

Factors affecting bowel gangrene development in patients with sigmoid volvulus

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BACKGROUND AND OBJECTIVES: Sigmoid gangrene develops in 6.1% to 93.4% of sigmoid volvulus (SV) cases, and increases the mortality rate from 0% to 40% without bowel gangrene to 3.7% to 80%. This study aimed to investigate factors that induce bowel gangrene development in SV patients.

DESIGN AND SETTINGS: Retrospective study from a single center.

PATIENTS AND METHODS: We determined whether there was any correlation between sigmoid gangrene and the following factors: age, gender, a previous history of a volvulus, previous history of abdominal surgery, pregnancy, major comorbidities, shock, duration of symptoms, direction and degree of rotation of volvulus, and ileosigmoid knotting.

RESULTS: Of 442 patients, 271 (61.3%) had sigmoid gangrene. The presence of pregnancy was negatively correlated with sigmoid gangrene development ($P<.05$), while comorbid diseases ($P<.01$), associated shock ($P<.01$), prolonged symptom duration ($P<.05$), overrotation ($P<.05$), and associated ileosigmoid knotting ($P<.01$) were positively correlated with bowel gangrene. However, no correlation was observed between sigmoid gangrene and the other studied factors.

CONCLUSION: An inverse correlation between pregnancy and sigmoid gangrene was observed. On the other hand, a positive correlation was noted between bowel gangrene and comorbid diseases, shock, prolonged duration of symptoms, overrotation, and associated ileosigmoid knotting.

Sigmoid volvulus (SV), the wrapping of the sigmoid colon around itself and its mesentery, is an unusual but serious type of intestinal obstruction.¹ Both luminal obstruction and vascular occlusion are important pathophysiological consequences that arise in SV. Increased intracolonic pressure that decreases capillary perfusion coupled with mechanical occlusion, and vessel thrombosis contribute to mucosal ischemia, resulting in bowel gangrene.^{1,2}

Sigmoid gangrene develops in 6.1% to 93.4% of SV cases.³⁻⁷ In SV, prognostic risk factors like advanced age, comorbid diseases, shock, delayed presentation, and sigmoid overrotation are well documented.^{3,8,9} Bowel gangrene has been associated with increased mortality.^{8,9} However, the risk factors for bowel gangrene development have not been thoroughly investigated in SV.¹⁰ In this article, we report on our 45.5 years of experience with a total of 442 SV cases treated surgically, in Eastern Anatolia, Turkey, a region in which SV is endemic.^{9,10}

PATIENTS AND METHODS

We retrospectively reviewed the clinical records of 442 patients with sigmoid volvuli, including 271 patients with bowel gangrene surgically treated under emergency conditions at the Department of General Surgery, Faculty of Medicine, Ataturk University over a 45.5-year period from June 1966 to January 2012. Age, gender, history of a volvulus, previous history of abdominal surgery, pregnancy, major comorbidities, shock, duration of symptoms, direction and degree of rotation, and ileosigmoid knotting were studied to determine any correlations with sigmoid gangrene.

The chi-square test or Fisher exact test were used for statistical analysis, statistical significance was set at $P<.05$, and odds ratio estimates were given with 95% confidence intervals.

RESULTS

In this series, 271 (61.3%) of the 442 patients with SV had sigmoid gangrene. In 93 of 271 gangrenous volvuli

(34.3%), sigmoid gangrene was diagnosed utilizing rectal digital examination by determining melanotic stool, while endoscopic examination demonstrated bowel gangrene in 37 patients (13.7%), and sigmoid gangrene was diagnosed at laparotomy in the remaining 141 patients (52.0%). The presence of pregnancy ($P<.05$) was negatively correlated with sigmoid gangrene development, while major comorbid diseases (chronic obstructive pulmonary disease, hypertension, coronary disease, cardiac failure, diabetes mellitus, chronic renal insufficiency, hemiplegia, and Parkinson's disease) ($P<.01$), the presence of toxic and/or hypovolemic shock ($P<.01$), prolonged symptom duration ($P<.05$), overrotation ($P<.05$), and the presence of ileosigmoid knotting ($P<.01$) were positively correlated with bowel gangrene. However, no correlation was found between sigmoid gangrene and the other criteria evaluated, in-

cluding being 60 years of age or older, gender, history of volvulus, previous abdominal surgery, and direction of rotation ($P<.05$). In this series, 58 of 271 patients (21.4%) died. The findings and results of the statistical analyses are presented in **Table 1**.

DISCUSSION

Sigmoid gangrene is a potentially catastrophic complication of SV and develops in 6.1% to 30.2% of all SV cases and 10.7% to 93.4% of surgically treated SV cases, as shown in **Table 2**.^{3-7,9-18} In SV, volume loss into the obstructive bowel lumen leads to hypovolemia as well as mucosal ischaemic injury; necrosis facilitates bacterial translocation and the absorption of toxic products, resulting in toxemia.^{1,2} Thus, the mortality rate increases from 0% to 40% in SV to 3.7-80% in SV with bowel gangrene.^{3-7,9,10,14,16,18}

Table 1. Results of the statistical analyses.

