



Risk factors affecting failure of colonoscopic detorsion for sigmoid colon volvulus: a single center experience

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Abstract

Purpose Colonoscopic detorsion (CD) is the first treatment option for uncomplicated sigmoid volvulus (SV). We aim to examine the factors affecting the failure of CD.

Methods The files of patients, treated after diagnosis of SV between January 2015 and September 2020, were retrospectively reviewed. Patients' demographic data, comorbidities, endoscopy reports, and surgical and other treatments were recorded. Patients were divided into two groups, as the successful CD group and unsuccessful CD group. The data were compared between the groups, and multivariate analysis of statistically significant variables was performed.

Results There were 21 patients in the unsuccessful CD group and 52 patients in the successful CD group. The unsuccessful CD rate was found to be 28.76%; this is likely a function of more neuropsychiatric disease, more accompanying sigmoid diverticulum, previous abdominal surgery, abdominal tenderness, onset of symptoms for more than 48 h, higher mean intra-abdominal pressure (IAP), IAP over 15 mmHg, larger mean diameter of the cecum, the cecum diameter over 10 cm, and higher mean C-reactive protein (CRP) values as statistically significant. In the multivariate analysis, previous abdominal surgery and cecum diameter over 10 cm were seen as predictive factors for failure of CD ($p=0.049$, $OR=0.103$, and $p = 0.028$, $OR=10.540$, respectively).

Conclusions CD failure rate was significantly associated with previous abdominal surgery and a cecum diameter over 10 cm. We found that patients with these factors will tend to need more emergency surgery.

Keywords Sigmoid volvulus · Colonoscopic detorsion · Endoscopy

Introduction

Volvulus usually refers to the rotation of the alimentary tract, causing intestinal obstruction and occurring most frequently in the sigmoid colon [1]. Sigmoid volvulus (SV) is caused by the rotation of the sigmoid loop around its own mesentery axis, resulting in closed loop occlusion [2]. Although its frequency varies according to geographical location, it is the

third most common cause of obstruction of the alimentary tract [3]. Predisposing risk factors are the presence of a long redundant sigmoid colon, older age, male gender, chronic constipation, use of laxatives, previous abdominal surgery, and neuropsychiatric disease [4–6].

Diagnosis can be made by either plain X-ray abdominal radiography or computed tomography (CT). The coffee bean image is typical in plain X-ray abdominal radiography. Sensitivity of CT in SV is close to 100% [7]. In patients with SV but without signs of acute abdomen and necrosis in the colon mucosa, primary therapy is CD, and placing a rectal tube proximal to the area of the volvulus that will remain for 24–72 h [8, 9]. CD is successful in 65–90% of patients. Surgical intervention is strongly recommended before the patient is discharged, as the risk of recurrence is high after successful CD [9]. Emergency surgery is required in cases in which CD is unsuccessful along with intestinal non-viability [8, 9].

In this study, we investigated factors affecting the failure of colonoscopic detorsion in sigmoid volvulus.

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Materials and methods

The files of patients treated in our general surgery department, with a diagnosis of SV between January 2015 and September 2020, were retrospectively reviewed. Patients under 18, who were referred for emergency surgery without CD due to the presence of acute abdomen, and patients with signs of necrosis or ischemia in the colon mucosa during the endoscopic

procedure were excluded from the study (Fig. 1). Patients older than 18 and those with successful or unsuccessful CD procedures, without necrosis in the colon mucosa, were included in the study. The patients included in the study were divided into two groups: those in whom endoscopic detorsion failed were referred to as the unsuccessful CD group, and patients in whom the treatment was effective with endoscopic detorsion were referred to as being in the successful CD

