



Management and risk factors for colonic volvulus: retrospective national cohort study

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Abstract

Background: This study evaluated the outcomes of colonic volvulus management in a national cohort, and identified risk factors for morbidity and mortality.

Methods: This was a multicentre national retrospective study of patients presenting with colonic volvulus between 2010 and 2019. Main outcome measures were 30-day and 1-year mortality. Multivariable regression and Kaplan–Meier analyses were used to study predictors of mortality and survival.

Results: Of the 559 patients presenting with sigmoid volvulus, 381 underwent surgery and 178 received conservative treatment. The 30-day mortality rates were 11.0% and 19.0%, respectively. Emergency surgery ($P = 0.030$), nursing home residence ($P = 0.040$), increased co-morbidity ($P = 0.017$), and male sex ($P = 0.029$) predicted postoperative 30-day mortality. Primary endoscopic detorsion followed by elective surgery during a subsequent hospital admission resulted in best survival. Of the 342 patients presenting with caecal volvulus, 340 underwent surgery. The 30-day mortality rate was 6.4%. Increased co-morbidity ($P = 0.008$), nursing home residence ($P = 0.002$), and necrotic caecum ($P = 0.007$) predicted 30-day mortality. At 1 year, the mortality rate among patients with sigmoid volvulus was 19.9% after surgery and 43.2% after conservative treatment. Emergency surgery ($P = 0.023$), nursing home residence ($P = 0.009$), and increased co-morbidity ($P < 0.001$) were associated with 1-year postoperative mortality. In patients with caecal volvulus the 1-year mortality rate was 13.1%. Increased co-morbidity ($P < 0.001$) and nursing home residence ($P < 0.001$) were predictive. Anastomotic leakage in patients with sigmoid volvulus was associated with an American Society of Anesthesiologists fitness grade of III ($P = 0.032$) and total colectomy ($P = 0.012$).

Conclusion: Surgery should be recommended for colonic volvulus where co-morbidity, patient preference, and functional status allows. Surgically unfit patients have poorer outcomes. Elective sigmoidectomy after endoscopic detorsion is preferred as it carries the lowest mortality risk. Necrotic bowel, dependency, and co-morbidities predict death for both sigmoid and caecal volvulus.

Introduction

Colonic volvulus most commonly occurs in the sigmoid colon, accounting for approximately 60.9% of all gastrointestinal volvuli¹. The next most common location is the caecum (34.5% of all volvuli)¹. In Western countries, sigmoid volvulus is more common in elderly men with chronic constipation and neuropsychiatric conditions, whereas caecal volvulus is more commonly seen in younger women². Volvulus is the third most common cause of large bowel obstruction in Western countries³. Small bowel volvulus typically occurs during

childhood, and is commonly associated with disturbances in normal embryological gut development, with an estimated incidence of 1 in 6000 live births⁴. In contrast, gastric volvulus commonly presents during the fifth decade, with an equal distribution between men and women, and is frequently associated with paraoesophageal hiatal hernia⁵.

Colonic volvulus is a potentially life-threatening emergency condition that requires timely diagnosis and management to prevent serious complications. The diagnosis of colonic volvulus is challenging as other causes of abdominal pain may present with similar symptoms, thus requiring high clinical suspicion

Received: April 12, 2025. Revised: July 28, 2025. Accepted: July 29, 2025

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and prompt radiological evaluation, often with contrast-enhanced computed tomography, which remains the standard for diagnosis⁶. Despite advances in diagnostic imaging and endoscopic techniques, volvulus continues to be associated with significant morbidity and mortality⁷.

The World Society of Emergency Surgery⁸ has provided consensus guidelines on the diagnosis and management of sigmoid volvulus. The recommended management of sigmoid volvulus is emergency endoscopic decompression^{3,8}. When unsuccessful or in the presence of peritonitis or sepsis, emergency surgery is necessary with sigmoid resection⁹. An urgent resection is required in 5–25.0% of patients¹⁰. For a frail patient unfit for general anaesthesia, percutaneous endoscopic colostomy tube fixation or endoscopic treatment alone can be considered⁸. After successful endoscopic decompression, sigmoid volvulus recurs in 43–80.0% of patients^{11–13}. Because of this high recurrence rate, and potential morbidity and mortality associated with recurrent episodes, timely operative intervention is recommended¹². However, the optimal schedule for elective surgery after primary endoscopic detorsion remains unknown. For caecal volvulus, emergency surgery is the recommended treatment¹⁴.

Given the limited evidence and guidelines regarding the management of volvulus, the aim of this study was to describe the patient population with colonic volvulus, outcomes, and associated risk factors.

Methods

Patients

A multicentre retrospective analysis was undertaken of consecutive patients treated for sigmoid or caecal volvulus during the years 2010–2019 at four tertiary referral centres in Finland (university hospitals of Helsinki, Turku, Tampere, and Oulu) and seven secondary referral centres (central hospitals in Seinäjoki, Rovaniemi, Lahti, Jyväskylä, Kotka, Joensuu, and Vaasa). Records of all patients were collected from hospital databases according to the diagnostic code for volvulus (International Classification of Diseases ICD-10, K62.5). Patients with gastric or small bowel volvulus were excluded. The inclusion criteria were treatment for either caecal or sigmoid volvulus during the selected time period and aged 18–99 years. Patients with incomplete hospital records were excluded.

The study protocol was reviewed and approved by the institutional review board of Helsinki University Hospital (HUS/115/2021), and this study adhered to the Declaration of Helsinki and the International Conference on the Harmonization of Good Clinical Practice. The study was approved by the Research Ethics Board of the Finnish Institute for Health and Welfare (THL/6090/14.02.00/2020), and the study protocol was approved by separate institutional review boards at each contributing centre. Data were collected and linked under permissions granted by the Research Ethics Board of the Finnish Institute for Health and Welfare. Finnish law allows the use of medical records in medical research without necessitating the patient's consent. The requirement for informed consent was waived in accordance with national guidelines by the institutional review board of Helsinki University Hospital (HUS/115/2020) because of the retrospective nature of the study.

This study was reported in accordance with the STROBE guidelines for observational research. A completed STROBE checklist is provided in the [supplementary material](#).

Patient groups

Patients were divided into groups according to the chosen treatment. Patients with sigmoid volvulus were treated with: immediate emergency surgery if peritonitis was present (group 1, 133 patients); emergency endoscopic detorsion and emergency surgery in the event of unsuccessful decompression (group 2, 147 patients); emergency endoscopic detorsion and elective surgery during the same hospital stay (group 3, 17 patients); emergency endoscopic detorsion and elective surgery during a new hospital stay (group 4, 84 patients); or conservative endoscopic treatment for patients deemed unfit for surgery or general anaesthesia (group 5, 178 patients). Patients with caecal volvulus mostly had surgery immediately (317 patients) and a smaller group was treated first with endoscopy followed by an operation (23). Two patients with caecal volvulus were managed with endoscopy only.