Criteria	Patient	Gangrene	Statistical analysis	OR with 95% CI
Under 60 years of age (RC)	217	128 (59.0%)	Chi-squared test, P .324	1.21 (0.83-1.78)
60 years of age and older	225	143 (63.6%)	Non-significant	
Male	364	225 (61.8%)	Chi-squared test, P .640	1.13 (0.68-1.85)
Female (RC)	78	46 (59.0%)	Non-significant	
No history of volvulus	320	198 (61.9%)	Chi-squared test, P .694	1.09 (0.71-1.67)
History of volvulus (RC)	122	73 (59.8%)	Non-significant	
No history of abdominal surgery (RC)	371	225 (60.6%)	Chi-squared test, P .512	1.19 (0.70-2.03)
History of abdominal surgery	71	46 (64.8%)	Non-significant	
No pregnancy	69	44 (63.8%)	Fisher exact test, P .028	6.16 (1.19-31.96)
Presence of pregnancy (RC)	9	2 (22.2%)	Significant ^a	
No comorbid disease (RC)	328	189 (57.6%)	Chi-squared test, P .007	1.88 (1.19-3.00)
Presence of comorbid disease	114	82 (71.9%)	Highly significant	
No shock (RC)	337	187 (55.5%)	Chi-squared test, P .000	3.21 (1.90-5.42)
Presence of shock	105	84 (80.0%)	Highly significant	
Symptom period <24 hrs (RC)	88	45 (51.1%)	Chi-squared test, P .029	1.69 (1.05-2.70)
Symptom period \geq 24 hrs	354	226 (63.8%)	Significant	
Volvulus in clockwise direction (RC)	167	101 (60.5%)	Chi-squared test, P .821	1.05 (0.68-1.62)
Volvulus in counterclockwise direction	180	111 (61.7%)	Non-significant ^b	
Volvulus degree <360° (RC)	102	52 (51.0%)	Chi-squared test, P .013	1.81 (1.13-2.89)
Volvulus degree \geq 360°	245	160 (65.3%)	Significant ^b	
No ileosigmoid knotting (RC)	442	271 (61.3%)	Chi-squared test, P .001	2.66 (1.44-4.91)
Presence of ileosigmoid knotting	73	59 (80.8%)	Highly significant ^c	

OR: Odds ratio, CI: Confidence interval, RC: Reference category ^aIn 78 female patients, ^bIn 212 patients for whom information was available, ^cSigmoid colon and/or ileum gangrene.

Bhatnagar et al³ found no correlation between age and sigmoid gangrene when comparing patients less than 60 years of age with greater than 60 years of age; they also found no correlation between gender and bowel gangrene. Similarly, Raveenthiran¹⁴ reported that there was no significant difference between the gangrenous and viable groups in mean age or gender. Our series had similar characteristics. Although advanced age is a known risk factor for increased mortality in SV,¹⁰ and an increased rate of bowel gangrene is expected in elderly patients due to vascular pathologies and other associated diseases, this hypothesis has not been confirmed by previous reports and was not confirmed in the present study.

According to Bhatnagar et al,³ patients experiencing bowel gangrene did not have a greater incidence of previous volvulus. Our study showed similar results concerning the relationship between volvulus history and abdominal surgery and sigmoid gangrene. However, the clinical appearance of SV and incidence of bowel gan-

grene in pregnant SV cases is controversial. Kulusari et al¹⁹ found sigmoid gangrene in all of four pregnant SV patients. In contrast, Atamanalp et al²⁰ reported a bowel gangrene incidence rate of 22.2% in a series of nine pregnant SV patients, which was less than that of the non-pregnant SV patients. Some authors have asserted that the diagnosis of SV is often delayed because the pregnancy itself clouds the clinical picture. Some clinical SV symptoms can occur in normal pregnancies, and an x-ray examination is generally avoided due to the risk of radiation to the fetus.^{19,21,22} Other studies have suggested that the enlarged uterus narrows the intra-abdominal area, which may cause symptoms to appear earlier and complications to be less frequently observed.²⁰ Interestingly, in the present study, there was an inverse correlation between pregnancy and sigmoid gangrene. In our opinion, some pregnant patients may present clinical symptoms earlier than those without pregnancy due to the dramatic clinical signs caused by the narrowed intra-abdominal area.

Table 2. Rates of sigmoid gangrene and mortality in various sigmoid volvulus series.

