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ORIGINAL PAPER

Colorectal resection in end-stage renal disease (ESRD) patients: experience from a single tertiary center

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ABSTRACT

Background: End-stage renal disease (ESRD) and renal replacement therapy (RRT) are important risk factors for post-operative morbidity and mortality but remains poorly reported in colorectal surgery. This study aims to evaluate postoperative outcomes of ESRD patients under RRT undergoing colorectal resection.

Methods: All ESRD patients under RRT who underwent colorectal resection between 2006 and 2019 were retrospectively reviewed. Perioperative outcomes were analysed, such as risk factors of postoperative complications.

Results: Forty-two patients were analysed, including 27 emergency and 15 elective surgeries. The most frequent indication was acute colonic ischemia for emergency and malignancy for elective procedures. Laparoscopic approach was used in 12 patients (29%), without difference between elective and emergency groups. Postoperative severe complications rate (including deaths) was 50% (21/42), including 56% (15/27) and 40% (6/15) in emergency and elective groups, respectively ($p = .334$). Anastomotic leak was observed in 3 of the 23 patients (13%) undergoing digestive anastomosis, (1 in emergency and 2 in elective groups, $p = .246$). The postoperative mortality rate was 29%, not significantly different between groups. The median hospital stay was 14.5 days (8–42). At univariate analysis, history of cardiac event ($p = .028$) and open approach ($p = .040$) were associated with severe complications, and ASA score >3 ($p = .043$), history of cardiac event ($p = .001$) and diabetes ($p = .030$) associated with mortality.

Conclusions: Colorectal surgery in ESRD patient exposes to high risk of morbidity and mortality, even in the elective setting, especially in patients with comorbidities like cardiac event and diabetes. Careful patient selection and closed management is required in such fragile patients.

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Colorectal surgery; end-stage renal disease; dialysis; renal replacement therapy

Introduction

End-stage renal disease (ESRD) is the last and non-reversible stage of chronic kidney disease and the number of patients requiring renal replacement therapy (RRT) increases growingly, currently around 2.5 million and projected to double by 2030 [1]. In 2016, there were 726,331 reported cases of ESRD in the US, and that number grows by 20,000 cases every year [2]. The most frequent causes of ESRD are diabetes mellitus and high blood pressure, comorbidities commonly encountered in the population [3]. This is a life-threatening condition with an estimated 5-year survival of 35% and annual mortality around 20%, mainly due to cardiovascular disease [3,4]. Indeed, renal failure is associated with accelerated atherogenesis, and uremia is associated with increased risk of surgical complications due to poor wound healing, sepsis and bleeding [3,5]. However, ESRD patients are more likely to have other significant comorbidities and therefore, renal failure could disproportionately contribute to the high rate of postoperative adverse outcome in the various reported series, including after colorectal surgery [6].

ESRD and RRT represent a challenge for the surgeon when faced with a patient in need for emergency or elective surgery. While the overall mortality after colorectal surgery in the general population ranges from 1 to 6% [5], the reported postoperative mortality and morbidity for ESRD patients undergoing elective colorectal surgery is around 6–10% and 12–15% respectively rising to 47–50% and 62–70% in emergency situations [7]. Although ESRD patients are more and more frequent, it still represents a small part of the general

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population and series of patients on dialysis undergoing colorectal surgery remain small and scarce [7–9]. Accordingly, still little is known on how to best evaluate and prepare these patients for surgery.

Herein we reported our experience on ESRD patients with RRT who underwent colorectal surgery in a single tertiary center.

Methods

All patients receiving chronic RRT undergoing a colic or rectal resection between 2006 and 2019 in CHU de Québec (Québec, Canada) were retrospectively reviewed and analysed. Data concerning patient's comorbidities, demographics, surgical procedure, postoperative complications and deaths were collected. The present study was approved by the Institutional Review Board and was performed in accordance with the precept of the Declaration of Helsinki.

Surgical colorectal procedures included total colectomy, right hemicolectomy, sigmoidectomy, Hartman's procedure, low anterior resection and abdomino-perineal resection. Patients with renal transplant were excluded as well as patients requiring only postoperative dialysis due to acute renal insufficiency. Operative risk and comorbidities were evaluated according to the American Society of Anesthesiology (ASA) physical score [10] and the Charlson's Comorbidity Index (CCI) [11]. Baseline preoperative creatinine (μm/l), urea (mmol/l), albumin (g/l) and hemoglobin (g/l) levels were recorded. Surgery in emergency was considered as unplanned surgery performed within 24 h of the diagnosis.

