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Analysis of laboratory-based laparoscopic colorectal surgery workshops within the English National Training Programme

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Abstract

Background This study aimed to determine and compare the opinions of trainees and trainers attending courses using two simulation models (fresh frozen cadavers or anaesthetized pigs) and to assess trainees' degree of insight into both the difficulty of different procedures and their operative performance in the simulated environment.

Methods Trainers and trainees attending the training courses completed questionnaires. Performance was evaluated using the Global Assessment Score (GAS).

Results Data were collected over a 12-month period from 26 trainers and 77 trainees. The overall satisfaction was high after attendance at either course (4.50 vs. 4.49; $p = 0.83$). When the opinions of the trainees and trainers in cadaveric and animal courses were compared, the findings rated the animal model as superior in terms of tissue quality (3.97 vs. 3.55; $p = 0.02$), persistence of air leak (1.43 vs. 2.40; $p < 0.001$), and lack of disturbance by odor (4.24 vs. 3.41; $p < 0.001$). The cadaveric model provided more realistic simulation for port placement (4.02 vs. 3.11; $p < 0.001$) and anatomy (4.25 vs. 3.00; $p < 0.001$) and was perceived to be superior as a training model (4.53 vs. 3.61; $p = 0.001$). The trainees demonstrated good insight into procedure difficulty and their operative performance. The trainees and trainers were shown to have a good concordance of scores. The trainees were more inclined to underrate and the peers to overrate their performance.

Conclusions Trainees appear to have a good insight into procedure difficulty and their ability. Both training models have advantages and disadvantages, but overall, the cadaveric model is perceived to have a higher fidelity and greater educational value.

Keywords Abdominal · Bowel · Colorectal · Education · Surgical · Training courses

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Laparoscopic surgery requires a subset of skills distinct from those used in open surgery, including proficiency in handling tissue in a two-dimensional representation of the three-dimensional field and ability to use instruments that operate at a distance from the surgeon's hands [1]. Colorectal resections performed laparoscopically are known to be more complex than a cholecystectomy, for example, because they involve additional challenges such as the necessity to operate within multiple quadrants in the peritoneal cavity, the dissection of inflamed or obliterated tissue planes, and the safe mobilization of the bowel from confined spaces [2]. Courses aimed at training for advanced operations, particularly colorectal laparoscopic surgery, are scarce [3, 4].

The National Training Programme (NTP) for laparoscopic colorectal surgery, established in England in 2008, aims to facilitate the training of consultant colorectal surgeons ("trainees") to proficiency in the laparoscopic approach [5]. This was in direct response to a change in the National Institute of Clinical Excellence (NICE) guidelines [6].

Each NTP trainee participates in a course that may use a porcine or fresh frozen cadaveric model before starting "real-life" supervised training. Although many different training models have been suggested, including bench models, virtual reality and hybrid simulators, and cadaveric and porcine models, little research has been undertaken to determine which of these, if any, provides the most realistic and effective training for laparoscopic colorectal surgery [7–16]. The only available studies investigating courses assessed a single model using satisfaction questionnaires [7, 15, 16].

This study aimed to determine and compare the overall opinions of both trainees and trainers attending training courses using a simulation model of either fresh frozen cadavers or anesthetized pigs concerning the model's perceived fidelity, interference, and educational value; and to assess trainees' degree of insight into both the difficulty of different procedures and their operative performance in the simulated environment.

Materials and methods

Course programs and materials

Each course followed a similar structure irrespective of the simulation model used. It ran during 2 days and included a period of lectures and video demonstrations of procedures, usually followed by a live demonstration of a laparoscopic colorectal resection and then hands-on training sessions in the laboratory. The trainees were consultant surgeons, laparoscopic fellows, or senior surgical trainees in their last year of speciality training. They were taught in pairs by an expert laparoscopic surgeon (trainer).

The laboratories were set up as operating rooms, with full laparoscopic stacks, monitors, equipment, drapes, and instruments. A range of energy sources, ports, and stapling devices were available for the trainees to maximize their exposure to different equipment and to provide an opportunity for practise.