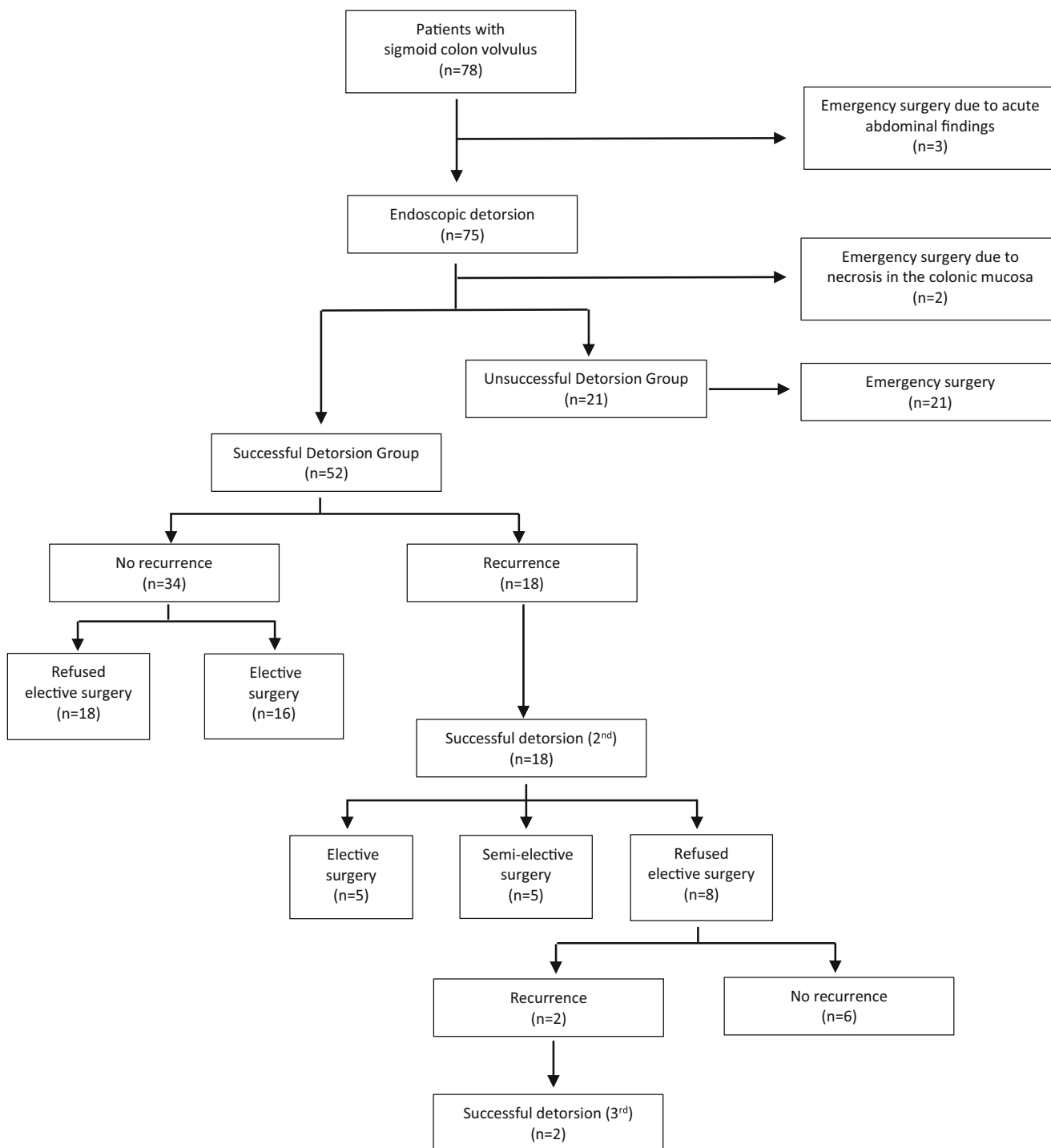


Fig. 1 Flow chart of the study

group. In the successful CD group, only the first colonoscopies of patients with more than one favorable detorsion were included. Patients' age, gender, body mass index (BMI), comorbidities, American Society of Anesthesiologists (ASA) scores, duration of symptoms, physical examination findings, history of previous abdominal surgery, presence of accompanying sigmoid diverticulum, chronic constipation, use of laxatives, intra-abdominal pressure (IAP), diameter of cecum, white blood cell count (WBC), and C-reactive protein (CRP) values were recorded. These variables were compared between groups, and multivariate analysis of statistically significant variables was performed. All procedures were performed by experienced endoscopists in the surgical endoscopy unit. During the procedure, when signs of necrosis or ischemia in the colonic mucosa were observed, it was terminated with the patients directed to surgery.

