shown in Table 2.

Evaluation of the severity of Mesenteric disease

There were 68 answers reporting on severity of mesenteric disease. Interestingly, there was a significant variation in the evaluation of mild, moderate and severe mesenteric disease with overall agreement ranging from 33.3 to 100%, as demonstrated in Table 3.

Concordance between laparoscopic assessment ad surgical and histopathological findings

Assessors were blinded to preoperative imaging and were not shown the video footage of the "open" part of the procedure, with the specimen extraction and the bowel resection and anastomosis.

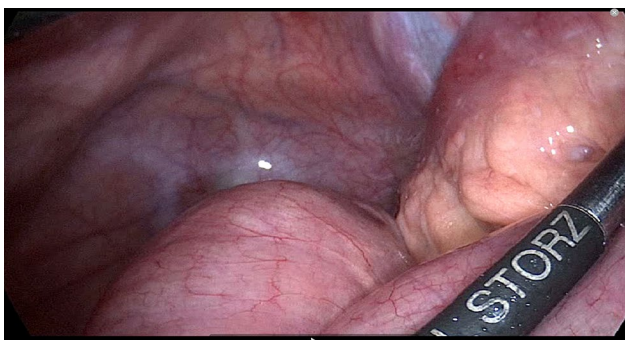

Fig. 3 Small bowel and mesenteric thickening. Evidence of upstream small bowel dilatation

We found significant heterogeneity in the agreement between the laparoscopic assessment evaluation provided by the 12 assessors (Table 2) and the surgical and pathological findings (Table 1) with rates of concordance ranging from 33 to 100% for the presence of strictures, 33% to 67% for the presence of fistulae and 44% to 77% for the presence of bowel dilatation. These results confirm the obvious role of careful review of preoperative imaging for appropriate planning of the surgical strategy and highlight the value of palpation and re-evaluation of the extend of disease performed extracorporeally prior to resection.

Discussion

CD surgery may prove technically challenging in view of multifocal inflammation as well as the potential for fistulae, abscesses, and large phlegmons which may require additional or unplanned procedures [17]. Moreover the surgeon must be prepared to control a thickened mesentery [18], whilst the lack of tactile feedback may limit the identification of occult disease [19]. Our study evaluated the reliability of the laparoscopic assessment of the entire small bowel, which is routinely performed in our unit to confirm the preoperative imaging findings and to inform the surgical strategy. Preoperative imaging, often including MRI and/or CT enterography, is essential in evaluating complications, such as abscess formation [20, 21], stricture [22] or inflammatory activity [23, 24], and the value in informing the IBD MDT discussion cannot be over-emphasized. Nevertheless, its accuracy for the measurement of the length of the diseased segment may be limited and it should not replace careful intraoperative evaluation by the surgeon.

Our study reports a reliable agreement, amongst 12 assessors with expertise in minimally invasive IBD surgery, in the evaluation of bowel thickening and mesenteric fat wrapping [25], which is encouraging in view of the increased number of CD resections being performed laparoscopically, due to enhancing patient outcomes through shorter length of stay and less postoperative adhesion formation [26]. The results of our study may infer enhancement of the role of video-based education and tele-mentoring to overcome the reported limited surgical trainees' exposure to these complex procedures [27].

Mesenteric fat wrapping, which is the thickening of the mesenteric fat adjacent to inflamed intestinal segments, originally described as "creeping fat" [28] is now recognised as pathognomonic for CD [29], with strong correlation between intestinal and mesenteric histopathological abnormalities, with topographical coupling of mesenteric and mucosal abnormalities having been described in CD. Recent studies suggest that the mesenteric fat may be involved in the release of a great number of multifunctional proteins and

Table 2 Results of laparoscopic assessment of the small bowel as reported by the 12 assessors