The live porcine laboratories, fully certified and supported by veterinary staff, were situated in Hamburg (Germany) and Paris (France) due to the restrictions imposed by UK law. The three cadaveric labs were all based in the United Kingdom (Newcastle-upon-Tyne, Nottingham, Bristol) and used fresh frozen human cadavers donated in accordance with the Human Tissue Act [17]. The tissue was frozen to −20°C within 1 week after the time of death, defrosted 3 to 5 days before the course, and washed down with antiseptic soap.

Questionnaire and assessment method

At the end of each course, all the trainees and trainers were asked to complete a standardized, anonymous questionnaire. The questionnaire included 21 statements pertaining to the realism of the model (fidelity: 8 items), factors possibly interfering with learning (interference: 3 items), the educational value of the model (8 items), and the overall satisfaction with the course (2 items) (Table 1). Each trainee and trainer had to rate the degree of their agreement with each statement using a 5-point Likert scale as follows: 1 (strongly disagree), 2 (disagree), 3 (undecided), 4 (agree), 5 (strongly agree).

To study insight, the trainees were asked to rate a number of laparoscopic colorectal procedures according to their difficulty. The trainers were asked the same questions. Procedure difficulty was assessed by a questionnaire listing all types of colorectal resections and a breakdown of their operative steps and rated using a 6-point Juster scale ranging from 1 (easy) to 6 (most difficult).

The trainees' performance was assessed confidentially by their trainer and by the peer trainee who had assisted during the procedure using the Global Assessment Score (GAS). In addition, they had to assess their own performance (self-evaluation) using the same form. The GAS form is a previously validated generic task list designed specifically for colorectal resections that uses the amount of support required to perform the task as a measure of proficiency level. The GAS choice options are 1 (not performed, step had to be done by trainer), 2 (partly performed, step had to be partly done by trainer), 3 (performed with substantial verbal support), 4 (performed with minor verbal support), 5 (competent performance, safe, without guidance), 6 (proficient performance, could not be better) [18].

Table 1 Overall combined, trainer and trainee opinion of fresh frozen cadaveric and porcine training courses. Questions from the questionnaire have been grouped into those pertaining to "interference", "fidelity" and "educational value". The [a] relates the question to being "comparable to in vivo". A "P/C" denotes "porcine/cadaveric" depending on which course was attended. Scores were mean values from a 5-point Likert scale (1 = strongly disagree, 3 = undecided, 5 = strongly agree), with the standard deviation given in parentheses. p value was significant if <0.05

