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.

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
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(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 ($P<.01$), 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, including 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 2.3-7,8,18 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, $P_{.324}$ Non-significant | 1.21 (0.83-1.78) |
| 60 years of age and older             | 225     | 143 (63.6%) |                       |               |
| Male                                  | 364     | 225 (61.8%) | Chi-squared test, $P_{.640}$ Non-significant | 1.13 (0.68-1.85) |
| Female (RC)                           | 78      | 46 (59.0%)  |                       |               |
| No history of volvulus                | 320     | 198 (61.9%) | Chi-squared test, $P_{.694}$ Non-significant | 1.09 (0.71-1.67) |
| History of volvulus (RC)              | 122     | 73 (59.8%)  |                       |               |
| No history of abdominal surgery (RC)  | 371     | 225 (60.6%) | Chi-squared test, $P_{.512}$ Non-significant | 1.19 (0.70-2.03) |
| History of abdominal surgery          | 71      | 46 (64.8%)  |                       |               |
| No pregnancy                          | 69      | 44 (63.8%)  | Fisher exact test, $P_{.028}$ Significant* | 6.16 (1.19-31.96) |
| Presence of pregnancy (RC)            | 9       | 2 (22.2%)   |                       |               |
| No comorbid disease (RC)              | 328     | 189 (57.6%) | Chi-squared test, $P_{.007}$ Highly significant | 1.88 (1.19-3.00) |
| Presence of comorbid disease          | 114     | 82 (71.9%)  |                       |               |
| No shock (RC)                         | 337     | 187 (55.5%) | Chi-squared test, $P_{.000}$ Highly significant | 3.21 (1.90-5.42) |
| Presence of shock                     | 105     | 84 (80.0%)  |                       |               |
| Symptom period <24 hrs (RC)           | 88      | 45 (51.1%)  | Chi-squared test, $P_{.029}$ Significant | 1.69 (1.05-2.70) |
| Symptom period ≥24 hrs                | 354     | 226 (63.8%) |                       |               |
| Volvulus in clockwise direction (RC)  | 167     | 101 (60.5%) | Chi-squared test, $P_{.821}$ Non-significant* | 1.05 (0.68-1.62) |
| Volvulus in counterclockwise direction| 190     | 111 (61.7%) |                       |               |
| Volvulus degree <360° (RC)            | 102     | 52 (51.0%)  | Chi-squared test, $P_{.013}$ Significant* | 1.81 (1.13-2.89) |
| Volvulus degree ≥360° (RC)            | 245     | 180 (65.3%) |                       |               |
| No ileosigmoid knotting (RC)          | 442     | 271 (61.3%) | Chi-squared test, $P_{.001}$ Highly significant* | 2.66 (1.44-4.91) |
| Presence of ileosigmoid knotting      | 73      | 59 (80.8%)  |                       |               |

OR: Odds ratio, CI: Confidence interval, RC: Reference category *In 78 female patients, †In 212 patients for whom information was available, ‡Sigmoid colon and/or ileum gangrene.
Bhatnagar et al\(^3\) 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, Raveenthiran\(^14\) 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 been 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 gangrene in pregnant SV cases is controversial. Kolusari et al\(^19\) found sigmoid gangrene in all of four pregnant SV patients. In contrast, Atamanalp et al\(^10\) 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                          |
| Safioleas et al\(^7\) | 2007 | Surgically treated     | 28      | 10.7       | 21.4       | 20.0                               | 33.3                          |
| Oren et al\(^8\)    | 2007 | Surgically treated     | 33      | 6.1        | 3.0        | 0.0                                | 50.0                          |
| Atamanalp et al\(^9\) | 2008 | Surgically treated     | 7       | 28.6       | 14.3       | 0.0                                | 50.0                          |
| Khanna et al\(^10\) | 1999 | Surgically treated     | 827     | 30.2       | 8.1        | 2.6                                | 20.8                          |
| Grossmann et al\(^11\) | 2000 | Surgically treated     | 393     | 63.6       | 15.8       | 7.0                                | 20.8                          |
| De et al\(^12\)     | 2003 | Surgically treated     | 420     | 63.1       | 16.2       | 6.5                                | 21.9                          |
| Raveenthiran\(^13\) | 2004 | Surgically treated     | 111     | 36.0       | 6.3        |                                    |                               |
| Heis et al\(^14\)   | 2008 | Surgically treated     | 228     | 25.9       | 13.6       |                                    |                               |
| Nuhu et al\(^15\)   | 2010 | Surgically treated     | 178     | 33.1       | 14.0       |                                    |                               |
| Mulas et al\(^16\)  | 2010 | Surgically treated     | 197     | 11.7       | 1.0        |                                    |                               |
| Atamanalp et al\(^17\) | 2011 | All                    | 57      | 47.4       | 3.5        | 3.3                                | 3.7                           |
| Present series      | 2012 | Surgically treated     | 32      | 9.4        | 6.3        |                                    |                               |
|                     |      |                        | 7       | 42.9       | 28.6       |                                    |                               |
|                     |      |                        | 48      | 45.8       | 10.4       | 3.8                                | 18.2                          |
|                     |      |                        | 64      | 9.4        | 14.1       | 4.1                                | 22.0                          |
|                     |      |                        | 901     | 29.6       | 8.2        | 2.5                                | 21.7                          |
|                     |      |                        | 442     | 61.3       | 16.1       | 7.6                                | 21.4                          |
Although Bhatnagar et al. reported no correlation between shock and sigmoid gangrene, Raveenthiran 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. 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 al. found no correlation between symptom duration and sigmoid gangrene. However, according to Raveenthiran, 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. 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., 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. In many SV patients, torsion occurs in an anticlockwise direction for unknown reasons, 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., Oren et al., Kotisso et al., Machado, and Atamanalp. 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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