Postoperative surgical complications were graded according to the Clavien-Dindo classification [12]. Complications were divided into cardiac events (myocardial infarction and arrhythmia), pulmonary edema, thromboembolic events, sepsis (including pulmonary and urinary tract infection), deep surgical site infection (SSI), wound infection, anastomotic leak and bleeding.

Statistical analysis

All data were expressed as median values with interquartile range and frequency with percentages. Comparison of continuous variables was made using Student's t test or the Mann–Whitney *U*-test where appropriate. Chi-square was used for comparing qualitative variables. Two-sided $p \leq .05$ was considered statistically significant.

Results

Patients' characteristics

We identified 42 patients with ESRD on chronic dialysis who underwent colorectal surgical resection during the study period (Table 1). The median age at surgery was 70 (± 13) years old with a male: female ratio of 2 (28/14). Twenty-nine patients

Table 1. Patients' baseline characteristics.

	Total ($n = 42$)	Elective surgery ($n = 15$)	Emergent surgery ($n = 27$)	*p* Value
Sex ratio (m/f)	2.0 (28/14)	2.0 (10/5)	2.0 (18/9)	1.000
Age, y (median ± IQR)	70 (± 13)	76 (± 11)	68 (± 12.5)	.193
ASA score, n (%)				
3	33 (79)	14 (93)	19 (70)	.082
4 and 5	9 (21)	1 (7)	8 (30)	
Comorbidities, n (%)				
Peripheral vascular disease	18 (43)	4 (27)	14 (52)	.114
Cardiac events	25 (60)	5 (33)	20 (74)	.010
High blood pressure	37 (88)	12 (80)	25 (93)	.227
Diabetes mellitus	18 (43)	5 (33)	13 (48)	.353
Previous abdominal surgery	23 (55)	8 (53)	15 (56)	.890
Charlson Comorbodity Index, n (%)[a]				
<6	21 (50)	9 (60)	12 (44)	.228
≥6	20 (48)	5 (33)	15 (56)	
Type of dialysis, n (%)				
Hemodialysis	29 (69)	10 (67)	19 (70)	.804
Peritoneal dialysis	13 (31)	5 (33)	8 (30)	
Dialysis time before surgery, m (median ± IQR)	20 (± 28)	27 (± 54)	18 (± 23)	.097
Indication for surgery, n (%)				
Cancer	11 (26)	9 (60)	2 (7)	.001
Acute colonic ischemia	13 (31)	1 (7)	12 (44)	.011
Diverticulitis	12 (29)	4 (27)	8 (30)	.839
Other	6 (13)	1 (7)	5 (19)	.195
Preoperative laboratory tests (median ± IQR)				
Creatinine levels, μm/L	511 (± 319)	420 (± 565)	518 (± 244)	.694
Urea levels, mmol/L	13.7 (± 7.1)	13.1 (± 8)	16 (± 7)	.590
Albumin levels, g/L	36 (± 11)	36 (± 13)	36 (± 11)	.788
Haemoglobin levels, g/L	99 (± 21)	95.5 (± 19.8)	100 (± 16.5)	.626

[a]1 missing data.

were on hemodialysis and 13 on peritoneal dialysis. Operative risk evaluation classified 9 patients (21%) as in life-threatening condition (ASA 4 or 5). Vascular diseases were the commonest comorbidities with 37 patients (88%) presenting with high blood pressure and 18 (43%) with a history of peripheral vascular disease or cerebrovascular disease. Twenty-five patients (60%) had experienced a cardiac event and 18 (43%) suffered from diabetes. Surgical indication was mostly malignancy in case of elective surgery ($p = .001$), while emergent surgery was mainly indicated for acute colonic ischemia ($p = .011$).

Surgical procedure and postoperative outcome

Overall, 8 total colectomies, 16 right colectomies, one transverse colon resection, 6 sigmoidectomies, 10 Hartman's procedures and one abdomino-perineal resection were performed (Table 2). Emergent procedure was required in 27 patients (64%). Laparoscopic approach was used in 12 patients (29%), without any difference in elective and emergent groups. Twenty-three patients (55%) had primary anastomoses, 11 during elective surgeries and 12 during emergent ones. There were 14 ileocolic anastomosis, 7 colocolic anastomosis, and 2 ileorectal anastomosis. Diverting stomas were not used in any patient. Twelve anastomoses were performed using surgical stapler and 10 were handsewn (1 missing data).