Question[a]	Overall			Trainer			Trainee		
	Porcine ($n = 37$)	Cadaveric ($n = 66$)	p Value	Porcine ($n = 8$)	Cadaveric ($n = 18$)	p Value	Porcine ($n = 29$)	Cadaveric ($n = 48$)	p Value
Interference									
Not disturbed by odor	4.24 ± 0.9	3.41 ± 1.1	<0.001	4.38 ± 0.7	3.40 ± 1.2	0.08	4.21 ± 1.0	3.41 ± 1.1	0.001
Smell made it difficult to concentrate	1.46 ± 0.9	2.21 ± 1.0	<0.001	1.13 ± 0.3	2.13 ± 1.3	0.01	1.55 ± 0.9	2.24 ± 1.0	<0.001
Persistent air leak made it difficult to maintain a pneumoperitoneum	1.43 ± 0.7	2.40 ± 1.1	<0.001	1.25 ± 0.4	2.73 ± 1.3	0.001	1.48 ± 0.8	2.29 ± 1.0	<0.001
Fidelity									
Anatomic conditions authentic[a]	3.00 ± 1.0	4.25 ± 0.5	<0.001	2.38 ± 0.5	4.47 ± 0.5	<0.001	3.17 ± 1.1	4.17 ± 0.6	<0.001
Operative tactility[a]	3.84 ± 0.8	3.90 ± 0.8	0.86	3.75 ± 1.2	3.93 ± 0.7	0.97	3.86 ± 0.7	3.89 ± 0.8	0.88
Organ consistency[a]	3.84 ± 0.7	3.50 ± 0.8	0.04	3.88 ± 0.6	3.80 ± 0.6	0.93	3.83 ± 0.7	3.40 ± 0.8	0.02
Tissue and organ quality and color[a]	3.97 ± 0.6	3.55 ± 0.9	0.02	3.75 ± 0.8	3.87 ± 0.9	0.68	4.03 ± 0.5	3.44 ± 0.9	0.004
Operative stacks/equipment[a]	4.14 ± 0.5	4.03 ± 0.9	0.70	4.25 ± 0.4	4.13 ± 0.8	0.94	4.10 ± 0.5	4.00 ± 1.0	0.65
Reduced tactile feedback compared[a]	2.06 ± 0.8	2.57 ± 1.0	0.02	1.88 ± 0.8	2.71 ± 1.3	0.18	2.11 ± 0.8	2.52 ± 0.9	0.06
Tissue plane dissection is not[a]	2.57 ± 1.1	2.15 ± 0.9	0.06	2.25 ± 1.2	2.40 ± 1.1	0.66	2.66 ± 1.1	2.07 ± 0.9	0.01
Port placement authentic[a]	3.11 ± 1.1	4.02 ± 0.9	<0.001	2.88 ± 1.2	3.87 ± 1.0	0.05	3.18 ± 0.9	4.07 ± 0.9	<0.001
Educational value									
Training model is superior to P/C[a]	3.61 ± 1.1	4.53 ± 0.6	0.001	2.50 ± 1.0	4.67 ± 0.4	0.001	3.93 ± 1.0	4.48 ± 0.7	0.06
Training on porcine model is better due to tissue perfusion	3.79 ± 0.8	3.25 ± 1.4	0.22	3.71 ± 0.9	3.00 ± 1.8	0.53	3.82 ± 0.8	3.36 ± 1.2	0.32
Training only allowed for familarization with laparoscopic instruments	2.78 ± 1.2	1.96 ± 0.9	0.02	2.63 ± 1.5	2.08 ± 0.51	0.51	2.83 ± 1.2	1.93 ± 1.0	0.003
Able to learn as much as did from course by watching in theater	1.49 ± 0.8	1.71 ± 0.8	0.07	1.50 ± 0.7	1.36 ± 0.4	0.77	1.48 ± 0.8	1.82 ± 0.9	0.03
P/C model is superior to virtual reality training model	4.03 ± 1.0	4.29 ± 1.2	0.19	3.75 ± 1.3	4.53 ± 0.5	0.15	4.10 ± 0.9	4.20 ± 1.0	0.50
Theory/live surgery teaching high value	3.79 ± 0.7	4.03 ± 0.8	0.07	3.86 ± 0.9	4.07 ± 0.4	0.73	3.77 ± 0.7	4.02 ± 0.9	0.08
Technical equipment of a high standard	4.41 ± 0.4	4.42 ± 0.6	0.62	4.63 ± 0.5	4.47 ± 0.5	0.47	4.34 ± 0.4	4.40 ± 0.7	0.36
Course will help improve laparoscopic skills in clinical practice	4.31 ± 0.6	4.36 ± 0.6	0.70	4.17 ± 0.7	4.38 ± 0.5	0.54	4.34 ± 0.6	4.36 ± 0.6	0.86
Overall very satisfied with the course	4.49 ± 0.5	4.50 ± 0.5	0.83	4.63 ± 0.5	4.53 ± 0.5	0.68	4.45 ± 0.5	4.49 ± 0.5	0.67
Would recommend the course to others	4.56 ± 0.5	4.57 ± 0.5	0.84	4.63 ± 0.5	4.60 ± 0.5	0.90	4.54 ± 0.5	4.56 ± 0.5	0.79

P/C, porcine/cadaveric as appropriate for course

[a] Comparable with in vivo

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 17 (SPSS, Chicago, IL, USA). Data were collected prospectively and analyzed using the Mann–Whitney *U* test. Mean values are presented. A *p* value less than 0.05 was considered statistically significant.

Results

Over a 12-month period (January 2009 to January 2010), 103 responses from 26 trainers and 77 trainees responses in 10 cadaveric and 3 porcine courses were evaluated (response rate, 94%). There were 66 responses (59 male and 7 female responses) from the cadaveric and 37 responses (30 male and 7 female responses) from the porcine course. The median age of the trainees was 42 years (range, 32–62 years), and the median age of the trainers was 41 years (range, 36–60 years). The trainees had, on average, less than 2 years of experience in laparoscopic surgery, and the trainers 5 to 10 years of experience.