Colonoscopic detorsion procedure

All patients who underwent endoscopic procedures were diagnosed with SV by plain radiographic image of the abdomen and a CT before the procedure (Fig. 2a–b). A fleet enema was routinely applied to patients to empty the rectum before the procedure. All procedures were performed under conscious sedation in the surgical endoscopy unit, intravenous (I.V.) tramadol and midazolam applied. The dose was calculated by the anesthesiologist, given the weight and age of the patient. The endoscopic procedures were performed with flexible colonoscopy, using low and intermittent air in the left lateral Sims position. When distal stenosis was observed from torsion (Fig. 3a), the colonoscope was advanced into the slightly dilated sigmoid colon. The air and fluid in the dilated sigmoid colon were then aspirated and decompressed, while colonic mucosa viability was evaluated.

Cases with necrosis and ischemia in the colon mucosa needed urgent surgery (Fig. 3b). In the absence of signs of necrosis and ischemia in the colon mucosa, the colonoscope

was advanced slightly through the proximal stenosis area (Fig. 3c). Colonic decompression was applied by advancing to the distal of the transverse colon and aspirating air and fluids in the proximal colon loops. After observing that distension of patients regressed, a guide wire was passed through the colonoscopy channel and advanced to the distal of the transverse colon. As the wire advanced through the transverse colon, the colonoscope was slightly rotated clockwise, and the detorsion process was performed. The procedure was terminated by placing a drainage catheter beyond the proximal stenosis over the wire (Fig. 3D). Generally, 18 F nasogastric tubes were used as drainage catheters, taped onto the perianal skin and left in place for at least 24 h after the procedure.

Statistical analysis

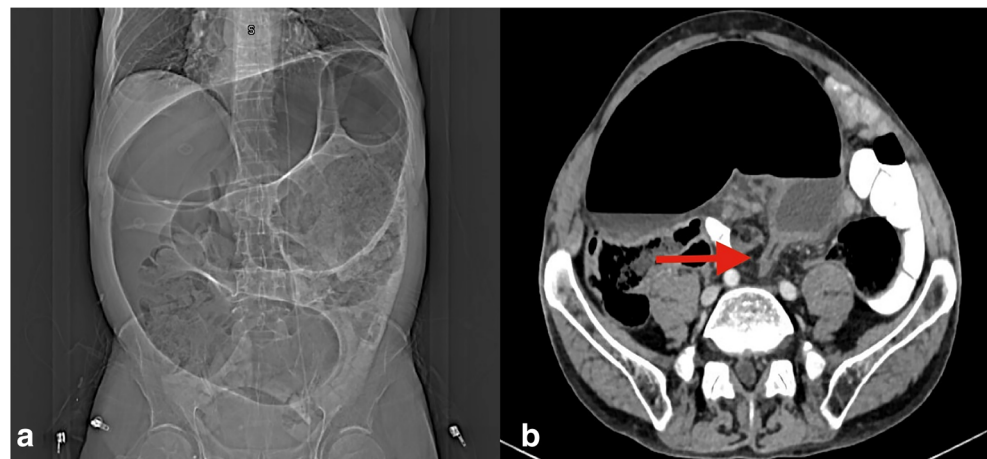
The Statistical Package for the Social Sciences (SPSS) 24.0 Version (IBM Corp, Armonk, NY, USA) was used for statistical analysis. Continuous variables were expressed as mean \pm SD or median and interquartile range. Categorical variables were expressed as frequencies and percentages. While evaluating the study data, the independent sample *t* test was used for comparison of normally distributed continuous parameters in the two groups, and the Mann-Whitney *U* test was used for comparison of the groups that did not show normal distribution. The Pearson chi-square test was used for analysis of qualitative data. Multivariate regression analysis determined effect levels. Significance was evaluated at $p < 0.01$ and $p < 0.05$ levels.

Results

Patient characteristics and outcomes

Files of 78 patients diagnosed with SV between January 2015 and June 2020 were reviewed. It was determined that three of

Fig. 2 Radiological images. **a** Plain radiographic image of abdomen showing a “coffee bean” sign. **b** Selected image of CT, showing spiraled loops of a collapsed bowel