Overall postoperative severe complications rate (Dindo-Clavien 3-4-5) was 50% (21/42), including 56% (15/27) and 40% (6/15) in the emergency and elective groups, respectively ($p = .334$). Complications included myocardial infarction ($n = 11$), pulmonary edema ($n = 8$), cardiac arrhythmia ($n = 5$), intraabdominal hemorrhage ($n = 3$), sepsis ($n = 9$), deep SSI ($n = 9$), wound infection ($n = 3$), and thromboembolic event ($n = 2$), several patients experiencing multiple complications. Anastomotic leakage was observed in 3 of the 23 patients (13%) with digestive anastomosis: after elective surgery in 2 (one sigmoidectomy and one right hemicolectomy for malignancies) and after an emergent total colectomy with ileorectal anastomosis for acute ischemic colitis. Reoperation rate was 14% (6/42), including 3 for anastomotic leakage, and 3 for intra-abdominal bleeding.

The postoperative mortality rate was 29% (12/42), including 9 and 3 patients in emergency and elective settings, respectively ($p = .359$), with a median time to death of 15 days (8–24). The causes of death within 30 days were postoperative refractory shock ($n = 2$), early postoperative respiratory insufficiency ($n = 1$), cardiogenic shock ($n = 2$), septic shock ($n = 3$) including one with peritonitis from anastomotic leak ($n = 1$), terminal renal

Table 2. Surgical details and postoperative outcomes.

	Total ($n = 42$)	Elective surgery ($n = 15$)	Emergent surgery ($n = 27$)	p Value
Intraoperative data				
Surgical approach, n (%)				
Laparoscopy	12 (29)	5 (33)	7 (26)	.611
Laparotomy	30 (71)	10 (67)	20 (74)	
Surgical procedure, n (%)				
Total colectomy	8 (19)	1 (7)	7 (26)	
Right colectomy	16 (38)	6 (40)	10 (37)	
Sigmoidectomy	6 (14)	5 (33)	1 (4)	
Hartmann's procedure	10 (24)	2 (13)	8 (30)	
Abdomino-perineal resection	1 (2)	1 (7)	0	
Transverse colectomy	1 (2)	0	1 (4)	
Digestive continuity, n (%)				
End-stoma	19 (45)	4 (27)	15 (56)	.071
Primary anastomosis	23 (55)	11 (73)	12 (44)	
Postoperative course				
Dindo-Clavien classification, n (%)				
≤ 2	21 (50)	9 (60)	12 (44)	.580
3–4	9 (21)	3 (20)	6 (22)	
5	12 (29)	3 (20)	9 (33)	
30-days mortality, n (%)	10 (24)	2 (13)	8 (30)	.235
Postoperative complications, n (%)				
Hemorrhage	3 (7)	2 (13)	1 (4)	.246
Anastomotic leakage	3 (7)	2 (13)	1 (4)	.246
Deep SSI	9 (19)	2 (13)	7 (22)	.341
Wound infection	3 (7)	0	3 (11)	.180
Pulmonary edema	8 (19)	2 (13)	6 (22)	.482
Myocardial infarction	11 (26)	2 (13)	9 (33)	.158
Cardiac arrhythmia	5 (12)	3 (20)	2 (7)	.227
Thromboembolic event	2 (5)	1 (7)	1 (4)	.666
Sepsis	9 (21)	4 (27)	5 (19)	.537
Reintervention, n (%)	6 (14)	4 (27)	2 (7)	.087
Transfusion, n (%)	25 (60)	8 (53)	17 (63)	.542
Postoperative hospital stay, d (median, Q1–Q3)	14.5 (8–42)	14.5 (7.5–45)	15 (11–42)	.946

insufficiency due to patient's desire to discontinuate hemodialysis after myocardial infarction ($n = 1$), and spinal cord ischemia ($n = 1$). Two other patients died after the 30 days, including one on postoperative day 78 after right open colectomy who needed reintervention for intraabdominal hemorrhage, then pulmonary edema, pneumonia, abdominal sepsis, wound infection, and at the end discontinuation of care according to patient's will. The other one died on postoperative day 106 following elective Hartmann procedure for diverticulitis, which developed multiple complications including postoperative bleeding, femoral pseudoaneurysm, perirenal hematoma, abdominal sepsis, Clostridium Difficile colitis, pericardial effusion and disseminated intravascular coagulation. The median postoperative length of stay was 14.5 days (8–42), and similar between elective and emergency groups ($p = .946$). Ten patients were hospitalized for more than 30 days.