Outcomes

The primary outcomes of this study were 30-day and 1-year mortality. Secondary outcomes included rates of the short-term surgical outcomes 30-day postoperative ileus, anastomotic leakage, and wound infection, fascial dehiscence or both, 30-day reoperation (unplanned postoperative visit to the operating room for a reason related to the primary operation), and readmission (unplanned postoperative visit to the hospital).

Statistical analysis

Categorical variables were analysed using Pearson's χ^2 test and Fisher's exact test. Continuous variables with a normal distribution, expressed as mean(standard deviation), were evaluated using one-way analysis of variance. Continuous variables with a non-normal distribution, expressed as median (interquartile range, i.q.r.), were compared with use of non-parametric tests. Univariable and multivariable logistic regression analyses were used to identify risk factors for morbidity and mortality. Kaplan–Meier analysis was used for survival analysis. $P < 0.050$ was considered statistically significant. An expert biostatistician at the University of Helsinki was consulted regarding the chosen statistical methodology and interpretation of the results. SPSS[®] version 28.0 for Windows[®] (IBM, Armonk, NY, USA) was used for statistical analysis.

Results

Patient characteristics

This study included 342 patients with caecal volvulus and 559 with sigmoid volvulus. Patient characteristics are summarized in [Table 1](#). The mean age was 63.9 years for those with caecal volvulus and 70.6 years for patients with sigmoid volvulus. The American Society of Anesthesiologists (ASA) grade was III or higher in 66.0% and 73.7% of patients with caecal and sigmoid volvulus, respectively. The median Charlson Co-morbidity Index (CCI) score was 3 in patients with caecal and 4 in patients with sigmoid volvulus. A neurological condition was present in 23.4 and 49.0% of patients with caecal and sigmoid volvulus, respectively. Psychiatric disorders were present in 13.5 and 15.2%, respectively. Some 13.5% of patients with caecal volvulus and 38.9% of those with sigmoid volvulus lived in a nursing home.

Table 1 Demographic data

	Caecal volvulus (n = 342)	Sigmoid volvulus (n = 559)
Hospital		
Etelä-Pohjanmaa Central Hospital	26 (7.6%)	43 (7.7%)
Helsinki University Hospital	77 (22.5%)	122 (21.8%)
Keski-Suomen Central Hospital	18 (5.3%)	34 (6.1%)
Kymenlaakson Central Hospital	16 (4.7%)	24 (4.3%)
Lapin Central Hospital	9 (2.6%)	11 (2.0%)
Oulu University Hospital	29 (8.5%)	36 (6.4%)
Päijät-Hämeen Central Hospital	31 (9.1%)	56 (10.0%)
Pohjois-Karjalan Central Hospital	24 (7.0%)	35 (6.3%)
Tampere University Hospital	50 (14.6%)	112 (20.0%)
Turku University Hospital	45 (13.2%)	63 (11.3%)
Vaasa Central Hospital	17 (5.0%)	23 (4.1%)
Sex		
Male	106 (31.0%)	369 (66.1%)
Female	236 (69.0%)	189 (33.9%)
Age (years), mean	63.9	70.6
BMI (kg/m ²), median (range)	23 (14–46)	23.1 (15–46)
ASA fitness grade		
I	30 (8.8%)	20 (3.6%)
II	78 (22.8%)	99 (17.7%)
III	128 (37.4%)	253 (45.3%)
IV	89 (26.0%)	139 (24.9%)
IV	9 (2.6%)	16 (2.9%)
Missing	8 (2.3%)	32 (5.7%)
Treatment group		
Group 1		
Emergency surgery	317 (92.7%)	133 (23.8%)
Group 2		
Endoscopy + emergency surgery during index hospital visit	23 (6.7%)	–
Endoscopy + emergency surgery	–	147 (26.3%)
Group 3		
Endoscopic treatment only	2 (0.6%)	–
Endoscopy + elective surgery during index hospital visit	–	17 (3.0%)
Group 4		
Endoscopy + elective surgery during new hospital visit	–	84 (15.0%)
Group 5		
Endoscopic treatment only	–	178 (31.9%)
Type of surgery		
	n = 340	n = 381
Resection + end ileostomy	3 (0.9%)	–
Resection + end colostomy or end ileostomy	–	82 (21.5%)
Resection + loop ileostomy	6 (1.8%)	–
Resection + loop colostomy	–	15 (3.9%)
Resection + anastomosis	316 (92.9%)	275 (72.2%)
Colopexy	6 (1.8%)	–
Stoma	–	3 (0.8%)
Detorsion	8 (2.4%)	5 (1.3%)
Adhesiolysis	1 (0.3%)	1 (0.3%)
Endoscopic treatment only		
Sex		
Male	–	113 (63.5%)
Female	–	65 (36.5%)
Neurological condition	–	113 (63.5%)
Nursing home residence	–	103 (57.9%)
ASA fitness grade, median (i.q.r., range)	–	III (III–IV, I–V)
CCI score, median (i.q.r., range)	–	5 (4–6.5, 0–12)

Values are n (%) unless otherwise stated. BMI, body mass index; ASA, American Society of Anesthesiologists; CCI, Charlson Co-morbidity index.

Patients with sigmoid volvulus who received only endoscopic treatment were considered frail and poor candidates for surgery. Among these, 63.5% had a chronic neurological condition, such as previous stroke or Parkinson's disease, and 57.9% lived in a nursing home.

The choice of surgical procedure showed no major differences between hospitals. Among patients with sigmoid volvulus who had surgery, 72.2% underwent resection with primary anastomosis. The second most common procedure was resection with end colostomy or end ileostomy, performed in 21.5% of patients.

In the cohort with caecal volvulus, the majority (92.9%) underwent resection with anastomosis, whereas colopexy was performed in only 6 patients (1.8%).

Thirty-day mortality

The overall mortality rate was 10.8% (90 deaths) at 30 days among 837 patients (data were not available for 64 patients).

