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ORIGINAL ARTICLE

Comparison of conventional access routes for right hemicolectomy in colon cancer—data from the DGAV StuDoQ registry

Christian Jurowich[1] · Sven Lichthardt[2] · Niels Matthes[2] · Caroline Kastner[2] · Imme Haubitz[2] · Andre Prock[1] · Jörg Filser[1] · Stefan Löb[2,3] · Christoph-Thomas Germer[2,3] · Armin Wiegering[2,3,4]

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Abstract

Background Access for right hemicolectomy can be gained by median or transverse incision laparotomy. It is not known whether these routes differ with regard to short-term postoperative outcomes.

Methods Patients in the DGAV StuDoQ|ColonCancer registry who underwent open oncological right hemicolectomy by median ($n = 2389$) or transverse laparotomy ($n = 1311$) were compared regarding Clavien–Dindo classification (CDC) complications (primary endpoint) as well as specific postoperative complications, operation time, length of stay, and MTL30 status (secondary endpoints).

Results A total of 3700 StuDoQ registry patients underwent open oncological right hemicolectomy by median ($n = 2389$) or transverse laparotomy ($n = 1311$) without additional interventions. The median and transverse access routes did not differ regarding CDC complication rates (CDC > =3a: 13.1% vs. 12.6%; $p = 0.90$). However, univariate and multivariate analyses showed that operation times (OR 0.71, 95% CI 0.62–0.81; $p < 0.001$), length of stay (OR 0.69, 95% CI 0.6–079; $p < 0.001$), and MTL30 (OR 0.7, 95% CI 0.61–0.81, $p < 0.001$) were significantly reduced in the transverse laparotomy group.

Conclusions For oncological right hemicolectomy, open transverse upper abdominal laparotomy appears to be superior to median laparotomy in short-term course.

Keywords Abdominal laparotomy · Complete mesocolic excision · Colon cancer · Tranverse incision · Midline incision · Right side hemicolectomie

Introduction

The surgical demands for oncologic right hemicolectomy have increased dramatically since the introduction of complete mesocolic excision (CME) almost 10 years ago [1]. The extended lymph and soft tissue dissection especially in the area of the superior mesenteric vein requires more refined surgical skills and greater subtlety [2]. Although several recent studies have shown that with the appropriate expertise oncologic right hemicolectomy can be safely performed minimally invasively even given the greater demands of CME and that it is certainly beneficial [3–5], no uniform minimally invasive technique currently exists [6]. Unlike left hemicolectomy or rectal resection, the large majority of right hemicolectomies in Europe are performed in open technique [7]. Open right hemicolectomy can be performed either by right transverse upper abdominal laparotomy or median laparotomy. Both access routes offer adequate access to the surgical field, though transverse laparotomy is thought to offer some advantages such as lower

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✉ Armin Wiegering
wiegering_a@ukw.de

[1] Department of General, Visceral and Thoracic Surgery, Kreiskliniken Altötting / Burghausen, Vinzenz-von-Paul-Str. 10, 84503 Altötting, Germany

[2] Department of General, Visceral, Transplantation, Vascular and Pediatric Surgery, University Hospital, University of Wuerzburg, Oberduerrbacherstr. 2, 97080 Würzburg, Germany

[3] Comprehensive Cancer Centre Mainfranken, University of Wuerzburg Medical Center, Josef-Schneiderstr. 6, 97080 Würzburg, Germany

[4] Department of Biochemistry and Molecular Biology, University of Wuerzburg, Würzburg, Germany

postoperative pain, less compromising of pulmonary function, and better cosmetic results [8, 9]. Moreover, the rate of incisional hernias appears to be lower for transverse than for median laparotomy [8].

A systematic review in 2014 comparing transverse and median versus minimally invasive techniques for right hemicolectomy, however, found that none of the routes had a significant advantage over the others [10]. This was true especially with regard to the short-term postoperative results.

Since in real-life practice large differences often exist between study results and results that can actually be attained, the present study aims to investigate the impact of conventional surgical access routes on short-term postoperative results using data from the Documentation and Quality Center|Colon (StuDoQ|Colon) registry of the German Society for General and Visceral Surgery (DGAV). The primary endpoint was the rate of postoperative CDC complications [11]; secondary endpoints were wound infections [12], anastomotic insufficiency [13], postoperative ileus, specific postoperative complications, non-surgical complications, operation time, length of stay, and MTL30 a newly validated endpoint parameter specific to the German health care system that combines mortality, transfer to higher level hospital, and length of stay beyond 30 days postoperative [14].