Colorectal resection for diverticulitis

Four patients underwent elective surgery for diverticulitis, including two Hartman's procedures following which both patients died (one on postoperative day 9 at the 77-year-old patient's request to stop hemodialysis after myocardial infarction and severely altered general state, and the other one on postoperative day 106 after multiple complications), and two sigmoid resections with primary anastomosis with uneventful postoperative courses. In the emergent group, there were 7 Hartman's procedures and one sigmoidectomy with primary anastomosis. One patient died from cardiogenic shock and 3 presented severe postoperative complications: myocardial infarction ($n = 1$), pulmonary edema ($n = 1$) and deep SSI which required drainage ($n = 1$).

Risk factors of morbidity and mortality

At univariate analysis, history of cardiac event ($p = .028$) and open surgical approach ($p = .040$) were associated with severe postoperative complications (Dindo-Clavien ≥ 3) (Table 3). Factors associated with postoperative mortality were a preoperative ASA risk score > 3 ($p = .043$), previous history of cardiac event ($p = .001$) and diabetes mellitus ($p = .030$).

Discussion

Patients on RRT for chronic renal failure are fragile patients at high risk of complications after surgery, and therefore less willingly candidate for surgery. In the present study of a relatively large series of such rare patients undergoing colorectal surgical resection, we observed a high rate of postoperative severe morbidity (50%), including mortality which represents 29%, but similar to previously reported in the literature [6]. These patients usually have multiple comorbidities, and history of cardiac event as well as diabetes mellitus have been identified as risk factors of postoperative death at univariate analysis. Therefore, ESRD patients who need colorectal surgical resection should be carefully selected, prepared and closely managed in the postoperative period.

A few series on chronic dialysis patients undergoing colorectal surgery have been reported, most of them being based on nationwide databases, and described increased postoperative morbidity and mortality in these ESRD patients [5,6,12]. Some rare single center series were reported in the last twenty years on this topic [7,9]. Krysa et al. presented a series of 73 colorectal procedures, including 38 patients on RRT and 35 with a renal transplant. They reported a much increased risk of postoperative complications and mortality in case of emergent surgery (81% and 26% vs. 19% and

Table 3. Risk factors of postoperative severe morbidity (Dindo-Clavien $\geq$3) and mortality (univariate analysis).

	Postoperative severe morbidity			Postoperative mortality		
	OR	95% CI	*p* Value	OR	95% CI	*p* Value
Age (>70 vs. $\leq$70 y)	2.167	0.631–7.442	.217	1.400	0.362–5.414	.625
Gender (male vs. female)	0.650	0.178–2.369	.513	1.000	0.242–4.138	1.000
ASA score (3 vs. 4/5)	2.400	0.511–11.263	.259	4.643	0.978–22.035	.043
Cardiac events (yes vs. no)	4.267	1.134–16.050	.028	1.923	1.320–2.803	.001
Vascular disease (yes vs. no)	2.200	0.632–7.660	.212	2.418	0.616–9.487	.200
Diabetes mellitus (yes vs. no)	0.455	0.131–1.583	.212	0.175	0.033–0.938	.030
Previous abdominal surgery (yes vs. no)	1.788	0.523–6.106	.352	2.000	0.494–8.089	.327
Dialysis type (hemo- vs. peritoneal dialysis)	0.800	0.216–2.969	.739	2.895	0.534–15.689	.205
Indication of cancer (yes vs. no)	0.471	0.114–1.942	.292	0.467	0.085–2.573	.375
Indication of ischemic colitis (yes vs. no)	1.969	0.518–7.488	.317	3.286	0.800–13.497	.091
Open approach (coelio vs. tomie)	0.222	0.050–0.993	.040	0.157	0.018–1.386	.066
Primary anastomosis (yes vs. no)	0.375	0.107–1.313	.121	0.289	0.071–1.187	.078
Emergent surgery (yes vs. no)	0.533	0.148–1.922	.334	0.500	0.112–2.234	.359