Among 313 patients with caecal volvulus, the 30-day mortality rate was 6.4% (20 deaths) (data were not available for 29 patients). Univariable regression analysis was used to identify risk factors for 30-day mortality in patients with surgically treated caecal

Table 2 Regression analysis for 30-day mortality for operated caecal volvulus (311 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
CCI score				
0–3	1.00 (reference)		1.00 (reference)	
4–5	5.64 (1.37, 23.25)	0.017	3.94 (0.91, 17.15)	0.067
≥ 6	14.70 (3.86, 55.93)	<0.001	6.98 (1.66, 29.37)	0.008
Nursing home residence	4.87 (1.79, 13.30)	0.002	6.509 (1.97, 21.45)	0.002
Female sex	0.74 (0.28, 1.94)	0.540		
BMI (kg/m²)				
19–24	1.00 (reference)			
0–18	0.54 (0.07, 4.51)	0.572		
≥ 25	0.41 (0.09, 2.00)	0.273		
Condition of caecum				
Viable	1.00 (reference)		1.00 (reference)	
Ischaemic	2.41 (0.77, 7.57)	0.132	2.73 (0.78, 9.49)	0.115
Necrotic/perforated	5.54 (1.50, 20.38)	0.010	8.44 (1.79, 39.90)	0.007
Postoperative ileus	1.43 (0.45, 4.49)	0.544		
Duration of operation > 150 min	0 (0)	0.998		
Anticoagulant medication	3.32 (1.24, 8.92)	0.017	2.36 (0.71, 7.90)	0.164
Nasogastric tube	2.49 (0.80, 7.77)	0.115		
Type of surgery				
Resection + anastomosis	1.00 (reference)			
Resection + stoma	3.03 (0.34, 27.36)	0.323		
Other (colopexy, detorsion)	0 (0)	0.999		
Reoperation	1.68 (0.35, 8.07)	0.515		
Additional factors with missing data				
Intraoperative blood loss > 200 ml	5.00 (1.58, 15.80)	0.006		
Postoperative mobilization				
POD 0–2	1.00 (reference)			
POD 3–30	6.87 (0.61, 77.47)	0.119		
Not mobilized	52.67 (41.74, 664.53)	0.002		
Timing of peroral liquids				
POD 0–1	1.00 (reference)			
POD 2	0 (0)	0.998		
POD 3–4	6.75 (1.71, 26.60)	0.006		

Values in parentheses are 95% confidence intervals. CCI, Charlson Co-morbidity Index; BMI, body mass index; POD, postoperative day.

volvulus (Table 2). All significant factors were included in multivariable logistic regression analysis, which revealed that necrotic bowel segment, increased co-morbidity (CCI score ≥ 6), and nursing home residence independently predicted an increased risk of death within 30 days (Table 2).

A further univariable regression analysis included additional factors not included in the previous analysis owing to missing data. Perioperative haemorrhage > 200 ml (198 patients), non-mobilization (222), and delay in peroral nutrition until postoperative day (POD) 3 (244) significantly increased the risk of 30-day mortality after surgery for caecal volvulus (Table 2).

Among 525 patients with sigmoid volvulus, the overall 30-day mortality rate was 13.5% (70 deaths) (data were not available for 34 patients). For patients treated surgically and conservatively, the 30-day mortality rate was 11.0% (39 of 356) and 19.0% (32 of 168), respectively. Univariate regression analysis was performed to evaluate risk factors for 30-day mortality in patients with surgically treated sigmoid volvulus (Table 3). All significant factors were included in multivariate logistic regression analysis, which revealed emergency surgery without previous endoscopy (group 1), nursing home residence, male sex, and increased co-morbidity (CCI score ≥ 4) to independently predict an increased risk of 30-day mortality (Table 3).

Kaplan–Meier analysis showed significantly better survival among patients with sigmoid volvulus who had elective surgery compared with those operated in an emergency setting ($P = 0.014$) (Fig. 1). Patients who had emergency endoscopic detorsion and elective surgery during a new hospital stay (group 4) had

the best survival. Among patients who underwent emergency surgery (groups 1 and 2), those with intraoperative findings of bowel necrosis or perforation had significantly worse survival ($P < 0.001$) (Fig. 2).

Univariable regression analysis of additional factors not included in the previous multivariable analysis owing to missing data showed that delayed or lack of mobilization (244 patients) significantly increased the risk of 30-day mortality after surgery for sigmoid volvulus (Table 3).

One-year mortality

The overall mortality rate at 1 year was 22.0% (184 deaths) among 837 patients (data were not available for 64 patients).

Among 313 patients with caecal volvulus, the 1-year mortality rate was 13.1% (41 deaths) (data were not available for 29 patients). Univariable regression analysis was used to analyse risk factors for 1-year mortality among patients with surgically treated caecal volvulus (Table 4). All significant factors were included in multivariable logistic regression analysis, which revealed that increased co-morbidity (CCI score ≥ 4) and nursing home residence independently predicted an increased risk of 1-year mortality (Table 4).

Among 524 patients with sigmoid volvulus, the overall 1-year mortality rate was 27.4% (144 deaths) (data were not available for 34 patients). For patients treated surgically and conservatively, the 1-year mortality rate was 19.9% (71 of 356) and 43.2% (73 of 169), respectively. Univariable regression analysis was undertaken to evaluate the risk factors for 1-year mortality

Table 3 Regression analysis for 30-day mortality for operated sigmoid volvulus (356 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Male sex	2.39 (1.02, 5.59)	0.045	2.909 (1.12, 7.51)	0.029
CCI score				
0–3	1.00 (reference)		1.00 (reference)	
4–5	3.86 (1.57, 9.52)	0.003	4.01 (1.48, 10.89)	0.006
≥ 6	5.18 (1.93, 13.89)	0.001	3.69 (1.26, 10.81)	0.017
ASA fitness grade				
I–II	1.00 (reference)			
III	4.43 (0.99, 19.73)	0.051		
IV–V	10.38 (2.35, 45.83)	0.002		
Nursing home residence	2.68 (1.37, 5.26)	0.004	2.19 (1.04, 4.61)	0.040
Patient group*				
Group 4	1.00 (reference)		1.00 (reference)	
Group 1	13.75 (1.80, 104.97)	0.011	9.91 (1.25, 7.89)	0.030
Group 2	11.40 (1.49, 87.15)	0.019	6.55 (0.83, 51.89)	0.075
Group 3	4.75 (0.28, 79.99)	0.279	3.209 (0.18, 57.36)	0.430
Condition of the sigmoid colon				
Viable	1.00 (reference)			
Ischaemic	6.43 (2.89, 14.28)	<0.001		
Necrotic/perforated	7.03 (2.49, 19.82)	<0.001		
Type of surgery				
Sigmoid resection	1.00 (reference)		1.00 (reference)	
Colectomy or other resection	2.91 (1.33, 6.33)	0.007	1.94 (0.81, 4.65)	0.137
Other (detorsion, colopexy, stoma)	1.26 (0.15, 10.41)	0.834	1.16 (0.12, 11.53)	0.900
Additional factors with missing data				
BMI (kg/m ²)†				
19–24	1.00 (reference)			
0–18	1.12 (0.24, 5.26)	0.890		
≥ 25	0.44 (0.14, 1.34)	0.149		
Postoperative mobilization‡				
POD 1–2	1.00 (reference)			
POD 3–30	10.82 (2.27, 51.49)	0.003		
Not mobilized	21.91 (3.94, 12.17)			