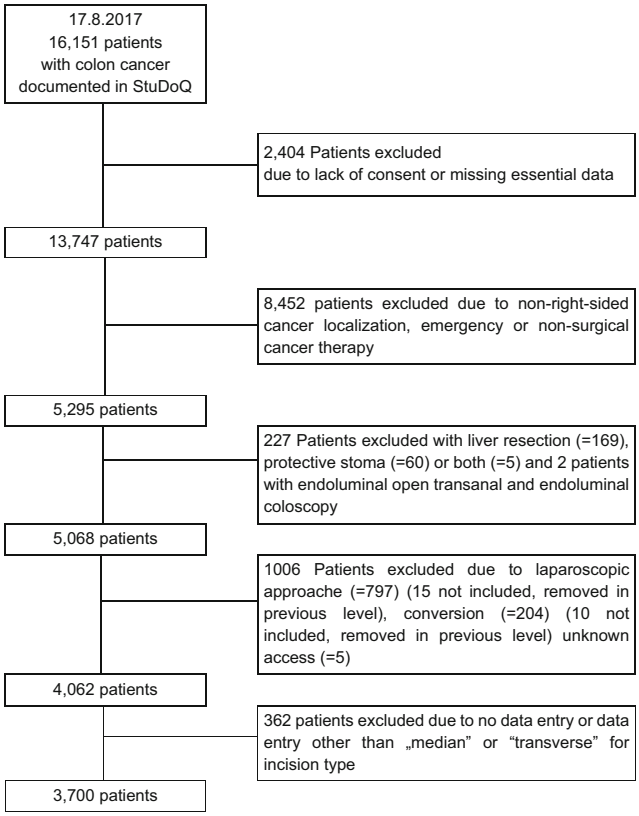

Fig. 1 Criteria for inclusion

Methods

The StuDoQ|ColonCancer registry is a voluntary prospectively created database for colon cancer surgery established by the DGAV in January 2010 (www.dgav.de/studoq, www.en.studoq.de). It was designed to facilitate assessment of quality and risk factors in colon cancer surgery in Germany.

Informed consent and data safety procedures were approved by the Society for Technology, Methods, and Infrastructure for Networked Medical Research (http://www.tmf-ev.de), and publication guidelines were established by the DGAV (http://www.dgav.de/studoq/datenschutzkonzept-und-publikationsrichtlinien.html).

Data from participating centers are entered in pseudonymized form using a browser-based tool and subjected to automatic plausibility and cross-checking controls.

For this study, all patients with right-sided or extended right hemicolectomy were identified from the registry and relevant demographic data, comorbidities, and information on operations, histology, and perioperative course were extracted in anonymized form for analysis.

Patients undergoing emergency surgery, non-right-sided resection, laparoscopic right-sided resection, endoluminal resection, simultaneous liver metastasis resection or creation of any kind of ostomy were excluded (Fig. 1). CME should be performed according to the description of Hohenberger et al. [1].

Anastomotic leakage needing intervention [13, 15], surgical site infections needing reopening of the wound, Clavien–Dindo classification, burst abdomen, reoperation, and in-hospital mortality were evaluated, along with any need for unplanned postoperative ventilation lasting more than 48 h, pneumonia, length of stay, and readmission. Overall postoperative morbidity was summarized according to the Clavien–Dindo grades as none (grade 0), minor (grades 1–2), major (grades 3a–4), and death (grade 5).

Patients were grouped according to the type of laparotomy (median vs. transverse). The registry does not contain specific details on wound closure, or type of material or drains used.

Primary endpoint was any complication according to Clavien–Dindo classification (CDC). Secondary endpoints were specific postoperative complications, postoperative ileus, reoperation, length of postoperative hospital stay, operation time, and MTL30 status [14].

Statistical analyses were two-sided with a significance level of 0.05. Continuous variables were expressed as medians with ranges and categorical parameters as absolute frequency and percentage. Univariate analysis was performed using the chi-squared and Mann-Whitney tests. Multivariate analysis was performed by Cox regression. All variables with a p value < 0.1 in univariate analysis were included in the multivariate analysis. Extended hemicolectomy is defined as any right-sided colon resection including ligation of the middle colic

artery and vein. Hospitals included in this study data are listed in Supplementary Table 1.

Results

Of the 16,151 patients on file in the StuDoQ|ColonCancer in August 2017, 3700 met the criteria for inclusion in the present analysis (Fig. 1). Their average age was 73.3 years (range 27–98 years), 47.6% were male. All told, 2389 (64.57%) patients underwent median laparotomy, 1311 (35.43%) right transverse upper abdominal laparotomy. Cardiovascular comorbidities were significantly more common in the median laparotomy group (Table 1). Patients in the median laparotomy group also had a significantly higher tumor stage (UICC stage, pT stage, pN stage) (Table 1).

