

# Base Excess and White Blood Cell Counts Predict Bowel Gangrene in Japanese Sigmoid Colon Volvulus Patients

Satoru Yamaguchi\*, Yosuke Shida, Keisuke Ihara, Hideo Ogata, Hiroto Muroi, Takeshi Yamaguchi, Masanobu Nakajima, Kinro Sasaki, Takashi Tsuchioka, Hiroyuki Kato

Department of Surgery I, Dokkyo Medical University, Mibu, Japan

Email: \*syamaguc@dokkyomed.ac.jp

**How to cite this paper:** Yamaguchi, S., Shida, Y., Ihara, K., Ogata, H., Muroi, H., Yamaguchi, T., Nakajima, M., Sasaki, K., Tsuchioka, T. and Kato, H. (2018) Base Excess and White Blood Cell Counts Predict Bowel Gangrene in Japanese Sigmoid Colon Volvulus Patients. *Open Journal of Gastroenterology*, 8, 140-146.  
<https://doi.org/10.4236/ojgas.2018.84015>

**Received:** March 7, 2018

**Accepted:** April 27, 2018

**Published:** April 30, 2018

Copyright © 2018 by authors and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

**Objective:** This study aimed to investigate factors that predict bowel gangrene in sigmoid colon volvulus patients. **Methods:** Nine sigmoid colon volvulus cases were retrospectively analyzed for prediction of bowel necrosis. Laboratory parameters were extracted from medical records, and subsequently, a receiving operator curve for each parameter was drawn. Using these cut-off values, a comparison between the “with necrosis” and “without necrosis” groups was performed. **Results:** In the emergent cases, necrosis of the intestine was observed in 4 cases and not observed in 4 cases. The values of area under the curve were high in metabolic acidosis and white blood cell counts. For base excess, the cut off value was  $-2.4$  mEq/L. A lower base excess is significantly associated with bowel gangrene ( $p = 0.029$ ). For white blood cell count, the cut off value is  $8400/\text{mm}^3$ . A lower white blood cell counts is significantly associated with bowel gangrene ( $p = 0.029$ ). **Conclusions:** In addition to physiological findings, blood gas analysis and white blood cell counts are useful to detect ischemia due to sigmoid volvulus.

## Keywords

Predictive Marker, Bowel Gangrene, Japanese, Sigmoid Colon Volvulus

## 1. Introduction

Sigmoid colon volvulus occurs with torsion of the sigmoid colon, leading to acute obstruction [1]. Twisting of the intestine on its vascular pedicle causes venous obstruction, followed by arterial compromise, then potentially causes necrosis in the intestinal wall by ischemia [2] [3]. Subsequently, a clinician must

determine its management by performing an urgent operation, endoscopic decompression, or observation, immediately. Volvulus of the sigmoid colon occurs worldwide, but its incidence is markedly varied by geography. The so-called “volvulus belt” extends across the equator and southern hemisphere from Brazil to sub-Saharan Africa, the Middle East, India, and Russia. Risk factors of sigmoid colon volvulus include an older age and neurologic and psychiatric diseases [4]. When a patient presents with acute abdomen, intestinal perforation, or ischemic necrosis of the intestine, emergent surgery is required. Severe dehydrations with shock and metabolic acidosis may develop, which also require rapid surgical intervention. Otherwise, endoscopic decompression is suitable for patients without emergent signs who are in a good general condition. However, clinical management of sigmoid volvulus remains controversial, as the diagnosis of acute abdomen is still difficult.

Here, we analyzed our retrospective cases to elucidate the surrogate marker for necrotizing ischemia in sigmoid colon volvulus patients. Blood gas analyses and a white blood cell count were useful markers.

## 2. Patients and Methods

Nine sigmoid colon volvulus cases presenting at Dokkyo Medical University from January 2005 to November 2011 were retrospectively analyzed (men/women, 6/3; median age, 80 years (28 - 83)). First-time attacks were observed in 8 patients, whereas one patient experienced repeated attacks. Symptoms of the attacks were an abdominal colic pain and distension in all patients. Clinical parameters such as Base excess (BE), white blood cell counts (WBC), C-reactive protein (CRP), aspartate aminotransferase (AST), and lactate dehydrogenase (LDH) were analyzed for prediction of bowel necrosis. No missing data were observed regarding these parameters. Receiving operator curves (ROC) for each parameter were created. The values of the area under the curve (AUC) were compared. Fisher exact test was performed for categorical analyses. Statistical analyses were performed by using R statistical software. Written informed consent was obtained from all patients.

