Systematic video documentation is superior to the narrative operative report in colorectal cancer surgery. Results of the IQ-Trial

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JAMA surgery (2019) 154 (5), 381-389

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ABSTRACT

Importance

Despite ongoing advances in the field of colorectal surgery, the quality of surgical treatment is still variable. As an intrinsic part of surgical quality, the technical information regarding the surgical procedure is reflected only by the narrative operative report (NR), which has been found to be subjective and regularly omits important information.

Objective

To investigate systematic video recording (SVR) as a potential improvement in quality and safety with regard to important information in colorectal cancer surgery.

Design, Setting, and Participants

The Imaging for Quality Control Trial was a prospective, observational cohort study conducted between January 12, 2016, and October 30, 2017, at 3 centers in the Netherlands. The study group consisted of 113 patients 18 years or older undergoing elective laparoscopic surgery for colorectal cancer. These patients were case matched and compared with cases from a historical cohort that received only an NR.

Interventions

Among study cases, participating surgeons were requested to systematically capture predefined key steps of the surgical procedure intraoperatively on video in short clips.

Main Outcomes and Measures

The SVRs and NRs were analyzed for adequacy with respect to the availability of important information regarding the predefined key steps. Adequacy of the reported information was defined as the proportion of key steps with available and sufficient information in the report. Adequacy of the SVR and NR was compared between the study and control groups, with the SVR alone and as an adjunct to the NR in the study group vs NR alone in the control group.

Results

Of the 113 study patients, 69 women (61.1%) were included; mean (SD) age was 66.3 (9.8) years. In the control group, a mean (SD) of 52.5% (18.3%) of 631 steps were adequately described in the NR. In the study group, the adequacy of both the SVR (78.5% [16.5%], $P<.001$) and a combination of the SVR with NR (85.1% [14.6%], $P<.001$) was significantly superior to NR alone. The only significant difference between the study and historical control groups regarding postoperative and pathologic outcomes was a shorter postoperative mean (SD) length of stay in favor of the study group (8.0 [7.7] vs 8.6 [6.8] days; $P=.03$).

Concusions and Relevance

Use of SVR in laparoscopic colorectal cancer surgery as an adjunct to the NR might be superior in documenting important steps of the operation compared with NR alone, adding to the overall availability of necessary intraoperative information and contributing to quality control and objectivity.

INTRODUCTION

During the past decades, colorectal cancer treatment has been subject to some of the most successful developments in modern medicine, constantly improving its quality and outcome. Laparoscopic surgery is now the standard of colorectal cancer treatment, resulting in similar oncologic outcomes and improved short-term results compared with conventional open surgery.[1,2] Also, 5-year survival rates of colon and rectal cancer are rising, and the incidence has been decreased owing to the establishment of preventive measures.[3,4] Despite these positive developments, the quality of surgical treatment, possibly the most significant factor in short- and long-term outcomes, remains variable. This variability is not only evident in postoperative mortality and morbidity, ranging from 0.5% to 6% and 15% to 25%, respectively,[1,5-7] but also in oncologic outcomes, with disease recurrence varying from 5% to 50% of patients and 5-year survival rates ranging from 32% to 64%.[8-11] The importance of quality assurance to reduce this variability is recognized and several quality improvement programs have already been established, such as the implementation of the surgical safety checklist used in the time-out procedure, effectively reducing perioperative mortality.[12,13] In addition, different clinical audits have been developed in the pursuit of quality improvement. These programs, however, focus on either preoperative or postoperative concerns. The essential steps during the surgical procedure are not specifically examined, and might be skipped or inadequately performed. Currently, the only source of information regarding the essential intraoperative surgical steps is represented by the narrative operative report (NR). This source is, however, subjective by definition and proved to be lacking necessary information on a regular basis.[14] A lack of clear description of actual intraoperative events could affect the patient's postoperative therapeutic management and delay diagnosis of complications.[15,16]

Using systematic video recording (SVR), it is possible to capture all important intraoperative steps in more detail and provide a source of objective information. In a pilot study, we have evaluated the use of SVR in laparoscopic colorectal cancer surgery.[17]

In this study we aimed to investigate SVR as a potential improvement in quality and safety with focus on the availability of important information in colorectal cancer surgery.