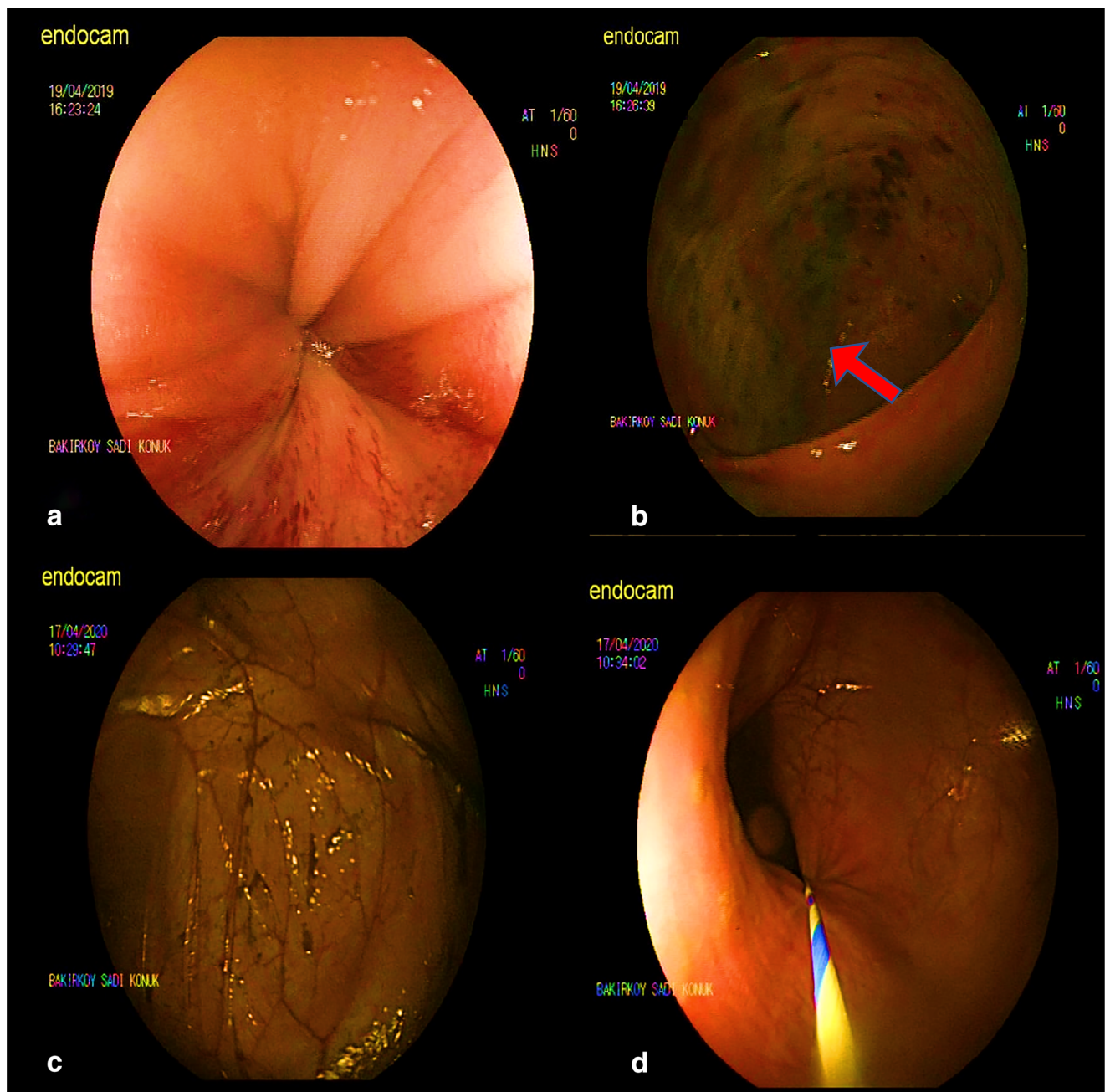


Fig. 3 Colonoscopic images. **a** Endoscopic image showing the spirally twisted rectal or converging mucosa (“whirl sign”). **b** Endoscopic image of necrosis in the rotating sigmoid colon mucosa (this patient was referred for emergency surgery). **c** Endoscopic image of viable mucosa in the

rotating sigmoid colon mucosa. **d** Image of guide wire placement beyond the proximal stenosis area for the drainage tube after the detorsion procedure

the patients were referred to emergency surgery without CD, with acute abdominal findings at the time of admission, and two patients had emergency surgery after showing signs of necrosis in the colon mucosa during the CD (Fig. 3b); these five patients were excluded from the study with the remaining 73 patients included (Fig. 1).