Overall, the findings showed several significant differences of opinion between those attending the cadaveric training course and those attending the porcine course. Compared with the cadaveric course, the porcine course exhibited significantly better quality and color of organs (3.84 vs. 3.50; $p = 0.04$) and tissues (3.97 vs. 3.55; $p = 0.02$) and less air leak (1.43 vs. 2.40; $p < 0.001$) and odor (4.24 vs. 3.41; $p < 0.001$) (1.46 vs. 2.21; $p < 0.001$). The cadaveric model was found to be significantly better as a training model (3.62 vs. 4.53; $p = 0.001$) for anatomy (3.00 vs. 4.25; $p < 0.001$) and realistic port placement (3.11 vs. 4.02; $p < 0.001$). Tissue perfusion (3.79 vs. 3.25; $p = 0.22$) in the live porcine course did not significantly improve training. All agreed that the tactility and tissue plane dissection in both models was authentic to real life and that simply watching in the operating theater would not have taught them as much as the course. Furthermore, both models were thought to be superior to virtual reality and able to improve laparoscopic skills in clinical practice. There was overall high satisfaction with the standard of the equipment, teaching, and structure of both courses (Table 1).

The opinion differences between the trainers and trainees for each course were compared and analyzed in more detail, and the statements were grouped in accordance with the themes of fidelity, interference, and educational value to determine whether there was a discrepancy in opinion depending on the level of experience.

Fidelity

Both the trainers and the trainees rated the cadavers significantly better than the porcine model in terms of anatomic accuracy (trainers: 4.25 vs. 2.38, $p < 0.001$; trainees: 4.17 vs. 3.17, $p < 0.001$). This also was reflected by a more realistic port placement (trainers: 3.87 vs. 2.88, $p = 0.05$; trainees: 4.07 vs. 3.18, $p < 0.001$). In addition, the trainees rated tissue dissection in the porcine model as less realistic to live human tissue compared with the trainees using cadavers (2.66 vs. 2.07; $p = 0.01$). Although tissue quality and color (4.03 vs. 3.44; $p = 0.004$) and organ consistency (3.83 vs. 3.40; $p = 0.02$) were rated slightly better for the porcine model by the trainees, there was no difference in operative tactility compared with cadavers (3.86 vs. 3.89;

Table 2 Trainee ($n = 75$) and trainer ($n = 26$) opinion of laparoscopic colorectal procedure overall difficulty using a 6-point Juster scale (1 = easy, 6 = most difficult). Mean values were quoted, with the standard deviation in parentheses. *p* value was significant if <0.05

Procedure	Trainee ($n = 75$)	Trainer ($n = 26$)	*p* Value
Right hemicolectomy (extracorporeal anastomosis)	2.48 ± 1.00	1.96 ± 0.91	0.01
Right hemicolectomy (intracorporeal anastomosis)	4.39 ± 0.99	4.17 ± 1.2	0.42
Transverse colectomy	4.55 ± 1.0	4.64 ± 0.8	0.78
Left hemicolectomy	3.73 ± 0.9	3.58 ± 0.8	0.52
Hartmann's procedure	3.28 ± 1.0	2.76 ± 0.9	0.04
Sigmoid colectomy	3.04 ± 1.0	2.58 ± 0.9	0.05
Sigmoid colectomy with splenic flexure mobilization	4.22 ± 0.8	3.92 ± 0.7	0.09
Splenic flexure resection	4.66 ± 0.7	4.36 ± 0.9	0.18
Anterior resection	4.31 ± 0.8	3.77 ± 0.9	0.01
Low anterior resection	5.23 ± 0.8	5.31 ± 1.0	0.44
Reversal of Hartmann's procedure	4.69 ± 1.1	4.52 ± 1.2	0.60
Abdominoperineal resection	4.44 ± 1.0	4.19 ± 0.9	0.28
Subtotal/total colectomy	4.65 ± 0.8	4.04 ± 1.4	0.06

$p = 0.88$). The realism of laparoscopic equipment in the cadaveric and porcine courses was perceived to be high by both the trainers (4.25 vs. 4.13; $p = 0.94$) and the trainees (4.10 vs. 4.00; $p = 0.65$).