	Video 1	Video 2	Video 3	Video 4	Video 5	Video 6	Video 7	Video 8
Structures								
Absent	4 (33.7%)	1 (11.1%)	2 (22.2%)	2 (22.2%)	1 (8.3%)	0	0	0
Present	8 (66.7%)	7 (77.7%)	7 (77.8%)	4 (44.4%)	9 (75%)	10(90.1%)	11 (100%)	11 (100%)
Unable to evaluate	0	1 (11.1%)	0	1	0	0	0	0
Undecided	0	0	0	2 (22.2%)	2 (16.7%)	1 (9.1%)	0	0
Dilatations								
Absent	11 (91.7%)	2 (22.2%)	3 (33.3%)	2 (22.2%)	1 (8.3%)	3 (27.2%)	0	1 (9.1%)
Present	1 (8.3%)	7 (77.8%)	4 (44.4%)	5 (55.6%)	8 (66.7%)	8 (72.8%)	11 (100%)	9 (81.8%)
Unable to evaluate	0	0	0	0	2 (16.7%)	0	0	0
Undecided	0	0	2 (22.2%)	2 (22.2%)	1 (8.3%)	0	0	1 (9.1%)
Fistulae								
Absent	12 (100%)	1 (11.1%)	8 (88.9%)	0	4 (33.3%)	2 (18.2%)	11 (100%)	9 (81.8%)
Present	0	6 (66.7%)	0	6 (66.7%)	4 (33.3%)	6	0	1 (9.1%)
Unable to evaluate	0	0	0	0	3 (25%)	2 (18.2%)	0	0
Undecided	0	2 (22.2%)	1 (11.1%)	3 (33.3%)	1 (8.3%)	1 (9.1%)	0	1 (9.1%)
Abscess								
Absent	12 (100%)	5 (55.6%)	8 (88.9%)	5 (55.6%)	4 (33.3%)	3 (27.3%)	11 (100%)	10 (90.9%)
Present	0	2 (22.2%)	1 (11.1%)	4 (44.4%)	5 (41.7%)	7 (63.6%)	0	1 (9.1%)
Unable to evaluate	0	0	0	0	0	0	0	0
Undecided	0	2 (22.2%)	0	0	3 (25%)	1 (9.1%)	0	0
Bowel Thickening								
Absent	6 (50%)	0	0	0	1 (8.3%)	0	0	0
Present	4 (33.3%)	9 (100%)	7 (77.8%)	8 (88.9%)	11 (91.7%)	11 (100%)	11 (100%)	11 (100%)
Unable to evaluate	0	0	0	0	0	0	0	0
Undecided	2 (16.7%)	0	2 (22.2%)	1 (11.1%)	0	0	0	0
Fat wrapping								
Absent	8 (66.7%)	0	1 (11.1%)	0	1 (8.3%)	0	0	1 (9.1%)
Present	3 (25%)	8 (88.9%)	7 (77.8%)	9 (100%)	11(91.7%)	11 (100%)	10(90.9%)	9 (81.8%)
Unable to evaluate	0	0	0	0	0	0	0	0
Undecided	1 (8.3%)	1 (11.1%)	1 (11.1%)	0	0	0	1 (9.1%)	1 (9.1%)

Table 3 Assessment of severity of Mesenteric Disease

Case number	Unable to assess	Mild	Moderate	Severe	Total answers	% Agreement
1	0	1	1	1	3	33.3
2	1	0	3	4	8	50
3	0	2	4	1	7	57.1
4	0	0	2	7	9	77.8
5	0	0	2	9	11	81.9
6	0	0	0	11	11	100
7	0	1	3	6	10	60
8	0	1	6	2	9	66.7

Adapted from Coffey et al. [12] with mild defined as minimal mesenteric thickening and minimal fat wrapping; moderate defined as mesenteric thickening in vascular pedicles and fat wrapping covering < 25% of the small bowel circumference; severe defined as panmesenteric thickening and fat wrapping covering > 25% of the bowel circumference

an abnormal expression of leptin, adiponectin and resistin has been recently reported in patients with CD suggesting that mesenteric adipocytes may act as immunoregulatory cells in intestinal inflammatory infiltration [25]. Understanding these interactions may guide the development of novel targets for the treatment of CD-associated changes and the avoidance of radical surgery [30].

Unsurprisingly, current discussion on CD recurrence is on the role of surgery in mesenteric disease treatment, with Coffey et al. demonstrating a significantly reduced surgical recurrence rate when including a substantial part of mesentery in the specimen [14]. While the mesentery is likely to play a pathogenic role in CD, it is also crucial for intestinal vascularization, and extensive removal may compromise bowel tissue with concerns regarding haemorrhagic dangers associated with division of the mesentery in patients with CD and potential need for increased length of resected bowel if larger mesenteric segments are removed [31]. Additionally, our study demonstrated a limited value of the laparoscopic assessment for the evaluation of the severity of mesenteric disease, which may be explained by the need for tactile feedback and by the lack of widespread use of a standardised reporting system for intraoperative assessment of mesenteric disease severity in CD.

Our study did not include patients undergoing open procedures, and this must be acknowledged as a limitation. Nevertheless, open surgery is now rarely offered in our minimally invasive unit in the elective and even emergency setting. Moreover, the assessment of the small bowel obtained via the mini-laparotomy used for specimen extraction and anastomosis (when performed extracorporeally) may be incomplete, particularly in the assessment of proximal disease. Additionally, the blinding of the assessors to the preoperative imaging and to the clinical details of the patient introduced an artificial scenario, which does not exist in clinical practice. However, blinding of the assessors while watching the small bowel "walkthrough" video-recordings was considered necessary to minimise cognitive bias, and to obtain results focussed uniquely on the evaluation of the intestinal and mesenteric appearances.

Conclusion

Laparoscopic assessment of the small bowel thickening and of the presence of mesenteric fat wrapping is reliable for the intraoperative evaluation of CD with high inter-rater agreement. There is significant heterogeneity in the assessment of the severity of the mesenteric disease involvement; however, our study would need to be replicated on a wider sample to produce statistically significant results that would inform protocol change.

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Compliance with ethical standards

Disclosures The authors Celentano V, Garofalo E, Spinelli A, Pellino G, Flashman K, Frasson M, Carvello M, de'Angelis N, Garcia-Granero A, Harper M, Warusavitarne J, Coleman M, Espin E, Selvaggi F, have no conflict of interest or financial ties to disclose.

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