METHODS

The Imaging for Quality Control Trial is a multicenter, prospective, observational cohort study conducted at 3 centers in the Netherlands (Havenziekenhuis–Erasmus University Medical Center, Rotterdam; Jeroen Bosch Hospital, 's-Hertogenbosch; and University Medical Center Utrecht). The medical research and ethics committee of the Erasmus University Medical Center exempted this study from the Research Involving Human Subjects Act. Institutional review boards of the participating centers provided separate approval of this study prior to local initiation. Informed consent was waived by the medical research and ethics committee. Patients provided oral consent for use of video footage.

Patients

Patients 18 years or older who planned to undergo elective laparoscopic surgery for colorectal cancer were eligible for inclusion. Surgical procedures were defined as right hemicolectomy, transverse colectomy, left hemicolectomy, sigmoid colectomy, or low anterior resection or abdominoperineal resection. Patients who underwent treatment without curative intent, unresectable tumor, or absence of video data owing to technical malfunctioning of recording equipment or failure in data retrieval were excluded from the study. The study was conducted from January 12, 2016, to October 30, 2017.

Predefined Checklist

Surgical checklists compiled from the key moments of the aforementioned surgical procedures were previously defined and feasibility of the process was confirmed.[17] These surgical checklists were subsequently transcribed into a case report form (CRF); printable versions of the study CRFs are presented in the *Appendices*). The intraoperative video clips were then recorded according to the surgical checklist under the direction of the primary surgeon and the corresponding steps were marked on the CRF after completion of the procedure. If a step was not relevant in a particular procedure, not applicable or n/a was added next to the step on the CRF.

Data Collection

During each procedure, the primary surgeon was requested to capture the predefined key moments intraoperatively on video in short clips. The recordings of the different steps were initiated and ceased at the judgment of the primary surgeon. High-definition images were obtained using the available endoscopy equipment in each institution. Subsequently, the video files were retrieved and anonymized for further analysis.

Patient data regarding baseline characteristics, comorbidities, oncologic outcomes, and postoperative complications were gathered from the patients' medical records and anonymously entered into a Good Clinical Practice–compliant electronic data capture system (OpenClinica Community, version 3.12, OpenClinica LLC and collaborators, http://www.OpenClinica.com)

Review for Adequacy

The video clips of the recorded procedures, as well as the corresponding NRs, were reviewed for adequacy according to the predefined key steps. Adequacy was defined as the competent depiction of a surgical step and expressed as the amount or percentage of adequate steps of the total applicable steps for each case. Requirements for adequacy of each step were formulated for both the SVR and NR to aid in the review process (Requirements for adequacy are presented in the *Appendices*). Steps in the CRF were classified as adequate, not adequate, or not applicable. For the review of the SVR, not meeting these requirements or any absence of a recording resulted in a not adequate classification. In reviewing the NR, a step would be labeled not adequate if there was either an incomplete description or a lack of description.

Outcomes

For the primary and secondary outcomes, cases from the study group were matched on an institutional level in a 1:1 ratio with cases from a historical cohort. Patients in this historical cohort had undergone surgery before the start of the study period to most accurately represent the standard situation in operative reporting by avoiding any bias related to the systematic use of the surgical checklists. Case matching was done based on the procedure performed (exact) and the American Society of Anesthesiologists score (tolerance of 1 American Society of Anesthesiologists class).

The primary outcome was the availability of essential information of the performed surgical procedure according to the predefined checklist. Accordingly, the amount of adequate information as provided by SVR of the study group and NR from both the study and control groups was obtained. To assess the added value of SVR to the current situation in which only NR is composed, 2 comparisons were made: SVR of the study group vs NR of the control group and SVR as an adjunct to NR of the study group vs NR of the control group alone.