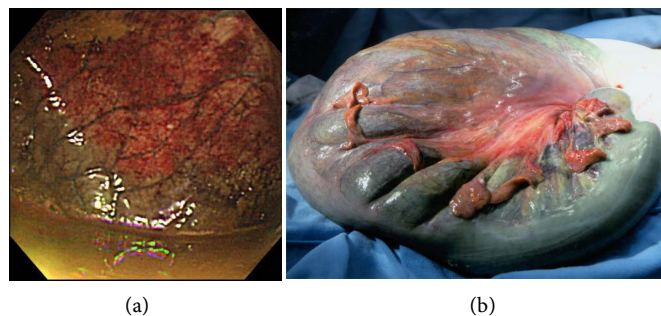
## 3. Results

Within the 9 patients, an emergent operation was performed in 8 patients, whereas elective surgery was performed in 1 patient. In the emergent cases, necrosis of the intestine was observed in 4 cases and was not observed in 4 cases. In necrosis cases, 4 patients underwent sigmoid colon resection. In viable intestinal wall cases, 3 patients received sigmoid colon resection, and 1 patient received sigmoidopexy. In the patient who received elective surgery, laparoscopic sigmoid colon resection was performed.

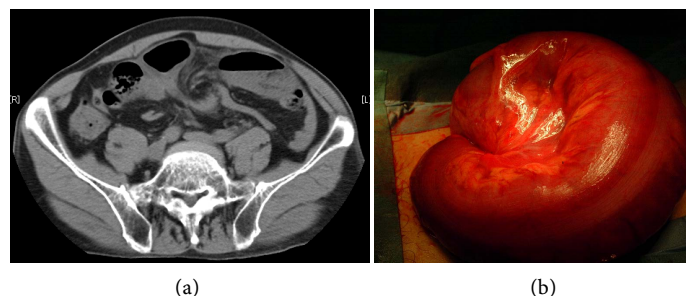
Here, two cases are presented. First, a 67-year-old man with Parkinson's Disease was admitted to our hospital with increasing abdominal pain that started from 4 days ago. Laboratory findings showed metabolic acidosis, a normal white

blood cell count, and high CRP values. Emergent colonoscopy showed blackened mucosa indicating intestinal necrosis. In an emergent operation, the necrotizing sigmoid colon was resected (**Figure 1**). Another case without intestinal necrosis was also presented. An 81-year-old man admitted to our hospital with abdominal pain that began 7 hours ago. Abdominal computed tomography showed torsion of the mesenteric vessels. Based on laparotomy results, sigmoid volvulus was the cause of obstruction; however, its color was maintained. Subsequently, repair of the rotation was performed (**Figure 2**). Laboratory findings indicated non-acidosis on blood gas analysis and a slightly elevated white blood cell count, but creatine phosphokinase (CPK) and LDH were not elevated.