Fifty patients were men and 23 were women. The mean age was 59.02 ± 20.46 years, and the mean BMI was 27.32 ± 3.24

kg/m^2 . Seven patients were ASA 1, 27 patients were ASA 2, 20 patients were ASA 3, and 19 patients were ASA 4. Twenty-one patients had cardiovascular disease, 22 had chronic pulmonary disease, 30 had diabetes mellitus, and 20 had neuropsychiatric disease. Twenty-four patients had chronic constipation, and 22 had a history of laxative use. It was found that 21 patients had diverticular disease, accompanying SV. Seventeen patients had a history of previous abdominal

Table 1 Patient characteristics

Parameter	Value
Age (mean ± SD)	59.02 ± 20.46
Gender, <i>n</i> (%)	
Male	50 (68.49)
Female	23 (31.51)
BMI kg/m ² (mean ± SD)	27.32 ± 3.24
ASA, <i>n</i> (%)	
I	7 (9.5)
II	27 (36.98)
III	20 (27.39)
IV	19 (26.02)
Comorbidity, <i>n</i> (%)	
Cardiovascular disease	21 (28.76)
Chronic pulmonary disease	22 (30.13)
Diabetes mellitus	30 (41.09)
Neuropsychiatric disease	20 (27.39)
Accompanying sigmoid diverticulum, <i>n</i> (%)	21 (28.76)
Chronic constipation, <i>n</i> (%)	24 (32.87)
Use of laxative, <i>n</i> (%)	22 (30.13)
Previous abdominal surgery, <i>n</i> (%)	17 (23.28)
Abdominal tenderness, <i>n</i> (%)	51 (69.86)
Intra-abdominal pressure (mean ± SD)	15.67 ± 3.20
Diameter of cecum (mean ± SD)	8.68 ± 2.03
WBC, ×10 ³ /μL (mean ± SD)	10.41 ± 5.00
CRP, mg/L (mean ± SD)	57.28 ± 78.07

BMI body mass index, ASA American Society of Anesthesiologists, WBC white blood cell, CRP C-reactive protein

surgery. The mean WBC value at admission was $10.41 \times 10^3/\mu\text{L}$, and the mean CRP value was 57.28 mg/L. Mean IAP was 15.67 ± 3.20 mmHg, and the mean diameter of the cecum was 8.68 ± 2.03 cm. Fifty-one patients had abdominal tenderness (Table 1). It was determined that 30 patients were admitted to the hospital within the 48 h after onset of symptoms and 42 after 48 h. While CD was favorably performed in 52 patients, it was not the case in 21 patients; these patients were directed to emergency surgery. CD procedure mean time was 19.91 ± 5.20 min (Table 2). Endoscopic complication occurred in only one patient in the failed detorsion group. Perforation occurred in the dilated sigmoid colon while advancing beyond the proximal stenosis. Eighteen patients who had an effective detorsion were admitted to the hospital within 3 months for recurrent SV and CD procedures. Recurrence rate was 34.6% (18/52) (Table 2). Elective surgery was recommended for all 52 patients with successful detorsion. Five patients were operated on semi-electively without discharge at the index admission, 21 patients were operated on electively after discharge, and 26 patients refused surgery. CD was required for a second procedure in six of 26 patients who did not accept

Table 2 Endoscopic and surgical outcomes

Parameter	Value
Endoscopic processing time, (mean ± SD) (min)	19.91 ± 5.20
Detorsion success rate, <i>n</i> (%)	52 (71.23)
Recurrence rate, <i>n</i> (%)	18 (34.61)
Endoscopic complication, <i>n</i> (%)	
Perforation	1 (1.36)
Emergency surgery, <i>n</i> (%)	21 (28.76)
Sigmoid colectomy + end colostomy	8 (10.95)
Detorsion + mesopexy	4 (5.47)
Detorsion + mesopexy + loop colostomy	2 (2.73)
Anterior resection	3 (4.10)
Low anterior resection	2 (2.73)
Total colectomy	1 (1.36)
Subtotal colectomy	1 (1.36)
Semi-elective surgery, <i>n</i> (%)	5 (6.84)
Total colectomy	2 (2.73)
Sigmoid colectomy + end colostomy	2 (2.73)
Anterior resection	1 (1.36)
Elective surgery, <i>n</i> (%)	21 (28.76)
Anterior resection	13 (17.80)
Low anterior resection	8 (10.95)
No surgery*, <i>n</i> (%)	26 (35.61)

* Patients who did not accept to undergo an elective surgery

surgery, and a third procedure was required in two of them (Fig. 1).