For the secondary outcome, surgical quality was evaluated. Adverse events associated with the surgical procedure within 30 days postoperatively were analyzed. Surgical complications were graded according to the Clavien-Dindo classification.[18] Furthermore, surgical wound infection, intra-abdominal abscess, urinary tract infection, respiratory tract infection, cardiologic complication, neurologic complication (including delirium), postoperative ileus, postoperative bleeding, and anastomotic leakage were separately documented. In addition, the postoperative length of stay and readmissions within the first 30 postoperative days were obtained.

Statistical Analysis

Categorical data are presented as numbers and percentages. Continuous data are described by mean (SD). Study cases and control cases were compared using $\chi 2$ test or Fisher exact test in case of categorical data. Continuous data were tested for normality using the Shapiro-Wilk test and, if normally distributed, analyzed using an independent-samples, 2-tailed t test. Otherwise, the Mann-Whitney test was conducted. In comparing the adequacy of reporting between the different modalities within the study group, a paired-samples t test or Wilcoxon signed rank test was used, depending on normality. A P value <.05 was considered statistically significant.

Based on pilot data,[17] the expected percentage of total adequate steps for NR was approximated at 50%. This percentage was expected to rise to approximately 80% by the addition of SVR. We anticipated minimal improvement in reporting adequacy of 15 percentage points between the study and control groups ($\delta = 0.15$). With $\alpha = .05$ and $\beta = .20$, the calculated sample size resulted in 113 cases for both the study and control groups. In the pilot study, 5 of 20 cases were excluded from further analysis. To account for this loss of data, 142 patients were intended to be included in this trial. Data were analyzed with IBM SPSS Statistics for Windows, version 21.0 (IBM Corp) and Microsoft Excel (Microsoft Corp).

RESULTS

Study Population

Between January 12, 2016, and October 30, 2017, a total of 141 patients meeting inclusion criteria underwent operations in participating centers and were included in this study. Subsequently, 28 patients were excluded from the analysis: 25 owing to technical malfunctioning of the recording equipment or problems in data storage, 2 because of the absence of curative intent, and 1 because of an unresectable tumor. Hence, 113 patients (69 women [61.1%]) were included for further analysis. Mean (SD) age was 66.3 (9.8) years. The control group was assembled from an equal number of case-matched patients from each institution who underwent an operation between February 2013 and December 2016. Patient and surgery characteristics of study and control cases are presented in Table 1 and Table 2. In the study group, 17 primary surgeons conducted the procedures, with a mean number of 7 cases (range, 1-38). For the control group, 15 primary surgeons were identified, with a mean number of 8 cases (range, 1-28).

Quantitative Technical Data

In the study group, a total of 59 hours 3 minutes of footage was recorded. The mean (SD) duration of 1 case recording was 31 (46) minutes. The total number of digital storage space occupied was 107 029 megabytes, with a mean (SD) size per case of 964 (1119) megabytes per case.

Primary Outcome

The number of adequate steps for the control and study groups is depicted in Table 3. Among the control cases overall, NR reflected the key moments adequately in mean (SD) 52.5% (18.3%) of procedure steps (631 of 1206). The adequacy of NR in the study group did not significantly improve after implementation of SVR, with an adequacy of 58.3% (19.9%) ($P = .07$). In the control group, the percentage of adequate steps for NR were as follows: introduction of trocars under vision, 42.2%; exploration, 62.9%; vascular control, 67.3%;

Table 1. Patient characteristics

Characteristic	No. (%) Study Cases (n= 113)	Historic control (n= 113)	*p* value
Age, mean (SD), y	66.30 (9.8)	67.80 (10.1)	.29
Women	35 (40.2)	34 (39.1)	.88
Height, mean (SD), cm	173.4 (10.0)	172.1 (9.7)	.32
Weight, mean (SD), kg	77.6 (14.8)	79.2 (15.2)	.48
BMI, mean (SD)	25.8 (4.0)	26.8 (4.5)	.14
ASA class			.78
ASA I	11 (12.6)	12 (13.8)	
ASA II	50 (57.5)	49 (56.3)	
ASA III	24 (27.6)	23 (26.4)	
ASA IV	2 (2.3)	1 (1.1)	
Missing	2 (2.3)	0	
Charlston Comorbidity Index			.72
None (0)	35 (40.2)	41 (47.7)	
Low (1-2)	42 (48.3)	35 (40.7)	
Moderate (3-4)	7 (8.0)	6 (7.0)	
High (≥5)	3 (3.4)	4 (4.7)	
Diabetes Mellitus	18 (15.9)	16 (14.2)	.85
Hypertension	48 (42.5)	52 (46.0)	.69
History of			
Cardiac disease	22 (19.5)	31 (27.4)	.21
Pulmonary disease	24 (21.2)	17 (15.0)	.30
Renal disease	9 (8.0)	8 (7.1)	1.00
Prior abdominal and/or pelvic surgery	28 (24.8)	37 (32.7)	.24
Metastasic disease	4 (3.5)	5 (4.4)	.90