The operation time (131.66 min ± 48.93 min vs. 125.20 min ± 47.58 min; $p < 0.000005$) and length of stay (14.1 days vs 12.5 days; $p = 0.001$) were significantly longer in the median laparotomy group. Extended hemicolectomy and CME were more common, and anastomoses were

Table 1 Preoperative patient characteristics by access route

Variable	Median laparotomy ($n = 2389$)	Transverse laparotomy ($n = 1311$)	p value
Age, average ± SD. years	73.6 ± 10.4	72.7 ± 11.3	0.078
Sex			
Male, *n* (%)	1110 (46.5%)	652 (49.7%)	0.057
Female, *n* (%)	1279 (53.5%)	659 (50.3%)	
BMI (kg/m^2)	26.8 ± 5.3	26.8 ± 5	0.58
Smoking, *n* (%)	159 (7.6%)	94 (7.7%)	0.94
ASA status, *n* (%)			
1	98 (4.1)	61 (4.7)	0.45
2	989 (41.4)	563 (42.9)	
3	1200 (50.2)	644 (49.1)	
4	98 (4.1)	42 (3.2)	
5	4 (0.2)	1 (0.1)	
Functional status, *n* (%)			
Independent	2074 (86.8)	1155 (88.1)	0.38
Partially dependent	268 (11.2)	137 (10.5)	
Totally dependent	47 (2.0)	19 (1.5)	
Comorbidities, *n* (%)			
Diabetes (IDDM and NIDDM)	602 (25.2)	290 (22.1)	0.09
Hypertension	1655 (69.3)	839 (64.0)	0.001
History of severe COPD	171 (7.2)	80 (6.1)	0.22
Chronic steroid use	36 (1.5)	22 (1.7)	0.69
Dialysis	24 (1.0)	9 (0.7)	0.32
Disseminated cancer	165 (6.9)	69 (5.3)	0.046
Weight loss (> 10% body weight)	318 (13.3)	143 (10.9)	0.03
Alcohol abuse	56 (2.3)	48 (3.7)	0.023
UICC stage			
1	478 (20.1)	307 (23.6)	< 0.001
2	907 (38.2)	502 (38.5)	
3	662 (27.9)	367 (28.2)	
4	328 (13.8)	127 (9.8)	
pT stage			
T0–2	550 (23.1)	359 (27.5)	< 0.001
T3/4	1.835 (76.9)	948 (72.5)	
pN stage			
N0	1444 (60.6)	834 (63.8)	0.03
N1/2	939 (39.4)	473 (36.2)	

Table 2 Study population surgical characteristics

Variable	Median laparotomy ($n = 2389$)	Transverse laparotomy ($n = 1311$)	p value
Total operation time (min)	131.7 ± 48.9	125 ± 47.6	< 0.001
Extended resection, n (%)	353 (14.8)	157 (12)	0.017
Anastomosis, n (%)			
Hand sewn	1543 (64.6)	930 (70.9)	< 0.001
Stapler	846 (35.4)	381 (29.1)	
CME, n (%)			
Yes	1857 (83.6)	935 (80.0)	0.01
No	365 (16.4)	234 (20.0)	
Length of hospital stay (days)	14.1 ± 9.9	12.5 ± 7.72	< 0.001
MTL30 positive	242 (10.1)	104 (7.9)	0.026
Death	84 (3.52)	39 (2.97)	0.38

significantly more often created by stapler than hand sewn (Table 2). The MTL30 as surrogate marker of postoperative course was significantly higher in the median laparotomy group (10.1 vs. 7.9; $p = 0.026$) (Fig. 2).

No differences in short-term postoperative course were found between the two groups regarding overall CDC complication rates (primary endpoint) (CDC 0: 63.3% vs. 63.4%; CDC 1–2: 23.6% vs. 24.0%; CDC 3a–5: 13.1% vs. 12.6%; $p = 0.9$).

Postoperative ileus (2.9% vs. 5.8%; $p = < 0.001$) and general internal complications (12.2% vs. 16.5%; $p < 0.001$) (secondary endpoint) occurred significantly more often in the transverse laparotomy group. Conversely, in the median laparotomy group, significantly more patients developed a burst abdomen (4.7% vs. 2.8%; $p = 0.004$) (Table 3).