Factors affecting unsuccessful CD

There were 21 patients in the unsuccessful CD group and 52 patients in the successful CD group. Unsuccessful detorsion rate was found to be 28.76%. In the univariate analysis between the two groups, there was no statistically significant difference in terms of gender, age, ASA score, BMI, cardiovascular diseases, chronic pulmonary diseases, diabetes mellitus, chronic constipation, use of laxatives, and mean WBC values at presentation. In the unsuccessful CD group, the presence of neuropsychiatric disease, accompanying sigmoid diverticulae, previous abdominal surgery, abdominal tenderness, onset of symptoms for longer than 48 h, higher mean IAP, IAP over 15 mmHg, larger mean diameter of the cecum, a cecum diameter over 10 cm, and higher mean CRP values were seen as statistically significant (Table 3). In the multivariate analysis, previous abdominal surgery and cecum diameter over 10 cm were determined as predictive factors for CD failure. A diameter of the cecum over 10 cm was the variable with the highest probability rate of failure of CD, according to the OR ($p=0.049$, OR=0.103, and $p=0.028$, OR=10.540, respectively) (Table 4).

Table 3 Univariate analysis of factors affecting an unsuccessful detorsion

Parameter	Unsuccessful detorsion group (<i>n</i> =21)	Successful detorsion group (<i>n</i> =52)	<i>p</i> value
Age (mean ± SD)	60.5 ± 22.5	58.4 ± 19.8	0.704
Age, <i>n</i> (%)			
< 65	10 (47.6)	27 (51.9)	0.739
≥ 65	11 (52.4)	25 (48.1)	
Gender, <i>n</i> (%)			
Male	12 (57.1)	38 (73.1)	0.185
Female	9 (42.9)	14 (26.9)	
BMI kg/m ² (mean ± SD)	27.8 ± 3	27.1 ± 3.3	0.424
BMI cut off, <i>n</i> (%)			
< 30	13 (61.9)	36 (69.2)	0.546
≥ 30	8 (38.1)	16 (30.8)	
ASA score, <i>n</i> (%)			
I	2 (9.5)	5 (9.6)	
II	7 (33.3)	20 (38.5)	0.474
III	4 (19)	16 (30.8)	
IV	8 (38.1)	11 (21.2)	
Comorbidity, <i>n</i> (%)			
Cardiovascular disease	5 (23.8)	16 (30.8)	0.552
Chronic pulmonary disease	7 (33.3)	15 (28.8)	0.705
Diabetes mellitus	7 (33.3)	23 (44.2)	0.392
Neuropsychiatric disease	10 (47.6)	10 (19.2)	0.014
Accompanying sigmoid diverticulum, <i>n</i> (%)	10 (47.6)	11 (21.2)	0.024
Chronic constipation, <i>n</i> (%)	8 (38)	16 (30.8)	0.546
Use of laxative, <i>n</i> (%)	7 (33.3)	15 (32.6)	0.896
Previous abdominal surgery, <i>n</i> (%)	11 (52.4)	6 (11.5)	0.001
Abdominal tenderness, <i>n</i> (%)	21 (100)	30 (57.7)	0.001
IAP (mean ± SD)	18.4 ± 2.5	14.6 ± 2.8	0.001
IAP cut off, <i>n</i> (%)			
< 15 mmHg	1 (4.8)	29 (55.8)	0.001
≥ 15 mmHg	20 (95.2)	23 (45.2)	
Diameter of cecum (mean ± SD)	10.4 ± 1.8	7.9 ± 1.6	0.001
Diameter of cecum, cut off, <i>n</i> (%)			
< 10 cm	4 (19)	43 (82.7)	0.001
≥ 10 cm	17 (81)	9 (17.3)	
Onset to symptoms, cut off, <i>n</i> (%)			
< 48 h	2 (9.6)	29 (55.8)	0.001
> 48 h	19 (90.4)	23 (44.2)	
WBC, ×10 ³ /μL (mean ± SD)	10.96 ± 4.17	10.20 ± 5.32	0.186
CRP, mg/L (mean ± SD)	112.1 ± 103.1	35.2 ± 52	0.003