ASA American Society of Anesthesiologists, *BMI* Body Mass Index (calculated as weight in kilograms divided by height in meters squared)

mobilization and resection, 35.1%; creation of anastomosis, 49.2%; and closure, 57.9%. For the study group, surgeons recorded a mean of 85.5% (16.0%) of the relevant key moments during surgery. After review, these recorded key moments were considered adequate in 78.5% (16.5%) of the cases, significantly higher than the NR of both control and study groups (52.5% [18.3%], P<.001 and 58.3% [19.9%], P<.001, respectively). In the study group, the percentage of adequate steps for SVR and SVR combined with NR, respectively, were as follows: introduction of trocars under vision, 84.5% and 85.5%; exploration, 79.4% and 88.5%; vascular control, 74.8% and 83.7%; mobilization and resection, 79.7% and 84.2%; creation of anastomosis, 76.1% and 83.0%; and closure, 79.0% and 85.7%. With these findings, the adequacy of the reviewed SVR was significantly higher than that of NR

Table 2. Surgery characteristics

Characteristic	No. (%) Study Cases (n= 113)	Historic control (n= 113)	*p* value
Type of laparoscopic surgery			
Right hemicolectomy	40 (35.4)	40 (35.4)	>.99
Transverse colectomy	1 (0.9)	1 (0.9)	
Left hemicolectomy	11 (9.7)	11 (9.7)	
Sigmoidectomy	28 (24.8)	28 (24.8)	
LAR / APR	33 (29.2)	33 (29.2)	
Surgery duration, mean (SD), min	147 (62.7)	146 (62.4)	.95
Operator function			.004
Surgeon	85 (75.2)	79 (69.9)	.46
Fellow	17 (15.0)	32 (28.3)	.02
Resident	11 (9.7)	2 (1.8)	.02
Stoma	21 (20.0)	26 (23.0)	.51
Stoma type			
Loop ileostomy	12 (57.1)	15 (57.7)	<.99
End colostomy	8 (38.1)	10 (38.5)	
Other	1 (4.8)	1 (3.8)	
Anastomosis type			
Side-to-side	59 (56.7)	46 (43.4)	.19
Side-to-end	30 (28.8)	36 (34.0)	
End-to-side	0	3 (2.8)	
End-to-end	7 (6.7)	10 (9.4)	
None	8 (7.7)	11 (10.4)	
Missing	9 (8.0)	7 (6.2)	

LAR Low Anterior Resection, APR Abdominoperineal Resection

of both study and control cases (58.3% [19.9%] and 52.5% [18.3%], respectively; both P<.001 with Wilcoxon signed-rank test).

When SVR was combined with NR, a mean percentage of adequate steps of 85.1% (14.6%) was achieved, which was a significant increase from both the NR and the reviewed SVR (P<.001 for both). Figure 1 delineates the reporting adequacy for each of the key moments per documentation method.