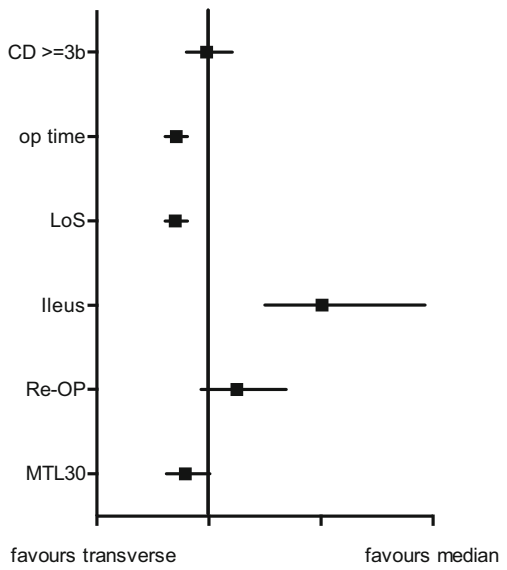

Fig. 2 Adjusted odds ratios for outcomes by type of laparotomy

Multiple regression analysis

Multivariate analysis revealed the following factors predictive of short-term outcomes: age (OR 1.17; CI 1.05–1.3; $p < 0.006$), ASA score (OR 1.87; CI 1.57–2.22; $p < 0.001$), and BMI (OR 1.13; CI 1.03–1.23; $p < 0.006$). The surgical access route was not found to be a predictive factor for complications. Independent predictors of operation time were extended resection and high BMI. Use of staplers and transverse laparotomy were predictors of shorter operation time. Postoperative length of stay was negatively influenced by age, ASA score, BMI, and median laparotomy (Table 4). Occurrence of postoperative Ileus was negatively influenced by patient age and transverse laparotomy (Table 5).

Discussion

The present analysis offers the first registry-based comparison of conventional surgical access routes (median versus transverse) for oncologic right hemicolectomy with regard to short-term postoperative results. Although the minimally invasive surgical technique is being increasingly used in oncologic surgery for right-sided colon cancer [16], in general practice, over 50% of patients still undergo conventional surgery [7]. Moreover, important questions remain to be resolved with regard to minimally invasive surgery [17].

Based on data from 3700 patients, we could show for the first time that under real-world conditions the choice of median versus transverse access route does not impact the number and severity of short-term postoperative CDC complications (primary endpoint). Specific surgical complications (secondary endpoints) were unequally distributed between the two groups, which suggests that there was no impact on the overall complication rate (CDC). The median laparotomy group, however, had a higher rate of burst abdomens, a more serious

Table 3 Unadjusted postoperative complications by access route

Variable	Median laparotomy ($n = 2389$)	Transverse laparotomy ($n = 1311$)	p value
Anastomotic leak, n (%)	88 (3.68)	47 (3.59)	0.92
Burst abdomen	113 (4.73)	37 (2.82)	0.004
Postoperative ileus, n (%)	69 (2.89)	76 (5.8)	< 0.001
Return to operating room, n (%)	238 (9.96)	123 (9.38)	0.35
Re-hospitalization	84 (3.52)	39 (2.97)	0.4
Internal complication	292 (12.2)	216 (16.5)	< 0.001
Superficial site infection, n (%)	219 (9.2)	156 (11.9)	< 0.01
Postoperative bleeding, n (%)	39 (1.63)	21 (1.6)	0.94
Clavien–Dindo, n (%)			
0	1509 (63.3)	830 (63.4)	0.9
1–2	562 (23.6)	314 (24.0)	
3–5	312 (13.1)	165 (12.6)	
Clavien–Dindo, n (%)			
0	1509 (63.32%)	830 (63.41%)	0.076
1	121 (5.08%)	55 (4.20%)	
2	308 (12.92%)	206 (15.74%)	
3a	133 (5.58%)	53 (4.05%)	
3b	158 (6.63%)	96 (7.33%)	
4a	53 (2.22%)	23 (1.76%)	
4b	23 (0.97%)	11 (0.84%)	
5	78 (3.27%)	35 (2.67%)	

complication than the wound infections whose rate was higher in the transverse laparotomy group. As a consequence, the median laparotomy group had a significantly longer length of stay. This accords with the results of Tanis et al., who in a prospective study comparing minimally invasive surgery, transverse upper abdominal laparotomy, and median laparotomy found the first two groups to have a significant advantage with regard to morbidity and length of stay [9].

The MTL30 [14], which as surrogate parameter for patients' status on day 30 postoperative is more sensitive than the single parameters death, transfer to another center or length of stay, was significantly elevated in the median laparotomy group.