Values in parentheses are 95% confidence intervals. *Group 1: emergency surgery without previous endoscopy; group 2: endoscopy followed by emergency surgery; group 3: endoscopy followed by elective surgery during index hospital visit; group 4: endoscopy followed by elective surgery during a subsequent hospital visit. Data missing for †106 and ‡137 patients. CCI, Charlson Co-morbidity Index; ASA, American Society of Anesthesiologists; BMI, body mass index; POD, postoperative day.

among patients with surgically treated sigmoid volvulus, followed by multivariable logistic regression including all factors shown to be significant in univariable analysis (Table 5). Only ASA grade was excluded because of its dependence on another variable (CCI). The analysis revealed that CCI ≥ 4, nursing home residence, and emergency surgery (groups 1 and 2) independently predicted an increased risk of 1-year mortality (Table 5). Kaplan–Meier analysis also demonstrated significantly better survival among patients who underwent elective surgery compared with those operated on in an emergency setting (Fig. 2). Consistent with the 30-day postoperative findings, patients with emergency endoscopic detorsion and elective surgery during a new hospital stay (group 4) had the best survival rates.

To assess the role of performing elective surgery during a subsequent admission (group 4), groups were compared based on co-morbidity and dependence (Table S1). This analysis showed a significant difference for age, CCI score, and ASA grade among all groups. However, when comparing elective surgery during the same hospital admission versus at a subsequent visit (groups 3 and 4), the differences were no longer significant for these variables.

Anastomotic leakage

A total of 275 patients with sigmoid volvulus underwent resection with anastomosis. Of these, 28 patients (10.2%) developed anastomotic leakage. Among patients treated with emergency surgery without previous endoscopy (group 1), anastomotic

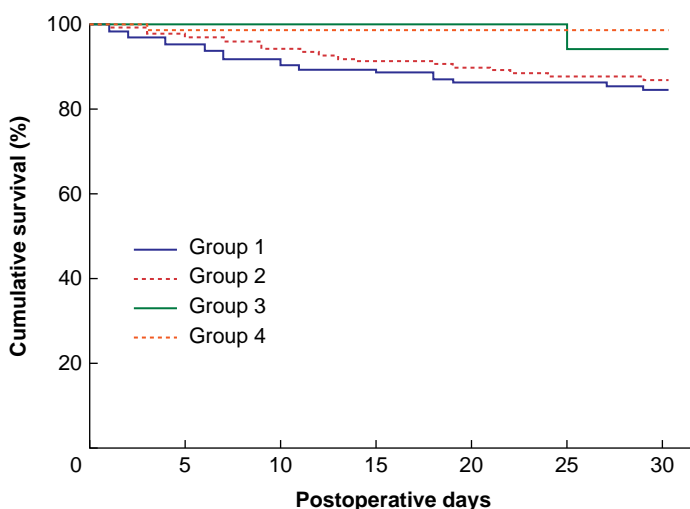
leakage occurred in 12 (16.2%), and, of those who had endoscopy followed by emergency surgery (group 2), 8 patients (7.6%) developed anastomotic leakage. No anastomotic leakage was observed in patients who underwent endoscopy followed by elective surgery during the index hospital visit (group 3). Among patients who underwent endoscopy followed by elective surgery during a subsequent hospital visit (group 4), eight (10.0%) developed anastomotic leakage. The difference was not statistically significant between groups. A total of 26 of 28 patients with anastomotic leakage required reoperation. Two patients had an intra-abdominal abscess with minor leakage and were treated with antibiotics.

Univariable regression analysis was undertaken to determine factors associated with the risk of anastomotic leakage (Table 6). All significant factors were included in multivariable logistic regression analysis, which revealed that ASA grade III and total colectomy with ileorectal anastomosis independently predicted an increased risk of anastomotic leakage after surgery for sigmoid volvulus (Table 6).

A total of 316 patients with caecal volvulus were operated with resection and anastomosis, of whom 5 (1.6%) developed anastomotic leakage. All patients required reoperation. Univariable regression analysis did not identify any significant predictors of leakage (data not shown).

Postoperative ileus

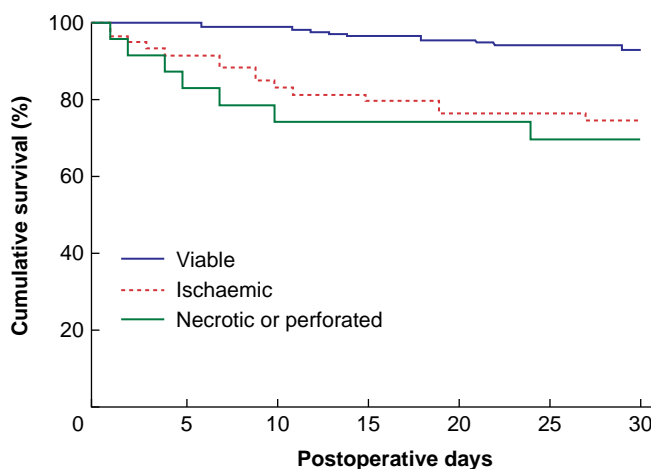
Of all 340 patients who had surgery for caecal volvulus, 50 (14.7%) developed postoperative ileus. Univariable regression analysis



No. at risk	0	5	10	15	20	25	30
Group 1	133	129	123	118	116	116	115
Group 2	147	144	140	132	130	130	129
Group 3	17	17	17	17	17	17	16
Group 4	84	83	83	83	83	83	83

Fig. 1 Kaplan–Meier survival analysis comparing 30-day survival among patients with sigmoid volvulus across four treatment groups

Group 1: emergency surgery; group 2: endoscopic decompression followed by emergency surgery; group 3: endoscopic decompression followed by elective surgery during the same hospital admission; group 4: endoscopic decompression followed by elective surgery during a subsequent hospital admission. Statistically significant differences in survival were observed among the groups. Overall survival curves were compared using the log rank (Mantel–Cox), Breslow (generalized Wilcoxon), and Tarone–Ware tests, all indicating significance ($\chi^2 = 10.67\text{--}10.69$, 3 degrees of freedom, $P = 0.014$).