BMI body mass index, *ASA* American Society of Anesthesiologists scores, *IAP* intra-abdominal pressure, *WBC* white blood cell, *CRP* C-reactive protein

Discussion

The first treatment option for SV is endoscopic detorsion in the absence of acute abdominal findings. In the presence of necrosis or ischemia signs in the colonoscopic examination, the CD procedure would be terminated and patients directed to emergency surgery [5, 10, 11]. In this study, three patients

were referred to emergency surgery without attempting CD due to acute abdominal findings and two patients due to signs of necrosis in the colon mucosa on colonoscopic examination. CD was performed in 73 patients, which was unsuccessful in 21 (28.76%) and successful in 52 (71.24%). In previous studies, the success rate of CD was reported as between 65 and 90%, and the success rate of this study was similar according

Table 4 Multivariate analysis of factors affecting unsuccessful detorsion

	Multivariate <i>p</i> value	Odd's ratio	95% C.I. for EXP(B)	
			Lower	Upper
Neuropsychiatric disease	0.341	0.392	0.057	2.701
Accompanying sigmoid diverticulum	0.580	0.597	0.096	3.714
Previous abdominal surgery	0.049	0.103	0.010	1.030
Abdominal tenderness	0.998	0.000	0.000	0.000
Onset to symptoms > 48 h	0.113	0.090	0.005	1.765
IAP > 15 mmHg	0.494	0.279	0.007	10.824
Mean IAP	0.658	0.871	0.473	1.604
Diameter of cecum > 10 cm	0.028	10.540	10.293	85.938
Mean diameter of cecum	0.233	0.546	0.208	1.471
Mean CRP	0.480	0.996	0.983	1.008

IAP intra-abdominal pressure, *CRP* C-reactive protein

to the literature [9, 12]. The recurrence rate after CD was reported as 25.8% for Kim et al. and 46.2% for Lida et al. [12, 13]. The recurrence rate was reported as 46% for Ataman et al., which is one of the largest series, with 952 patients [8]. Larkin et al. observed that there was recurrence in 86% of patients after CD [14]. In the present study, the recurrence rate was 34.6% (18/52). Both this and previous studies revealed that patients should be directed to surgery after a well-done endoscopic detorsion, due to the high recurrence rate after CD.

If patients are directed to surgery next, one might ask why CD is performed first? One of the most important advantages of CD is to have patients in elective surgery and increase the possibility of resection and anastomosis. In elective surgery, the rate of resection anastomosis is higher than emergency surgery. Colostomy rate is also high in emergency surgery. For Kim et al., with the resection anastomosis rate of patients in elective surgery after CD was 80%, the rate was found at 50% in emergency surgery, which was statistically significant [12]. In the present study, the rate of colostomy in patients undergoing emergency surgery was 47.61% (10/21), while this rate was 7.69% (2/26) for elective surgeries performed after CD. This protected patients from colostomy, i.e., by referring high-risk patients to elective surgery. Although the rate of mortality and morbidity in sigmoid volvulus patients in emergency surgery was higher than elective surgery with Kim et al., it was found as statistically insignificant [12]. For Mullen et al., mortality was 0.4%, morbidity was 6.7% in patients undergoing elective surgery in general surgery cases, while mortality was 3.4% and morbidity was 13.8% for emergency surgery; these rates have demonstrated that both mortality and morbidity are statistically higher in emergency surgery [15].

In a study by Samuel et al., the Hartmann colostomy was recommended in the presence of colon necrosis. It has also been reported that resection anastomosis or mesosigmoidopexy can be performed in patients without

necrosis [16]. In the present study, the Hartmann colostomy was performed in patients with colon necrosis. In other emergency cases without colon necrosis, mesosigmoidopexy was preferred in 7 patients, resection anastomosis in 6 patients, and Hartmann colostomy in 8 patients. Surgical advice for elective cases was resection and anastomosis [17]. In our study, resection anastomosis was used in 21 patients who underwent elective surgery. Anastomotic resection was performed in three of five patients who underwent semi-elective surgery, while sigmoid resection and colostomy were performed in two patients. Use of colostomy was due to the severe dilatation of the proximal colon loops, with total colectomy for three patients who underwent emergency and semi-elective surgery for serosal separations in the cecum, with thinning of the cecum wall due to severe dilatation.