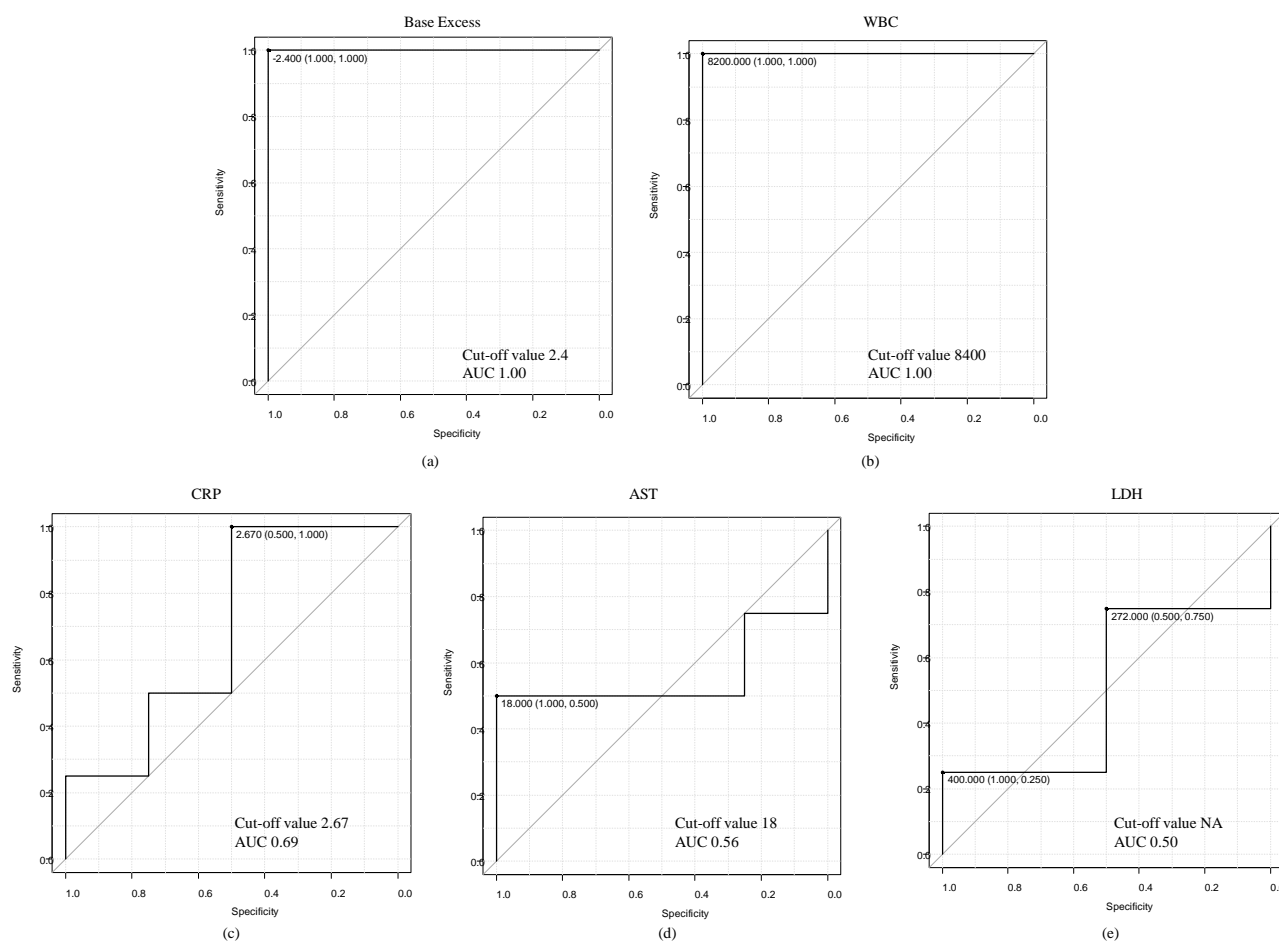
From these experiences, we analyzed the factors that predict intestinal necrosis. For these purposes, laboratory parameters were extracted from medical records. Case series were summarized in **Table 1**. Next, we created a ROC for each parameter in emergent operation cases. The values of AUC were high in metabolic acidosis and white blood cell count (**Figure 3**). The values of AUC were low in CRP, AST, and LDH. For BE, the cut off value was determined as  $-2.4$  mEq/L from the present ROC. Using this value, the cases were divided into two groups. Lower BE was significantly associated with bowel gangrene ( $p = 0.029$ ). For the WBC count, the cut off value was determined as  $8400/\text{mm}^3$  from the present ROC. A lower WBC count is significantly associated with bowel gangrene ( $p = 0.029$ ). For CRP, the cut off value was determined as  $2.67$  mg/dL from the ROC of the present study. The association between CRP and bowel gangrene was not proved (**Table 2**).



**Figure 1.** (a) Colonoscopic findings indicate necrosis of the intestinal mucosa; (b) Laparotomy reveals intestinal necrosis.