A total of 1213 applicable steps among the procedures of the study group could be documented on SVR or NR. Overall, 97 steps (8.0%) were checked on the CRF as having been recorded, yet they were not adequately perceived. Furthermore, 80 steps (6.6%) were described on the NR but were not observed on SVR. A total of 322 steps (26.5%) were adequately seen on the SVR, but were inadequately described on the NR. This disparity

Table 3. Number of Adequate Steps

Procedure steps	No. Adequate steps/No. Total steps (%) Historic control, NR		Study Cases SVR		SVR and NR		*p* value[a]	*p* value[b]
Step 1. Introduction of trocars under vision	46/109	(42.2)	93/110	(84.5)	94/110	(85.5)	< .001	< .001
Step 2. Exploration	205/326	(62.9)	255/321	(79.4)	284/321	(88.5)	< .001	< .001
Step 3. Vascular control	103/153	(67.3)	110/147	(74.8)	123/147	(83.7)	.69	.045
Step 4. Mobilization and resection	91/259	(35.1)	212/266	(79.7)	224/266	(84.2)	< .001	< .001
Step 5. Creation of Anastomosis	124/252	(49.2)	201/264	(76.1)	219/264	(83.0)	< .001	< .001
Step 6. Closure	62/107	(57.9)	83/105	(79.0)	90/105	(85.7)	.009	< .001
Total	631/1206	(52.3)	954/1213	(78.6)	1034/1213	(85.2)	< .001	< .001

NR narrative operative report; *SVR* systematic video recording

[a] Control group; NR vs study group SVR

[b] Control group; NR vs study group NR with SVR

Table 4. Discrepancies between video recordings, video review and narrative operative report within 113 study group cases

Procedure steps of study cases (n=113)	Total steps	Recorded but not seen[a]	Described but not seen[b]	Seen but not described[c]
Step 1 - Introduction of trocars	110	8 (7.3)	1 (0.9)	45 (40.9)
Step 2 - Exploration	321	37 (11.5)	29 (9.0)	65 (20.2)
Step 3 - Vascular control	147	10 (6.8)	13 (8.8)	20 (13.6)
Step 4 - Mobilization and resection	266	14 (5.3)	12 (4.5)	103 (38.7)
Step 5 - Anastomosis	264	17 (6.4)	18 (6.8)	71 (26.9)
Step 6 - Closure	105	11 (10.5)	7 (6.7)	18 (17.1)
Total steps	1213	97 (8.0)	80 (6.6)	322 (26.5)

Data are presented as *N* (%) of adequate steps.

[a] Steps stated to have been recorded by primary surgeon, but not seen upon video review.

[b] Steps adequately described in the narrative operative report, but not adequately seen upon video review.

[c] Steps adequately seen upon video review, but not adequately described in the narrative operative report

predominantly comprised the steps regarding introduction of trocars and mobilization and resection (40.9% and 38.7%, respectively). The full list of discrepancies can be found in Table 4.

Secondary Outcome

Postoperative outcomes and pathologic outcomes are summarized in Table 5 and Table 6. Aside from a significant difference regarding the postoperative length of stay in favor of the study group (8.0 [7.7] vs 8.6 [6.8] days; P = .03), no significant differences were found