While CD is performed well in most patients, this can sometimes not be the case. In this study, we examined factors that related to the failure of CD. When demographic data were examined, we determined that age, gender, ASA scores, BMI, cardiovascular disease, diabetes mellitus, and chronic pulmonary disease did not affect CD failure. Similarly, for Lida et al., it was concluded that demographic data had no effect on CD failure [13]. The only difference was that having a neuropsychiatric disease was found to be one of the statistically significant factors affecting CD failure in a univariate analysis, but it was statistically insignificant in a multivariate analysis. Since neuropsychiatric diseases limit individuals' self-expression, that can cause late admission to hospitals [18]. This suggests that delayed admission may create more edema in the colon and its mesentery, more dilated proximal colonic loops, and increased IAP, in turn causing a decrease in CD's success rate.

Use of laxatives and chronic constipation are predisposing factors in the development of SV [19]. In the study of Lida et al., it was concluded that the history of laxative use

increases the success of CD [13]. In this study, it was determined that laxative use and chronic constipation did not affect the success or failure of CD.

Previous abdominal surgery was reported as one risk factors in the development of SV. [4–6]. For Lida et al, it was stated that having an abdominal surgery increased the success of CD [13]. Yet, in this study, previous abdominal surgery was found to be a statistically significant factor affecting the failure of CD in both univariate and multivariate analysis. This can be seen as the immobility of the torsion aspect and fixation to the pelvic area due to adhesions developing in the sigmoid colon and its mesentery, or it could be the resistance of the adhesions to the colonoscope and the inability to ideally perform colonoscopic maneuvers.

In this study, abdominal tenderness and onset of symptoms for longer than 48 h were found to be factors that statistically affect CD failure in a univariate analysis. However, in the multivariate analysis, they were found to be statistically insignificant. Lida et al. stated that the presence of abdominal tenderness was one of the factors affecting the failure of endoscopic treatment [13]. In Atamanalp's article, late admission was a factor in the failure of decompression in their series, which could be related to edema in the sigmoid colon and its mesentery [20]. In our opinion, in the presence of abdominal tenderness and late admission, intestinal edema is more common, which leads to detorsion being more unsuccessful.

Colon diverticulae accompanying SV were identified as one of the factors affecting CD failure in univariate analysis. However, in multivariate analysis, it was found to be statistically insignificant. The failure may have been adhesions between the sigmoid colon and its mesentery with neighboring organs, due to a previous diverticulitis attack.

In the unsuccessful CD group, higher mean IAP and higher mean diameter of the cecum were statistically significant in a univariate analysis. However, they were found to be insignificant in a multivariate analysis. In addition, IAP over 15 mmHg and cecum diameter over 10 cm were found to be statistically significant in affecting failure. In the multivariate analysis, only cecum diameter over 10 cm was found to be significant. An increased IAP over 10 mmHg can affect the gastrointestinal system, along with edema, and mesentery thickening occurring in the gastrointestinal organs due to a decrease in arterial blood flow and venous return: this becomes a vicious cycle, causing further increase in the IAP [21, 22]. The larger cecum diameter and dilated proximal colon loops may increase the IAP. Due to excessive expansion of the proximal colon loops, with edema in the intestines and mesentery, as a function of increased intra-abdominal pressure, the torsioned sigmoid colon is compressed by the adjacent colon, small intestines, surrounding tissues, and the abdominal wall, resulting in a failed detorsion process by restricting movement of the bent bowel segment.

Lida et al. stated that mean WBC and CRP values had no effect on failure with colonoscopic detorsion [13]. The mean WBC value was statistically insignificant, while the high mean CRP value was statistically significant in the failed CD group, with univariate analysis. However, in the multivariate analysis, it was found to be statistically insignificant.

In conclusion, SV is a condition that requires urgent intervention. First, CD and decompression should be performed with uncomplicated SV. Since the recurrence rate is high after endoscopic treatment, elective surgery should be performed for patients: if CD fails, patients should be referred for emergency surgery. As a result of this study, CD failure rate is associated with previous abdominal surgery and a diameter of the cecum over 10 cm.

Declarations

Conflict of interest The authors declare no competing interests.

Human and animal rights All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki declaration and its latest amendments and comparable ethical standards. These authors do not perform a study with animals.

Informed consent This was obtained from all participants in the study.

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