5%, respectively), although these results should be interpreted with cautions as both ESRD patients on RRT and patients after renal transplantation (with persistent renal function) were considered together [7]. Newman et al. [9] reported a series of 26 patients undergoing major abdominal procedures, observing a poorer prognosis in patients undergoing emergency surgery. In our study, we observed a trend to more severe postoperative events in emergency situations but without statistical significance. Also, beside the 'common' postoperative abdominal complications, our series showed a high rate of cardiopulmonary complications. Therefore, elective and (when possible) emergency surgeries should be carefully prepared and performed, and closed postoperative management is paramount in such fragile patients very sensible to hemodynamic changes and with delayed healing. Acute colonic ischemia is known to be the most common indication for emergency digestive surgery in ESRD patients, representing around 45% of surgical indications as in the present study [9,13]. In general population, acute colonic ischemia is associated with a high postoperative mortality ranging from 25% to 37% [5,14,15]. Colonic ischemia is more prevalent in ESRD patient due to accelerated atherogenesis on one hand and hemodynamic changes and volume shift during dialysis on the other hand [5,16,17]. This can explain also the poor outcome observed after digestive surgery in such patients.

Concerning diverticular disease, our study included a few patients operated for diverticulitis ($n = 12$). There was no difference in morbidity and mortality between elective and emergency surgery. However, the rate of ostomy was higher in the emergency surgery group. Moran-Atkin et al. [18] compared 834 ESRD patient operated in emergency for diverticulitis with 161 ESRD patients who beneficiated from elective surgery. The two groups were matched for age categories, race, sex and period of admission. In-hospital mortality was not significantly different but overall morbidity, ostomy placement and LOS was higher in the emergency group. Compared to the general population, ESRD operated electively still had a 17.3 increased odd of mortality. Thus, indication for elective surgery after diverticulitis in ESRD patients should be individualized as it is still associated with high morbidity and mortality.

Anastomotic leak is a complication feared by the surgeon. The estimated rate in the general population is 5–15% depending on the type of anastomosis [7]. Risk factors known to be associated with anastomotic leak are male gender, tobacco use, immunosuppression and emergency situations [19,20]. ESRD is sometimes mentioned as a risk factor for anastomotic leak, but the literature is scarce on this topic. Alves et al. [21] suggest preoperative renal failure (defined as creatinine level $>110\,\mu$mol/L and uremia level >7 mmol/L) as risk factor associated with anastomotic leak, but this was not confirmed at multivariate analysis. Krysa et al. [7] observed in their series on ESRD and renal transplanted patients 16% of anastomotic leak during emergent surgery (vs. 5% in elective surgery, no statistical analysis performed), and therefore preferred to avoid primary anastomosis during emergency colorectal surgery in ESRD patients. Herein we reported an overall incidence of anastomotic leaks of 13% (3/23), including one leak occurring after emergency surgery and two after elective surgery. Our findings suggest that primary anastomosis can be performed even in the emergency setting, in carefully selected patients.

Laparoscopic approach could help to decrease the risk of postoperative morbidity and mortality, although it should be taken with caution because of the selection bias in patients undergoing laparoscopy who could have a better general condition regarding hemodynamical parameters at the time of surgery. Some studies have demonstrated the benefits of laparoscopic surgery extending to the so called 'high-risk' patients (cardiac disease, diabetes, kidney disease, pulmonary disease, liver disease, elderly) with reduced morbidity, mortality, hospital stay and costs [22,23]. Furthermore, laparoscopy in peritoneal dialysis patients decreases the risk of shift to hemodialysis thanks to better preservation of the peritoneum integrity and earlier resumption of peritoneal dialysis [24]. Recently, a Japanese team investigated the impact of chronic dialysis on outcomes of patients undergoing laparoscopic colorectal cancer resection, compared with a non-dialysis population (including non-ESRD patients) [25]. They observed comparable outcomes in their small group of dialyzed patients, which suggests that minimally invasive approach could be preferred.

The present study carries some limitations. The retrospective design of the study precluded from collecting some biological and clinical data which were not available for all patients and could not be analyzed. Secondly, the small sample size, even large for a single center series, brings us to pool together all types of colorectal surgeries, which do

not expose to the same surgical risk. But colorectal surgery in ESRD patients is not frequent and poorly reported, therefore such experience remains interesting to be published.

In conclusion, colorectal surgical resection in ESRD patients is associated with a high risk of postoperative morbidity and mortality, especially in patients presenting multiple comorbidities such as history of cardiac event and diabetes mellitus. Primary anastomosis can be performed even in the emergency setting, but patients should be selected. ESRD patients remain very fragile patients who need a special attention and a closed management if a colorectal surgery must be performed.

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Disclosure statement

The authors report no conflict of interest.

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