**Figure 2.** (a) Torsion of the mesentery is detected; (b) No evidence of intestinal necrosis.



**Figure 3.** ROC curves for (a) Base excess; (b) WBC; (c) CRP; (d) AST; and (e) LDH are shown.

**Table 1.** Case series of the present study.

Case	Age	Gender	Attack	Operative procedure	Bowel gangrene	Colonoscopy	Time from onset	Morbidity
1	81	M	First	sigmoidopexy	absent	not performed	7 h	
2	82	M	First	sigmoidectomy	present	mucosal color change	24 h	
3	83	M	First	sigmoidectomy	absent	mucosal color change	2 - 3 h	
4	67	M	First	sigmoidectomy	present	mucosal color change	4 d	pneumonia
5	76	F	First	sigmoidectomy	present	not performed	3 d	pneumonia
6	80	M	First	sigmoidectomy	absent	not performed	unknown	
7	82	F	First	sigmoidectomy	absent	mucosal color change	3 d	
8	67	M	First	sigmoidectomy	present	mucosal color change	2 d	
9	28	F	Repeated	sigmoidectomy	absent	NA	NA	

M, male; F, female.

**Table 2.** Statistical comparison between “with necrosis” and “without necrosis” using the cut-off values for BE, WBC, and CRP.

	With necrosis	Without necrosis	p-value
BE $\geq$ -2.4	4	0	

**Continued**

BE < -2.4	0	4	0.029*
WBC ≥ 8400	0	4	
WBC < 8400	4	0	0.029*
CRP ≥ 2.67	4	2	
CRP < 2.67	0	2	N.S.

**4. Discussion**

Patients with a long loop sigmoid colon and narrow base of the mesenteric attachment are more prone to sigmoid volvulus [5]. Once torsion of the sigmoid colon was occurred, spontaneous recovery was difficult. In the absence of clinical, laboratory, or radiological signs of bowel necrosis or perforation, colonoscopic volvulus de-rotation is recommended in all cases of acute colonic volvulus, followed by semi-elective single-stage colonic resection [6]. Emergent sigmoidoscopy was performed in 5 of our 8 emergent patients. Three patients not undergo sigmoidoscopy based on the clinicians' decision. In 5 cases, the color of the mucosa changed. Usually, mucosa is weaker than muscular tissue in ischemia. It is difficult to distinguish intestinal necrosis or mucosal necrosis. Peritonitis and endotoxemia, which are caused by various reasons, including delayed diagnosis and treatment, intestinal obstruction, intestinal ischemia, necrosis, and hypovolemic shock, increase mortality and morbidity [7] [8]. Therefore, it is important to determine the markers for ischemia. Reperfusion of an ischemic or gangrenous large bowel can produce metabolic acidosis or bacterial translocation [9] [10]. Blood gas analysis is useful in abdominal emergencies because it is convenient. White blood cell count accounts for gangrenous necrosis. However, in this study, leukocytosis revealed that gangrene did not occur. Occasionally, severe sepsis presents a lower white blood cell count. Furthermore, Kasirajan *et al.* reported that intestinal gangrene pH and lactate are determinant on hospital stay and mortality [11]. Thus, a correct diagnosis for ischemia is necessary.

The other parameters were negative for predicting ischemia. In the patients with hepatic portal venous gas, AST, alanine aminotransferase, and LDH, all were significantly associated with bowel necrosis [12]. In animal experiments, creatinine phosphokinase (CPK) was more likely to be elevated during intestinal ischemia. Enzyme levels were not influenced by the extent and reversibility of the ischemic injury [13].

Once decompressed by endoscopy, the recurrence rate of volvulus was high. Subsequently, elective surgery was recommended for sigmoid volvulus [14]. However, preoperative colonoscopic de-rotation is beneficial for patients with acute colonic volvulus [6]. Fecal and bacterial load of an unprepared left colon were believed to increase anastomotic dehiscence and mortality; therefore, colostomy and Hartmann's procedure became popular. Primary anastomosis is reported to promote morbidity and mortality in gangrenous patients in African populations [15]. Sigmoidectomy with primary anastomosis is a good option for

the definitive management of sigmoid volvulus. In this study, Hartmann's operation was performed in 7 cases.

A limitation of this study is the small number of cases. However, in conclusion, in addition to the physiological findings, blood gas analysis and a white blood cell count are useful to detect ischemia due to sigmoid volvulus.

## Acknowledgements

The authors would like to thank Innami H, Ohashi Y, and Yuzawa N, for their secretarial assistance.