No. at risk	0	5	10	15	20	25	30
Viable	181	181	180	173	170	170	169
Ischaemic	65	60	55	52	51	51	50
Necrotic or perforated	25	24	21	19	19	19	18

Fig. 2 Kaplan–Meier analysis of 30-day survival of sigmoid volvulus patients following emergency surgery, stratified by condition of bowel

There were significant differences between groups (log rank, Breslow, and Tarone–Ware tests; all $P < 0.001$, 2 degrees of freedom). Survival was significantly better among patients with sigmoid volvulus who had elective surgery compared with those operated in an emergency setting ($P = 0.01$).

was carried out to determine factors associated with the risk of postoperative ileus (Table 7), and all significant factors were included in multivariable logistic regression analysis. This revealed that nursing home residence and delayed postoperative mobilization from POD 3 onwards predicted an increased risk of postoperative ileus after surgery for caecal volvulus (Table 7).

Of all 381 patients who underwent surgery for sigmoid volvulus, 63 (16.5%) developed postoperative ileus. Univariate regression analysis was undertaken to determine factors associated with the risk of postoperative ileus (Table 8), followed by inclusion of all significant factors in multivariate logistic regression analysis. This showed that patients who underwent immediate emergency operation (group 1) had a tendency

Table 4 Regression analysis for 1-year mortality for operated caecal volvulus (313 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
CCI score				
0–3	1.00 (reference)		1.00 (reference)	
4–5	5.53 (1.96, 15.65)	0.001	4.40 (1.49, 12.98)	0.007
≥ 6	19.43 (7.19, 52.47)	<0.001	16.43 (5.65, 47.78)	<0.001
Female sex	0.62 (0.31, 1.22)	0.167		
ASA fitness grade				
IV–V	1.00 (reference)			
I–II	0 (0)	0.996		
III	0.70 (0.35, 1.41)	0.322		
Nursing home residence	5.497 (2.54, 11.91)	<0.001	3.19 (1.23, 8.26)	<0.001
Anticoagulant medication	2.69 (1.26, 5.76)	0.011	1.01 (0.40, 2.53)	0.985

Values in parentheses are 95% confidence intervals. CCI, Charlson Co-morbidity Index; ASA, American Society of Anesthesiologists.

Table 5 Regression analysis for 1-year mortality for operated sigmoid volvulus (356 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Male sex	1.56 (0.87, 2.81)	0.138		
ASA fitness grade				
I–II	1.00 (reference)			
III	2.36 (0.99, 5.64)	0.053		
IV–V	5.74 (2.39, 13.80)	<0.001		
CCI score				
0–3	1.00 (reference)		1.00 (reference)	
4–5	4.37 (2.15, 8.90)	< 0.001	3.70 (1.76, 7.77)	0.001
≥ 6	6.72 (3.06, 14.77)	<0.001	5.18 (2.29, 11.72)	<0.001
Nursing home residence	2.76 (1.61, 4.71)	<0.001	2.20 (1.22, 3.9)	0.009
Type of surgery				
Sigmoid resection	1.00 (reference)		1.00 (reference)	
Colectomy or other resection	1.99 (1.02, 3.92)	0.045	1.43 (0.67, 3.06)	0.352
Other surgery (detorsion, colopexy, stoma)	1.29 (0.26, 6.39)	0.754	1.42 (0.24, 8.33)	0.698
Anticoagulant medication	1.511 (0.87, 2.64)	0.146		
Patient group*				
Group 4	1.00 (reference)		1.00 (reference)	
Group 1	5.57 (1.88, 16.55)	0.002	3.78 (1.21, 11.82)	0.023
Group 2	6.44 (2.20, 18.89)	<0.001	3.92 (1.28, 11.99)	0.017
Group 3	2.43 (0.41, 14.52)	0.329	1.79 (0.28, 11.36)	0.538

Values in parentheses are 95% confidence intervals. *Group 1: emergency surgery without previous endoscopy; group 2: endoscopy followed by emergency surgery; group 3: endoscopy followed by elective surgery during index hospital visit; group 4: endoscopy followed by elective surgery during a subsequent hospital visit. ASA, American Society of Anesthesiologists; CCI, Charlson Co-morbidity Index.

towards an increased risk of postoperative ileus ($P=0.051$) after surgery for sigmoid volvulus. No significant predictors were identified (Table 8).

Postoperative wound complication

Of all 340 patients who had surgery for caecal volvulus, 26 (7.6%) developed a wound infection, fascial dehiscence, or both. Thirteen (50.0%) of these patients required reoperations and one had simultaneous anastomotic leakage. All 26 patients had undergone primary open surgery. Univariable regression analysis was used to determine factors associated with risk of wound complication (Table 9). All factors proven significant were included in the multivariable logistic regression analysis, which that revealed body mass index >33 kg/m² independently predicted the risk of wound complication after surgery for caecal volvulus (Table 9).

After surgery for sigmoid volvulus in 381 patients, 18 (4.7%) developed wound infection, fascial dehiscence, or both. Thirteen (72.0%) required reoperation. Two patients had both

anastomotic leakage and a wound complication. These two patients underwent primary laparoscopic surgery. The other 16 patients diagnosed with a wound complication underwent primary laparotomy. Univariable regression analysis did not identify any statistically significant predictors of wound infection, fascial dehiscence, or both after surgery for sigmoid volvulus.

Reoperations

Of all 721 surgically treated patients, 94 had a reoperation, 65 of 381 (17.1%) with sigmoid volvulus and 29 of 340 (8.5%) with caecal volvulus. Reasons for reoperation are listed in Table S2.

Postoperative 30-day readmissions

The readmission rate was 13.9% (53 of 381) among patients who had surgery for sigmoid volvulus and 11.1% (37 of 340) in those operated for caecal volvulus. Reasons for readmission are shown in Table S3.