Interference

The trainers and trainees perceived the cadaveric course to have a greater air leak and hence difficulty in maintaining the pneumoperitoneum, than the porcine course (trainer: 2.73 vs. 1.25, $p = 0.001$; trainee: 2.29 vs. 1.48, $p < 0.001$). The trainees in the animal courses were less disturbed by odors (4.21 vs. 3.41; $p = 0.001$). Odor did not seem to affect their concentration level, although in cadaveric courses, this was considered to be a slightly greater problem for both the trainees (2.24 vs. 1.55; $p < 0.001$) and the trainers (2.13 vs. 1.13; $p = 0.01$).

Educational value

Although the participants in both courses tended to agree that their course model was superior to the other, the respondents from the cadaveric course supported this statement significantly more strongly (4.53 vs. 3.61; $p = 0.001$). This difference was even more marked when the answers of trainers who often taught in both courses were compared (4.67 vs. 2.50; $p = 0.001$). The trainees in the porcine courses agreed more strongly with the statement that the course allowed only for familiarization with laparoscopic instruments (2.83 vs. 1.93; $p = 0.003$), (Table 1).

Trainees' insight

First, insight, defined as the perceived difficulty, was rated using a 6-point Juster scale ranging from 1 (easy) to 6 (most difficult). For overall difficulty, the trainees rated the following procedures as significantly harder than did the expert trainers: right hemicolectomy with extracorporeal anastomosis (2.48 vs. 1.96; $p = 0.01$), Hartmann's procedure (3.28 vs. 2.76; $p = 0.04$), and anterior resection (4.31 vs. 3.77; $p = 0.01$) (Table 2). The trainees rated dissection of the vascular pedicle and performance of an intracorporeal anastomosis as more difficult than did the trainers (Table 3). For the majority of steps and for all the overall procedure difficulty ratings, the trainees scored items higher than did the trainers (Tables 2, 3).

Second, the performance of the trainees was measured by the trainer, by their peers, and by themselves using a GAS. The GAS forms used a 6-point scale related to the amount of support required for the trainee to perform the operation. For the porcine course, the peer score for the dissection of the vascular pedicle was significantly higher than that given by the trainer (5.0 vs. 4.36; $p = 0.02$). Peers

Table 3 Trainee ($n = 75$) and trainer ($n = 26$) opinion of the difficulty of each of the main different stages (exposure, vascular pedicle mobilisation, mobilisation of the colon, and intracorporeal anastomosis) of laparoscopic colorectal procedures using a 6-point Juster scale (1 = easy, 6 = most difficult). Mean values were quoted, with the standard deviation in parentheses. p value was significant if <0.05

Procedure	Exposure			Vascular pedicle mobilization			Mobilization of the colon			Intracorporeal anastomosis		
	Trainee ($n = 75$)	Trainer ($n = 26$)	p Value	Trainee ($n = 75$)	Trainer ($n = 26$)	p Value	Trainee ($n = 75$)	Trainer ($n = 26$)	p Value	Trainee ($n = 75$)	Trainer ($n = 26$)	p Value
Right hemicolectomy	2.13	1.82	0.08	2.48	2.00	0.03	2.71	2.50	0.36	4.89	4.40	0.16
Transverse colectomy	3.45	3.00	0.16	3.76	4.00	0.37	3.93	3.60	0.26	4.90	4.58	0.45
Left hemicolectomy	2.86	2.65	0.50	3.03	2.59	0.06	3.36	3.00	0.12	4.21	2.80	<0.001
Hartmann's procedure	3.08	2.68	0.08	3.02	2.52	0.03	3.17	2.73	0.03	3.61	2.43	0.02
Reversal of Hartmann's	3.85	3.91	0.89	3.51	2.83	0.22	4.05	3.71	0.17	3.88	2.95	0.004
Sigmoid colectomy	2.76	2.48	0.21	2.94	2.52	0.06	3.00	2.52	0.03	3.70	2.52	<0.001
Sigmoid colectomy with splenic flexure mobilization	3.37	2.96	0.09	3.33	2.74	0.02	4.11	3.70	0.18	2.97	2.48	<0.001
High anterior resection	2.99	2.87	0.65	3.03	2.61	0.11	3.54	3.26	0.40	3.70	2.61	<0.001
Low anterior resection	3.71	3.96	0.31	3.41	2.61	0.002	4.48	4.35	0.93	4.00	3.48	0.07
Abdominoperineal resection	3.51	3.59	0.64	3.21	2.55	0.01	4.07	3.95	0.81	–	–	–