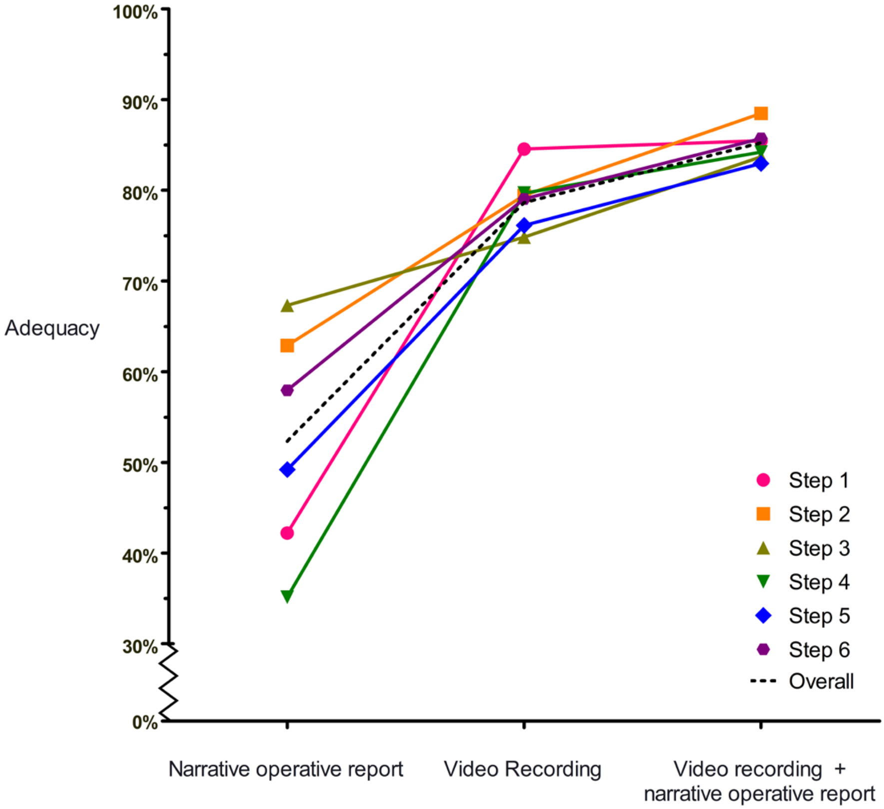

Figure 1. Reporting adequacy per documentation method among study cases
Adequacy is defined as the percentage of adequate steps per total number of applicable steps
Step 1: Introduction of trocars under vision
Step 2: Exploration
Step 3: Vascular control
Step 4: Mobilization and resection
Step 5: Creation of Anastomosis
Step 6: Closure

between the study and historical control groups regarding postoperative and pathologic outcomes.

DISCUSSION

Ever since George Berci, as early as 1962, created the foundation for video-assisted endoscopic surgery, technological advancements have made it increasingly practical for health

Table 5. Postoperative outcomes

Outcome	No. (%) Study Cases (n= 113)	Historic control (n= 113)	*p* value
Postoperative complication[a]	49 (43.4)	45 (39.8)	.69
Clavien-Dindo[a]			.20
I	11 (22.4)	8 (17.8)	
II	26 (53.1)	24 (53.3)	
III	8 (16.3)	8 (17.8)	
IV	1 (2.0)	5 (11.1)	
V	3 (6.1)	0	
Surgical wound infection	9 (8.0)	6 (5.3)	.60
Intra-abdominal abscess	8 (7.1)	3 (2.7)	.22
Urinary tract infection	6 (5.3)	6 (5.3)	>.99
Respiratory tract infection	9 (8.0)	8 (7.1)	>.99
Cardiological complication	4 (3.5)	3 (2.7)	>.99
Neurological complication	4 (3.5)	9 (8.0)	.25
Thrombotic complication[b]	2 (1.8)	0	.50
Prolonged Postoperative Ileus	23 (20.4)	14 (12.4)	.15
Postoperative bleeding	1 (0.9)	2 (1.8)	>.99
Anastomotic leakage	2 (1.8)	6 (5.3)	.28
Hospital admission, median (IQR), d	8.0 (7.7)	8.6 (6.8)	.03
Readmittance ≤30 d postoperatively	9 (8.1)	4 (3.5)	.16

IQR Interquartile range.
[a] Grading according to Clavien-Dindo classification
[b] Deep venous thrombosis or Pulmonary embolism

care professionals to display and record multimedia of intraoperative surgical events.[19,20] These events are known to significantly affect surgical quality, and inadequate reporting has previously been linked to several unfavorable effects on postoperative care.[15,16] Despite its ever-growing availability, and taking into consideration that the current method of documenting surgical care is substandard in most cases, use of video documentation in the surgical setting is still limited. To our knowledge, this trial, along with the preceding pilot study, has been the first to prospectively investigate the benefits of SVR relevant to quality and safety in colorectal cancer surgery.