Table 6 Regression analysis for risk factors for anastomotic leakage after operated sigmoid volvulus with resection and anastomosis (275 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Male sex	0.94 (0.40, 2.17)	0.878		
ASA fitness grade				
I-II	1.00 (reference)		1.00 (reference)	
III	5.20 (1.50, 18.02)	0.009	5.42 (1.16, 25.32)	0.032
IV-V	2.38 (0.51, 11.10)	0.269	4.809 (0.78, 29.38)	0.09
CCI score				
0-3	1.00 (reference)			
4-5	1.46 (0.61, 3.46)	0.394		
≥ 6	0.94 (0.25, 3.52)	0.926		
Patient group*				
Group 4	1.00 (reference)			
Group 1	1.74 (0.67, 4.54)	0.256		
Group 2	0.74 (0.27, 2.07)	0.569		
Group 3	0 (0)	0.998		
Nursing home residence	1.24 (0.52, 2.97)	0.635		
Anticoagulant medication	2.16 (0.96, 4.85)	0.063		
No. of preoperative detorsions				
2	1.00 (reference)			
0	1.84 (0.72, 4.70)	0.201		
1	0.95 (0.35, 2.57)	0.918		
Ischaemic/necrotic sigmoid	0.86 (0.24, 3.036)	0.811		
Duration of operation (min)				
< 150	1.00 (reference)		1.00 (reference)	
150-200	1.12 (0.31, 4.08)	0.868	0.74 (0.16, 3.54)	0.706
>200	4.19 (1.19, 14.79)	0.026	3.11 (0.74, 13.06)	0.121
Preoperative antibiotic prophylaxis	0.82 (0.27, 2.55)	0.733		
Bowel preparation/enema+antibiotics preoperatively	0.75 (0.27, 2.08)	0.581		
Intraoperative blood loss (ml)				
< 100	1.00 (reference)			
100-199	1.15 (0.33, 4.00)	0.828		
>200	1.29 (0.37, 4.52)	0.689		
Surgical approach				
Open sigmoid resection	1.00 (reference)		1.00 (reference)	
Laparoscopic sigmoid resection	1.14 (0.43, 3.01)	0.799	1.45 (0.44, 4.79)	0.543
Open left hemicolectomy	1.97 (0.40, 9.85)	0.408	1.83 (0.20, 16.67)	0.592
Open colectomy	5.92 (1.89, 18.56)	0.002	5.60 (1.45, 21.59)	0.012
Open proctocolectomy	0 (0)	0.999	0 (0)	0.999
Other open colonic resection	0 (0)	0.999	0 (0)	0.999
Laparoscopic left hemicolectomy	0 (0)	1	0	1

Values in parentheses are 95% confidence intervals. ASA, American Society of Anesthesiologists; CCI, Charlson Co-morbidity Index; min, minutes.

Length of hospital stay (LOS)

LOS was calculated for patients who had surgery for sigmoid volvulus, excluding those who died during the index hospital visit. In patients who underwent immediate emergency surgery (group 1), median LOS was 9.5 (i.q.r. 6-13, range 3-54) days. Among those who underwent emergency endoscopic detorsion followed by emergency surgery owing to unsuccessful decompression (group 2), median LOS was 10 (7-14, 3-39) days. Patients managed with emergency endoscopic detorsion followed by elective surgery during the same hospital stay (group 3) had a median LOS of 10 (7-12.5, 4-25) days. For patients who underwent elective surgery during a subsequent hospital visit after initial endoscopic detorsion (group 4), median LOS was 6 (4-11, 2-71) days. Comparison of groups using the Kruskal-Wallis test showed a statistically significant difference in LOS ($P < 0.001$).

LOS for patients who had surgery for caecal volvulus was calculated similarly, excluding in-hospital deaths. Median LOS was 7 (5-11, 2-40) days.

Conservative treatment

Of the 559 patients with sigmoid volvulus, 178 (31.8%) were treated conservatively (group 5). The proportion of

conservatively treated patients differed widely among participating centres (7.9-58.8%) owing to a lack of national guidelines. Patient characteristics are summarized in [Table 1](#).

A single detorsion was performed in 113 patients (57.9%). Thirty-three patients (18.5%) underwent 2 detorsions, 14 (7.9%) had 3 detorsions, and 28 (15.7%) had at least 4 detorsions. The median time to first recurrence was 76 (i.q.r. 11.25-351.75, range 1-1867) days and that to the second recurrence was 128.5 (43.5-272.25, 1-1493) days.

Kaplan-Meier analysis showed greatest 1-year survival for patients with five or more detorsions ($P = 0.08$) (data not shown). These patients would likely benefit from surgical care.

Discussion

This large multicentre cohort study included 901 patients. Most of the existing literature on colonic volvulus originates from countries within the 'volvulus belt', America and Turkey, where the underlying aetiology may differ. Finland has five tertiary university hospitals and numerous central hospitals. Four of the university hospitals and seven central hospitals participated in this study. The large number of patients offers the potential to inform and update the management of volvulus. Finland's

Table 7 Regression analysis for risk factors for postoperative ileus after operated caecal volvulus (340 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Male sex	1.29 (0.69, 2.42)	0.426		
Preoperative bowel function				
Normal	1.00 (reference)			
Constipation	1.50 (0.80, 2.79)	0.207		
Diarrhoea	1.33 (0.36, 4.96)	0.674		
Nursing home residence	2.81 (1.35, 5.84)	0.006	4.20 (1.75, 10.1)	0.001
CCI score				
0–3	1.00 (reference)			
4–5	0.48 (0.19, 1.20)	0.116		
≥ 6	1.21 (0.53, 2.74)	0.652		
ASA fitness grade				
I	1.00 (reference)			
II	6.34 (0.79, 50.56)	0.081		
III	6.35 (0.82, 49.05)	0.076		
IV–V	3.67 (0.45, 29.64)	0.223		
BMI (kg/m²)				
19–24	1.00 (reference)			
0–18	1.76 (0.59, 5.30)	0.314		
≥ 25	1.11 (0.49, 2.50)	0.810		
Anticoagulant medication	0.30 (0.09, 1.01)	0.051		
Duration of operation (min)				
<100	1.00 (reference)			
100–149	1.04 (0.52, 2.11)	0.903		
>150	0.89 (0.25, 3.18)	0.851		
Postoperative mobilization first on POD 3	2.97 (1.46, 6.03)	0.003	2.57 (1.23, 5.37)	0.012
Type of surgery				
Resection + anastomosis	1.00 (reference)			
Resection + stoma	1.15 (0.13, 10.02)	0.903		
Other (colopexy, detorsion)	0.88 (0.19, 4.03)	0.870		
Intraoperative blood loss (ml)				
< 100	1.00 (reference)			
100–200	1.50 (0.66, 3.41)	0.336		
>200	0.71 (0.24, 2.09)	0.534		
>2500 ml i.v. fluids on operation day	1.53 (0.50, 4.62)	0.454		
Surgical approach				
Open right hemicolectomy	1.00 (reference)			
Open ileocolic resection	1.93 (0.900, 4.14)	0.092		
Laparoscopic right hemicolectomy	1.33 (0.15, 11.77)	0.796		
Laparoscopic ileocolic resection	6.67 (0.41, 109.18)	0.184		
Other open colonic resection	3.33 (0.29, 37.79)	0.331		
Open colectomy	0 (0)	0.999		

Values in parentheses are 95% confidence intervals. CCI, Charlson Co-morbidity Index; ASA, American Society of Anesthesiologists; BMI, body mass index; min, minutes; POD, postoperative day; i.v., intravenous.

highly functional public healthcare system ensures that all emergency cases are treated within public hospitals. This minimizes potential socioeconomic biases commonly encountered in countries within the volvulus belt, and supports the representative nature of these data.