also scored trainees higher than themselves for safe dissection of the bowel (4.94 vs. 4.72; $p = 0.04$) and for overall performance (5.03 vs. 4.53; $p = 0.01$). For the fresh frozen cadaveric course, the trainees and their peers scored ability to expose the operating field significantly higher than did the trainers (4.58 vs. 4.651 vs. 4.12; $p = 0.01$, $p = 0.03$), whereas the trainers rated the trainees higher for their ability to dissect the ureter or duodenum safely (4.47 vs. 4.18; $p = 0.02$) (Tables 4, 5).

Discussion

This is the first study comparing a detailed opinion analysis of two course models for laparoscopic colorectal surgery. The opinion given by the trainees and trainers demonstrates benefits from both training models. However, the accuracy of the anatomic cadaveric model's complexity provides an advantage over the porcine model, which was clearly acknowledged by the respondents of the survey, especially the trainers, who perhaps had greater insight because they often taught in both courses. The disadvantages of the cadavers, such as bad odor and lack of tissue perfusion, were stated, but they did not have a substantial impact on the perceived educational value of the model.

Port-site-related air leaks, and hence smell, could be minimized in cadavers by making small port trocar skin incisions. Previous reports using fixated and fresh cadaveric models showed similarly high satisfaction levels [7, 15, 19].

Animal models have been used widely for training several surgical techniques, but the two models have not been compared directly for colorectal surgery using a trainee and trainer population of this size [16, 20–22]. In laparoscopic colorectal surgery, anatomic planes and spaces are crucial for an understanding of the procedure. Therefore, the value of a training model with an alternative structure is questionable. This also is supported by the fact that the trainees in the animal courses had a significantly strong agreement that the only benefit of the course was familiarization with the technical equipment, whereas participants in the cadaveric course disagreed with this conclusion. Furthermore, additional lectures, video sessions, practical tips, and a low trainer–trainee ratio most likely led to high "overall satisfaction" levels with both course models. The overall perceived benefit of the cadaver as a training model, particularly in the context of the recent change in the structure of surgical training such as a decrease in working hours, reduced exposure to real operations, and the need for more simulated training, suggests that more laboratories equipped with suitable facilities and staff are required [23].

To study the level of the trainees' insight, we analyzed their perception of the difficulty of several laparoscopic colorectal operations and of their own performance in the course compared with that of their trainers. The trainees in courses had previously shown a tendency to overestimate their own ability [24]. Reassuringly, these data are not reproduced in this report, and the trainees in fact demonstrated modesty and good insight to their own ability. This

Table 4 Assessment of trainee performance on a porcine course using a Global Assessment Score form (self, trainer, peer). Maximum score 6, "–" indicates insufficient data for analysis, mean values were quoted with the standard deviation, and the p value was considered to be significant if <0.05

Operative step	Self	Trainer	Peer	Self vs. trainer (p value)	Self vs. peer (p value)	Trainer vs. peer (p value)
Correct theater setup	4.50 ± 1.2	4.92 ± 0.7	4.58 ± 1.4	0.85	0.81	0.51
Appropriate patient positioning	4.50 ± 1.2	4.79 ± 0.7	4.93 ± 1.2	0.93	0.18	0.20
Safe-access technique	4.97 ± 0.7	4.93 ± 0.9	5.12 ± 0.7	0.75	0.61	0.20
Exposure of operating field	4.75 ± 0.6	4.76 ± 0.7	5.06 ± 0.7	0.84	0.07	0.20
Safe dissection of vascular pedicle	4.74 ± 0.8	4.36 ± 0.9	5.00 ± 0.8	0.35	0.09	0.02
Dissection of mesentry (retrocolic)	4.62 ± 0.7	4.50 ± 0.7	4.97 ± 0.7	0.57	0.07	0.09
Safe dissection of ureter or duodenum	4.60 ± 0.7	4.57 ± 1.1	5.0 ± 0.8	0.51	0.19	0.59
Dissection of hepatic or splenic flexure	3.0 ± 1.8	NA	4.50 ± 1.6	–	1.00	–
Mesorectal dissection	4.56 ± 0.8	4.74 ± 1.1	4.92 ± 0.9	0.48	0.19	0.39
Safe dissection of bowel	4.72 ± 0.7	4.80 ± 0.7	4.94 ± 0.8	0.50	0.04	0.83
Safe extraction of bowel	5.06 ± 0.8	5.19 ± 0.4	5.38 ± 0.6	0.41	0.22	0.31
Anastomosis	4.79 ± 0.8	4.85 ± 0.7	5.23 ± 0.6	0.52	0.18	0.10
Overall performance	4.53 ± 0.7	4.63 ± 0.7	5.03 ± 0.6	0.18	0.01	0.09