Of interest in our own analysis are the clear differences in postoperative lengths of stay and positive MTL30 scores in patients with similar CDC rates. Considering modern perioperative treatment routines, however, the postoperative lengths of stay appeared to be generally high, which may have diminished the access route-related differences. Minor complications, which can also increase length of stay, were relatively scarce in the present study; this may have been due to a documentation bias [18]. In this regard, the MTL30 appears to be the appropriate means for depicting the sum of complications of differing severity.

Patients in the median laparotomy group had more preexisting conditions and more advanced tumor stage. They were also more likely to undergo extended right hemicolectomy, which by its nature is associated with longer operation time. This may explain both the longer lengths of stay and longer operation times in univariate analysis. This

Table 4 Best-fit model for outcomes (multivariate)

	Clavien–Dindo ≥ 3b		Ileus	
	OR (95% CI)	p value	OR (95% CI)	p value
Median transverse	Ref 0.98 (0.8–1.21	0.87	Ref 2.10 (1.50–2.93)	< 0.001
Hemicolectomy ext. hemicolectomy	Ref 1.16 (0.88–1.52)	0.3	Ref 1.20 (0.75–1.91)	0.45
ASA I (per 1 ASA category)	Ref 1.86 (1.57–2.21)	< 0.001	Ref 1.37 (1.06–1.79)	0.016
BMI per 5 kg/m^2	Ref 1.13 (1.04–1.24	0.006	Ref 1.15 (0.99–1.33)	0.064
Age per 10 years	Ref 1.17 (1.05–1.30)	0.005	Ref 1.00 (0.84–1.19)	0.98

Table 5 Best-fit model for outcomes (multivariate)

	MTL30		Length of stay		Operation time	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Median transverse	Ref 0.79 (0.62–1.01)	0.065	Ref 0.69 (0.60–0.79)	< 0.001	Ref 0.71 (0.62–0.81)	< 0.001
Hemicolectomy ext. hemicolectomy	Ref 0.94 (084–1.32)	0.73	Ref 1.04 (0.86–1.27)	0.66	Ref 1.51 (1.24–1.82)	< 0.001
ASA I (per 1 ASA)	Ref 2.441 (1.97–2.94)	< 0.001	Ref 1.55 (1.38–1.75)	< 0.001	Ref 1.12 (0.99–1.25)	0.056
BMI per 5 kg/m^2	Ref 1.11 (0.99–1.22)	0.055	Ref 1.08 (1.02–1.16)	0.015	Ref 1.25 (1.17–1.33)	< 0.001
Age per 10 years	Ref 1.28 (1.12–1.46)	< 0.001	Ref 1.34 (1.25–1.44)	< 0.001	Ref 0.95 (0.89–1.01)	0.097

however could not be relativized in the multivariate analysis, which means that the median access route is inferior in this regard despite the differences in the initial population. In addition, in spite of the poorer cardiopulmonary risk profile in this group they had even fewer internal complications, which suggests that the longer lengths of stay are attributable to the median laparotomy, the pre-existing conditions, or higher tumor stage.

A Cochrane Review from 2005 (revised in 2011) encompassing 19 studies with a total of 3464 patients compared median laparotomies with transverse laparotomies for abdominal pathologies. Unlike the present analysis, however, the review included both malignant and benign disease entities [19]. The authors could show that pulmonary function as measured by FEV1 improved in the transverse laparotomy group while the need for pain medications lessened. Neither parameter, however, affected the rate of pulmonary complications.

The only double-blind randomized controlled study included here examine the short-term postoperative outcomes (median versus transverse) (POVATI: ISRCTN60734227) found no overall difference in 30-day mortality, rate of pulmonary complications or burst abdomens [20]. In it, though, colon resections comprised fewer than 20% of procedures; 50% of the analyzed interventions were pancreas operations, which are per se associated with a low rate of postoperative wound healing disorders.

As in our study, however, the transverse laparotomy group had a higher rate of wound infections than the median laparotomy group.

Santoro et al. reviewed 7 studies with a total of 350 patients in which the access routes for right hemicolectomy (open median/open transverse/laparoscopic) were specifically reviewed. The authors conclude not only that the differences in open access routes are minimal, but that also laparoscopy has only a slight advantage over the open procedures, especially in comparison to the transverse incision.

In summary, although transverse laparotomy for oncologic right hemicolectomy is associated with a higher rate of wound healing disturbances, it is superior to median laparotomy with regard to postoperative length of stay and MLT30 despite the same rate of complications.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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