This national cohort study revealed that patients living independently with mild co-morbidities (CCI score ≤ 3), who undergo surgery for colonic volvulus with non-necrotic bowel have the most favourable survival outcome among all patients with colonic volvulus. In the event of sigmoid volvulus, initial endoscopic detorsion followed by elective surgery during a subsequent hospital admission is associated with improved survival. In contrast, emergency surgery is linked to a significantly higher risk of death.

Postoperative mortality after surgically treated volvulus was studied at a national level in North America in 2014⁹. All the patients were admitted as an emergency and bowel necrosis predicted death. This study also demonstrated that patients with sigmoid and caecal volvulus who had surgery in the emergency setting with intraoperative findings of bowel necrosis or perforation had significantly worse survival.

Other independent factors, such as patient co-morbidities, play an important role in overall outcomes after abdominal surgery both for non-cancerous conditions and colorectal cancers^{15,16}. Halabi *et al.*² reported chronic diseases as strong predictors of death in patients with sigmoid volvulus regardless of the chosen management approach. Their study included conservatively managed patients who were not fit for surgery. Conservative treatment is often selected for frail individuals with a burden of co-morbidities, which explains the significance of co-morbidities in the mortality analysis conducted by Halabi *et al.* This study demonstrated that co-morbidities are associated with increased short- and long-term mortality even in surgically treated patients with sigmoid and caecal volvulus. Based on these findings, an argument can be made for carefully considering surgery in the management of volvulus, given its proven survival benefits compared with a non-operative approach^{2,17}.

The optimal timing of surgery for sigmoid volvulus remains unclear. Emergency surgery should be avoided because of its high associated mortality risk¹⁸. However, delaying surgery for too long after initial colonoscopic detorsion is also inadvisable, given the previously reported recurrence rates. Consequently,

Table 8 Regression analysis for risk factors for postoperative ileus after operated sigmoid volvulus (381 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Female sex	1.05 (0.59, 1.86)	0.870		
ASA fitness grade				
I-II	1.00 (reference)			
III	1.35 (0.66, 2.78)	0.414		
IV-V	1.59 (0.73, 3.46)	0.245		
Age (years)				
< 60	1.00 (reference)			
60-80	1.29 (0.65, 2.53)	0.468		
>80	07.99 (0.31, 2.06)	0.642		
CGI score				
0-3	1.00 (reference)			
4-5	0.83 (0.44, 1.56)	0.568		
≥ 6	1.26 (0.61, 2.62)	0.529		
Preoperative bowel function				
Normal	1.00 (reference)			
Constipation	4.09 (0.95, 17.52)	0.058		
Diarrhoea	3.41 (0.66, 17.50)	0.142		
No. of preoperative detorsions				
1	1.00 (reference)			
0	1.10 (0.57, 2.13)	0.784		
2	0.40 (0.14, 1.10)	0.076		
≥3	1.00 (0.44, 2.27)	0.996		
Type of surgery				
Resection and end colostomy	1.00 (reference)			
Resection and diverting stoma	1.93 (0.53, 7.00)	0.317		
Resection and anastomosis	1.04 (0.53, 2.05)	0.902		
Stoma only	0 (0)	0.999		
Detorsion	1.33 (0.14, 12.84)	0.807		
Adhesiolysis	0 (0)	1		
Type of resection				
Left-sided resection (sigmoid, hemicolectomy, anterior, Hartmann)	1.00 (reference)		1.00 (reference)	
Total colectomy +/- stoma	2.27 (1.09, 4.75)	0.029	2.03 (0.95, 4.31)	0.066
Other colonic resection (JFB50, JFB63, JFB96)	0.50 (0.06, 3.95)	0.51	0.45 (0.06, 3.58)	0.448
Other procedure (detorsion, adhesiolysis)	0.69 (0.08, 5.61)	0.725	0.58 (0.07, 4.79)	0.611
Intraoperative blood loss (ml)				
< 100	1.00 (reference)			
100-199	1.37 (0.61, 3.06)	0.449		
>200	0.81 (0.34, 1.92)	0.633		
Duration of operation (min)				
< 150	1.00 (reference)			
150-200	1.34 (0.60, 2.99)	0.479		
>200	0.70 (0.20, 2.44)	0.573		
Nursing home residence	1.23 (0.69, 2.20)	0.477		
Mobilization first after POD 2	1.45 (0.76, 2.74)	0.257		
Patient group*				
Group 4	1.00 (reference)		1.00 (reference)	
Group 1	2.57 (1.06, 6.25)	0.037	2.46 (1.00, 6.07)	0.051
Group 2	2.48 (1.03, 5.97)	0.043	2.28 (0.94, 5.55)	0.070
Group 3	3.39 (0.87, 13.21)	0.079	3.44 (0.88, 13.43)	0.076
> 2500 ml i.v. fluids on operation day	1.70 (0.63, 4.62)	0.298		

Values in parentheses are 95% confidence intervals. *Group 1: emergency surgery without previous endoscopy; group 2: endoscopy followed by emergency surgery; group 3: endoscopy followed by elective surgery during index hospital visit; group 4: endoscopy followed by elective surgery during a subsequent hospital visit. ASA, American Society of Anesthesiologists; CCI, Charlson Co-morbidity Index; min, minutes; POD, postoperative day; i.v., intravenous.

most evidence supports performing surgery after initial colonoscopy, preferably during the index admission for patients without features of acute abdomen¹⁹. These results demonstrate best survival outcomes in patients who were readmitted for elective surgery at least 1 week after the initial detorsion. Potential explanations include improved colonic healing compared with the immediate period after detorsion, as well as enhanced overall patient condition, including nutritional status following resolution of the obstruction. Additionally, a patient's mental preparedness for surgery improves when they are well informed, as emphasized in the enhanced recovery after surgery (ERAS) literature. Similar principles should be applied to patients with volvulus undergoing planned elective procedures^{20,21}.