In this study, we demonstrated a significant increase in reporting quality regarding the intraoperative key moments of laparoscopic colorectal oncologic surgery by using intraoperative SVR. Only 52.5% of the steps reported in NR were adequately described. This finding is consistent with our pilot study and earlier published findings in surgery.[17,21-24] The steps that were most adequately described in NR were vascular control (67.3%), followed by explora-

Table 6. Pathologic outcomes

Outcome	No. (%) Study Cases (n= 113)	Historic control (n= 113)	*p* value
Tumor type			
Benign	2 (1.8)	1 (0.9)	
Pre-malignant	2 (1.8)	2 (1.8)	.85
Malignant	108 (96.4)	109 (97.3)	
Resection margin, mm			
<5	7 (7.1)	9 (9.6)	
6-9	3 (3.0)	4 (4.3)	.73
≥10	89 (89.9)	81 (86.2)	
Tumor size, median (IQR), cm	3.7 (1.9)	3.5 (1.9)	.59
Total lymph node yield, median (IQR), No.	17.7 (10.1)	16.8 (7.4)	.94
Tumor-positive lymph nodes, median (IQR), No.	0.9 (2.2)	1.0 (2.0)	.28
pT-category[a]			
pT0	3 (2.8)	2 (1.9)	
pT1	16 (14.7)	24 (13.0)	
pT2	30 (27.5)	29 (26.9)	.87
pT3	53 (48.6)	52 (48.1)	
pT4	7 (6.4)	11 (10.2)	
pN-category[b]			
pN0	80 (72.7)	74 (66.7)	
pN1	23 (20.9)	25 (22.5)	.44
pN2	7 (6.4)	12 (10.8)	

IQR Interquartile range; *pN* pathologic evaluation of regional lymph nodes; *pT* pathologic evaluation of primary tumor

[a] For pT categories, T0 indicates no evidence of primary tumor; T1, tumor invades submucosa; T2, tumor invades muscularis propria; T3, tumor invades through the muscularis propria into pericolorectal tissues; and T4, tumor penetrates to the surface of the visceral peritoneum or directly invades or is adherent to other organs or structures

[b] For pN categories, N0 indicates no regional lymph node metastasis; N1, metastasis in 1 to 3 regional lymph nodes; and N2, metastasis in 4 or more regional lymph nodes.

tion (62.9%). The least adequately reported step was mobilization and resection (35.1%). This step included the substeps regarding the description of the resection specimen and the identification of the left ureter in left-sided resections. A possible explanation of why this step is only adequately reported in one-third of the cases might be owing to the custom to not include a remark regarding the quality of the resection specimen in NR. This suggestion is supported by the fact that 38.7% of the steps regarding the mobilization and resection is seen on SVR, yet not adequately described on NR within the study group. Almost all NRs included the statement, "resection specimen sent to pathology," or similar phrasing. Undeniably an important step, the addition of this sole phrase to NR is nugatory, as the only information it provides regarding the resection specimen is that it has been sent for pathologic evaluation. Whether the specimen has been investigated before hand-off is unknown. It is necessary to inspect the surgical specimen after resection, determining whether the tumor has been completely removed and with a sufficient resection margin. If the resection margin is deemed to be compromised on inspection, the surgeon can still act on this discovery perioperatively, thereby preventing the patient from having to undergo reintervention.

The most adequately recorded step among SVR in the study group was introduction of trocars under vision (84.5%), followed by exploration (88.5%). The least adequately recorded step was vascular control (79.4%) followed by creation of the anastomosis (76.1%). Although significantly higher in adequacy than was documented in NR, 21.5% of all cases remained inadequately recorded by SVR alone. No significant difference was found between the adequacy of NR and SVR for the vascular control step. It was not until the 2 methods were combined that a significant difference between the control and study group was achieved. A possible explanation of this result is the fact that in most cases, resections were endoscopically assisted (extracorporeal resection, including transection of vascular structures). Therefore, only the phase in which the transection of the central vasculature occurred intracorporally was often recorded on the endoscopic camera.