NA not available

Table 5 Assessment of trainee performance on a fresh frozen cadaveric course using a Global Assessment Score form (self, trainer, peer). Maximum score 6, "–" indicates insufficient data for analysis, mean values were quoted with the standard deviation, and the *p* value was considered to be significant if <0.05

Operative step	Self	Trainer	Peer	Self vs. trainer (*p* value)	Self vs. peer (*p* value)	Trainer vs. peer (*p* value)
Correct theater setup	4.21 ± 1.4	4.06 ± 1.2	4.03 ± 1.7	0.89	0.68	0.77
Appropriate patient positioning	4.37 ± 1.2	4.04 ± 1.2	4.21 ± 1.6	0.38	0.69	0.58
Safe-access technique	4.84 ± 0.7	4.63 ± 0.9	4.97 ± 0.6	0.29	0.37	0.05
Exposure of operating field	4.58 ± 0.7	4.12 ± 0.8	4.65 ± 0.8	0.01	0.30	0.03
Safe dissection of vascular pedicle	4.22 ± 0.8	4.32 ± 0.8	4.40 ± 0.9	0.26	0.09	0.86
Dissection of mesentry (retrocolic)	4.25 ± 0.8	4.28 ± 0.8	4.23 ± 0.7	0.58	0.88	0.86
Safe dissection of ureter or duodenum	4.18 ± 0.7	4.47 ± 0.7	4.38 ± 0.8	0.02	0.43	0.90
Dissection of hepatic or splenic flexure	3.93 ± 1.9	4.06 ± 0.8	4.09 ± 0.9	0.42	0.80	0.90
Mesorectal dissection	3.89 ± 0.9	4.12 ± 0.9	4.12 ± 0.8	0.17	0.05	0.28
Safe dissection of bowel	4.21 ± 0.8	4.21 ± 0.7	4.11 ± 1.1	0.99	0.24	0.76
Safe extraction of bowel	3.00 ± 2.0	4.79 ± 1.2	3.75 ± 1.8	0.65	–	–
Anastomosis	3.00 ± 2.0	4.40 ± 1.2	3.50 ± 1.9	0.31	–	1.0
Overall performance	4.06 ± 0.7	4.15 ± 0.7	4.35 ± 0.8	0.47	0.07	0.67

may be due to a different philosophy or approach to learning on the part of the trainees from opting to participate in such a structured program. Trainees' understanding of full procedure difficulty had not been assessed previously, and they demonstrated a respect for advanced operations [16, 25]. This may be due to the seniority level of the current trainee population because they were suitably experienced in other fields of surgery.

Nevertheless, these findings indicate that the trainees may be capable of selecting appropriate cases at the beginning of the proficiency gain curve, which is a crucial decision-making skill in advanced laparoscopic surgery [2]. Objective peer critique is notoriously difficult to achieve due to a well-known tendency for colleagues to overrate their peers. Therefore, it is not surprising that this is reflected in these data [26].

This study has limitations because the trainees did not attend both courses, which makes a direct comparison of the two training models more difficult. Given the range in the amount of prior exposure to laparoscopic colorectal surgery, it is difficult to establish a baseline and determine any increased proficiency directly associated with course attendance, and further work needs to be performed. Furthermore, the different training models need to be assessed for their specific demonstrable benefit.

Trainees appear to have good insight into laparoscopic colorectal operative procedure difficulty and their own ability. Both the animal and fresh frozen cadaveric training models have advantages and disadvantages, but trainees and trainers are highly satisfied with both models, perceiving higher fidelity and educational value with the fresh frozen cadaver. Assessments of trainee performance indicate that the GAS form also may be a useful tool for training in the simulated environment.

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