Althans *et al.*¹⁷ examined risk factors for short-term surgical complications in a database of patients who had surgery for volvulus. They reported similar anastomotic leakage rates following right- and left-sided resections (4.1-4.9%). In the present study, the leakage rate was higher in patients with sigmoid volvulus undergoing colorectal anastomosis (10.2%) than that in patients with caecal volvulus who had ileocolic anastomosis (1.6%). This study included other types of resection, such as total colectomy with primary anastomosis, which was associated with an increased risk of anastomotic leakage in patients with sigmoid volvulus even in the absence of megacolon or sepsis. A previous study⁶ from Turkey reported a 21.0% leakage rate following resection for sigmoid volvulus, whereas Moro-Valdezate *et al.*²²

Table 9 Regression analysis for risk factors for wound complication after operated caecal volvulus (340 patients)

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Male sex	2.38 (1.06, 5.32)	0.035	1.86 (0.66, 5.28)	0.241
ASA fitness grade				
I-II	1.00 (reference)			
III	2.13 (0.73, 6.25)	0.168		
IV-V	2.08 (0.67, 6.45)	0.203		
CCI score				
0-3	1.00 (reference)			
4-5	0.63 (0.20, 1.95)	0.423		
≥ 6	1.53 (0.56, 4.12)	0.405		
Preoperative antibiotic prophylaxis	0.36 (0.05, 2.78)	0.33		
BMI (kg/m²)				
0-25	1.00 (reference)		1.00 (reference)	
26-32	2.46 (0.77, 7.86)	0.129	2.07 (0.61, 7.07)	0.246
>33	5.06 (1.21, 21.23)	0.027	4.33 (1.04, 18.04)	0.044
Condition of caecum				
Viable	1.00 (reference)			
Ischaemic	1.14 (0.48, 2.73)	0.769		
Necrotic/perforated	1.29 (0.34, 4.84)	0.706		
Laparoscopic surgery	0 (0)	0.999		
Type of surgery				
Resection + anastomosis	1.00 (reference)			
Resection + stoma	0 (0)	0.999		
Other (colopexy, detorsion)	0 (0)	0.999		
Timing of peroral liquids				
POD 0-1	1.00 (reference)			
POD 2	0.96 (0.26, 3.53)	0.953		
POD 3-4	1.15 (0.31, 4.26)	0.830		

Values in parentheses are 95% confidence intervals. ASA, American Society of Anesthesiologists; CCI, Charlson Co-morbidity Index; BMI, body mass index; POD, postoperative day.

noted a 7.4% leakage rate after emergency sigmoid resection in a single-centre study. Althans *et al.*¹⁷ identified male sex as a risk factor for leakage; in contrast, co-morbidity was a stronger predictor in the present study. These discrepancies may be explained by differences in patient populations and the inherent challenges in capturing data on emergency procedures accurately, a limitation also noted by Althans *et al.*

Postoperative ileus represents another major complication after colonic surgery. Patients with volvulus often already present with a dysfunctional bowel on admission, which further complicates postoperative recovery of bowel function. In patients undergoing colonic resection for indications other than volvulus, postoperative ileus is more common after right-sided than left-sided resections²³. However, in patients with volvulus, the incidence of postoperative ileus appears similar between caecal and sigmoid volvulus, as reported by Althans *et al.*¹⁷ and confirmed here. This susceptibility to postoperative ileus can be managed with appropriate preventive actions. ERAS protocols are currently the standard for reducing postoperative complications.

Patients with volvulus are typically managed as an emergency admission. Despite frequent presentation in poor general health, it remains essential to provide patients with clear information regarding the risks and available treatment options. Caecal volvuli in fit patients are nearly always managed surgically. In contrast, patients with sigmoid volvulus present with more variable disease profiles. They should be informed about the risks associated with surgery, as well as the high likelihood of recurrence and repeated hospital visits when choosing solely endoscopic treatment. Although postoperative complications are of concern, patients with sigmoid volvulus should be counselled about all of the treatment options.

As a result of this national analysis, there is an opportunity to develop a treatment algorithm to guide the optimal

management of volvulus in Finland. In 2017, Atamanalp²⁴ published a classification system for treatment of sigmoid volvulus, which considers patient age, ASA grade, bowel condition, presence of sigmoid gangrene, and the success rate of primary endoscopy. Based on the present data, the algorithm should consider patients' co-existing co-morbidities and independence status. Surgical treatment should be considered for every patient. Sepsis or peritonitis should be managed immediately, especially in frail patients. Elective surgery should always be the primary goal and preferably after a short prehabilitation period. A well implemented and functional ERAS programme is paramount when managing elderly patients with co-morbidities, especially in an emergency setting.

This study has limitations including its retrospective design, which inherently creates bias. Patients with fewer co-morbidities were more likely to be selected for surgery and therefore to have better survival outcomes. Conversely, patients with sigmoid volvulus who received only endoscopic treatment, typically deemed unfit for surgery, had the poorest survival outcomes. It is crucial to establish the threshold of frailty at which a patient is considered unfit for surgery. Given that the 30-day mortality rate for conservatively treated patients with sigmoid volvulus was as high as 19.0%, it remains unclear whether offering surgery irrespective of patient co-morbidities would improve survival. Future studies should explore the association between patient frailty and mortality.

The second limitation is external validity as the study was conducted in a single country. However, the study population was drawn from a national cohort in a country with a population of 5.1 million, and the condition under investigation is relatively rare. The absence of major differences in management approaches across participating hospitals supports the internal consistency and enhances the generalizability of the findings.

Funding

This research received no external funding.

Author contributions

Suvi Rasilainen (Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing—original draft, Writing—review & editing), Mohamud Aden (Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing—original draft, Writing—review & editing), Antti Kivelä (Conceptualization, Funding acquisition, Methodology, Supervision, Validation, Visualization), Sakari Pakarinen (Data curation), Jukka Rintala (Data curation), Susanna Niemeläinen (Data curation), Ilona Helavirta (Data curation), Salla Moilanen (Data curation), Anne Mattila (Data curation), Tarja Pinta (Data curation), Kapo Saukkonen (Data curation), Päivi Vento (Data curation), Niko Turkkka (Data curation), Pasi Pengermä (Data curation), Jenny Häggblom (Data curation), and Tom Scheinin (Conceptualization, Formal analysis, Methodology, Supervision, Visualization)

Disclosure

The authors declare no conflict of interest.

Supplementary material

Supplementary material is available at [BJS Open](https://doi.org/10.1093/bjsopen/article/9/5/zraf113/8263437) online.

Data availability

The data presented in this study are available on request from the corresponding author.

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