Author	Year	Characteristic	Patient	Gangrene %	Mortality %	Mortality % in non-gangrenous cases	Mortality % in gangrenous cases
Bhatnagar et al ³	2004	Surgically treated	76	93.4	42.1	40.0	42.3
Ballantyne ⁴	1982	All	299			10.6	80.0
Ballantyne et al ⁵	1985	All	59	6.8	6.8	6.1	25.0
Pahlman et al ⁶	1989	All	60	10.0	15.0	11.1	50.0
		Surgically treated	28	10.7	21.4	20.0	33.3
Safioleas et al ⁷	2007	All	33	6.1	3.0	0.0	50.0
		Surgically treated	7	28.6	14.3	0.0	50.0
Oren et al ⁹	2007	All	827	30.2	8.1	2.6	20.8
		Surgically treated	393	63.6	15.8	7.0	20.8
Atamanalp et al ¹⁰	2008	Surgically treated	420	63.1	16.2	6.5	21.9
Khanna et al ¹¹	1999	Surgically treated	111	36.0	6.3		
Grossmann et al ¹²	2000	All	228	25.9	13.6		
		Surgically treated	178	33.1	14.0		
De et al ¹³	2003	Surgically treated	197	11.7	1.0		
Raveenthiran ¹⁴	2004	Surgically treated	57	47.4	3.5	3.3	3.7
Heis et al ¹⁵	2008	All	32	9.4	6.3		
		Surgically treated	7	42.9	28.6		
Nuhu et al ¹⁶	2010	Surgically treated	48	45.8	10.4	3.8	18.2
Mulas et al ¹⁷	2010	All	64	9.4	14.1		
		Surgically treated	41	14.6	22.0		
Atamanalp et al ¹⁸	2011	All	901	29.6	8.2	2.5	21.7
Present series	2012	Surgically treated	442	61.3	16.1	7.6	21.4

Although Bhatnagar et al³ reported no correlation between shock and sigmoid gangrene, Raveenthiran¹⁴ revealed a high incidence of circulatory shock in patients with bowel gangrene, likely due to hemorrhaging into the gangrenous bowel lumen and peritoneal cavity. Similar to the latter report, our study presented a high rate of sigmoid gangrene in patients suffering from toxic and/or hypovolemic shock. However, the cause and effect relationship between bowel gangrene and shock is unclear, and sigmoid gangrene likely causes hypovolemic and/or toxic shock due to volume loss into the obstructive bowel lumen and the absorption of toxic products.^{3,14} Our series showed a similar correlation between sigmoid gangrene and major comorbid diseases, including pulmonary, vascular, cardiac or coronary, metabolic, renal, and neurologic diseases.

When patients with a symptom period of less than 4 days were compared with patients with a symptom period of great than 4 days, Bhatnagar et al³ found no correlation between symptom duration and sigmoid gangrene. However, according to Raveenthiran,¹⁴ patients with bowel gangrene presented much earlier than patients with viable bowels, and this inverse correlation between symptom duration and gangrene occurrence is a well-known phenomenon. In contrast, another study demonstrated that a prolonged symptom period was a predisposing factor for shock, and the development of gangrene might also be attributed to a prolonged symptom period.¹⁰ In our study, an increased rate of bowel gangrene was observed when comparing patients having a symptom period greater than 24 hours with patients having a symptom period less than 24 hours. However, in our experience, a prolonged symptom period can affect mortality by predisposing the patient to shock and occasionally, gangrene.

According to Raveenthiran et al,² twists less than 180° are considered a normal physiological volvulus. Luminal obstruction occurs when torsion exceeds 180°, while vascular compromise ensues when torsion exceeds 360°. Our study revealed an increased rate of sigmoid gangrene in patients with overrotation (greater than 360°), which can be explained by mechanical factors. In some patients, bowel gangrene may develop at an earlier phase due to overrotation.¹⁰ In many SV patients, torsion occurs in an anticlockwise direction for unknown reasons,² as observed in our series. Although the present study revealed no correlation between torsion direction and sigmoid gangrene, there is not enough available literature to evaluate this connection.

The relationship between bowel gangrene and the presence of ileosigmoid knotting associated with SV is a well-discussed subject in the literature, and ileosigmoid knotting has been observed to increase the rate of bowel gangrene from 6.8-15.8% to 63.6-84.4%, according to Ballantyne et al,⁵ Oren et al,⁹ Kotisso et al,²³ Machado,²⁴ and Atamanalp.²⁵ Similar to the previous reports, in our series, SV patients with ileosigmoid knotting experienced a higher rate of bowel gangrene incidence than the other SV patients; likely due to double-loop obstruction.

In conclusion, an inverse correlation was found between pregnancy and sigmoid gangrene, while positive correlation was observed between bowel gangrene and major comorbid diseases, toxic and/or hypovolemic shock, prolonged duration of symptoms, overrotation, and associated ileosigmoid knotting.

Conflict of interest statement:

The authors declare that they have no conflict of interest to the publication of this article.

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