In this study, it appears that SVR is superior to NR in laparoscopic colorectal surgery, with an overall improvement of 26.3 percentage points compared with NR alone. However, NR and SVR provided the best results when complementing each other. In this combination, the reporting adequacy increased to 85.2% of the total relevant key moments—an increment of 32.9 percentage points. The best contribution of NR to the documenting adequacy of SVR was done by the exploration and vascular control phases, enhancing the adequacy with an absolute difference of 9.0% and 8.8%, respectively, compared with SVR alone. Furthermore, 26.5% of all possible steps were adequately documented by SVR, but were not adequately described in the NOR, of which the steps regarding introduction of trocars and mobilization and resection contained the most disparity (40.9% and 38.7%, respectively). The percentage of the former is comparable to the result found in the study conducted by Wauben et al.[14]

Before the start of the study, it was expected that the participating surgeons' knowledge of the key moments that were to be recorded and the corresponding checklist was a risk of bias, resulting in a more complete NR. However, the introduction of the systematic approach and procedural recording using a checklist did not seem to have a significant association with NR adequacy. Therefore, the amount of bias caused by this knowledge seems negligible.

We decided to record video fragments aimed to capture the essence of the surgical procedure in contrast to full-length video encompassing the entire operation. This method was chosen so that surgeons were committed to consciously start and stop the process of recording these essential steps, with the potential of improving quality, also by way of the Hawthorne effect: an increase in performance owing to the individual's awareness that it is being recorded. Furthermore, the recording of video fragments diminishes the digital storage space necessary, allowing for manageable content.

Regarding the secondary outcomes, SVR does not seem to significantly alter short-term postoperative and pathologic outcomes. It is plausible that the fact that parts of the surgery were videotaped did not influence the surgical approach in such a manner that a significant change in postoperative outcomes occurs. Conversely, the fact that short-term postoperative and pathologic outcomes do not differ between study and control settings might also indicate that SVR does not impair surgeons in their performance. The significant difference of length of stay can be explained by other improvements in patient care since the inclusion period of the historical control group, which is outside the scope of this study.

As this study suggests, SVR is able to document surgical procedures in a more complete manner than NR, which adds to the overall availability of essential intraoperative information, in turn contributing to quality control and objectivity. On evaluation, any given reviewer is able to observe how and when certain events happened, instead of reading another's perception of the procedure (eg, the exact positioning, size, and relative anatomy of vascular structures ligated, rather than merely the phrase ligation of arterial supply). Even the surgeon who was present during surgery is able to benefit from this technique. For instance, a surgeon who is notified of tumor-positive resection margins may review the SVR to evaluate whether this inadequate resection was unavoidable or the particular dissection technique used during the surgery was suboptimal. When only an operative note is obtained, further evaluation of the technical aspects is impossible. But with SVR, one is able to reflect on his or her actions more thoroughly than during or directly after surgery.[25]

We foresee video documentation of surgical procedures becoming an essential part of surgery in the near future. Use of SVR is, however, intended as an extension to the written operative report—not a substitute. Surgeons' considerations to perform or omit certain steps during the surgical procedure are difficult to capture using only video. Also, for sake of practicality in daily practice, a written record should still be available.

Limitations

This study has limitations. Because the operative steps were consciously recorded in a number of short clips, a considerable amount of information, which, according to the intraoperative checklist is deemed nonessential, was not recorded. With this method, adverse events that might occur in these parts of the procedure are not recorded. Furthermore, this method of documentation is prone to human error, with a probability of missing data that could range from insignificant details (eg, starting the recording too late or stopping the recording too early) to entire procedures in which recording has been omitted. Ultimately, full-length video recording of surgical procedures would be more informative, as it will also encompass the possible adverse events that would have been disregarded otherwise and will be able to provide for thorough analysis of technical performance data.[26] However, regarding user convenience, the density of valuable information of full-length surgical recordings is low, often necessitating arduous review processes, particularly in major surgery. To address this inconvenience and make review of the surgical procedure more convenient for daily practice, real-time annotation of these key moments might be a solution for easier retrieval and incorporation in the operative report. Furthermore, owing to staff changes in the participating centers, predominantly fellowship positions, continuity of the primary surgeons between the study and control group is limited, making direct comparison between surgeons difficult.

Conclusions

Intraoperative SVR in laparoscopic colorectal cancer surgery as an adjunct to the NR appeared to be associated with better documentation of intraoperative essential steps of the procedure compared with the traditional NR alone. For the use SVR combined with NR in surgical practice, implementation studies are necessary to provide the most adequate and convenient manner of recording and using these images.

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