## References

- [1] Hinshaw, D.B. and Carter, R. (1957) Surgical Management of Acute Volvulus of the Sigmoid Colon; a Study of 55 Cases. *Annals of Surgery*, **146**, 52-60. <https://doi.org/10.1097/00000658-195707000-00006>
- [2] Alver, O., Oren, D., Apaydin, B., Yigitbasi, R. and Ersan, Y. (2005) Internal Herniation Concurrent with Ileosigmoid Knotting or Sigmoid Volvulus: Presentation of 12 Patients. *Surgery*, **137**, 372-327. <https://doi.org/10.1016/j.surg.2004.07.008>
- [3] Turan, M., Sen, M., Karadayi, K., Koyuncu, A., Topcu, O., Yildirim, C. and Duman, M. (2004) Our Sigmoid Colon Volvulus Experience and Benefits of Colonoscope in Detortion Process. *Revista Espanola De Enfermedades Digestivas*, **96**, 32-35. <https://doi.org/10.4321/S1130-01082004000100005>
- [4] Kuzu, M.A., Aslar, A.K., Soran, A., Polat, A., Topcu, O. and Hengirmen, S. (2002) Emergent Resection for Acute Sigmoid Volvulus: Results of 106 Consecutive Cases. *Diseases of the Colon and Rectum*, **45**, 1085-1090. <https://doi.org/10.1007/s10350-004-6364-0>
- [5] Onder, A., Kapan, M., Arikanoglu, Z., Palanci, Y., Gumus, M., Aliosmanoglu, I. and Aldemir, M. (2013) Sigmoid Colon Torsion: Mortality and Relevant Risk Factors. *European Review for Medical and Pharmacological Sciences*, **17**, 127-132.
- [6] Renzulli, P., Maurer, C.A., Netzer, P. and Buchler, M.W. (2002) Preoperative Colonoscopic Derotation Is Beneficial in Acute Colonic Volvulus. *Digestive Surgery*, **19**, 223-229. <https://doi.org/10.1159/000064217>
- [7] Oren, D., Atamanalp, S.S., Aydinli, B., Yildirgan, M.I., Basoglu, M., Polat, K.Y. and Onbas, O. (2007) An Algorithm for The management of Sigmoid Colon Volvulus and the Safety of Primary Resection: Experience with 827 Cases. *Diseases of the Colon and Rectum*, **50**, 489-497. <https://doi.org/10.1007/s10350-006-0821-x>
- [8] Salinas, N.L., Carr, S.R., Han, D. and Mahmoud, N.N. (2007) A Surprising Twist to an Old Problem: Sigmoid Volvulus in a 19-Year-Old Man. *The American Surgeon*, **73**, 284-286.
- [9] Patel, A., Kaleya, R.N. and Sammartano, R.J. (1992) Pathophysiology of Mesenteric Ischemia. *Surgical Clinics of North America*, **72**, 31-41. [https://doi.org/10.1016/S0039-6109\(16\)45626-4](https://doi.org/10.1016/S0039-6109(16)45626-4)
- [10] Zimmerman, B.J. and Granger, D.N. (1992) Reperfusion Injury. *Surgical Clinics of North America*, **72**, 65-83. [https://doi.org/10.1016/S0039-6109\(16\)45628-8](https://doi.org/10.1016/S0039-6109(16)45628-8)
- [11] Kasirajan, K., Mascha, E.J., Heffernan, D. and Sifuentes, J. (2004) Determinants of In-Hospital Mortality and Length of Stay for Acute Intestinal Gangrene. *The American Journal of Surgery*, **187**, 482-485. <https://doi.org/10.1016/j.amjsurg.2003.12.049>
- [12] Koami, H., Isa, T., Ishimine, T., Kameyama, S., Matsumura, T., Yamada, K.C. and

Sakamoto, Y. (2015) Risk Factors for Bowel Necrosis in Patients with Hepatic Portal Venous Gas. *Surgery Today*, **45**, 156-161.

<https://doi.org/10.1007/s00595-014-0941-1>

- [13] Thompson, J.S., Bragg, L.E. and West, W.W. (1990) Serum Enzyme Levels during Intestinal Ischemia. *Annals of Surgery*, **211**, 369-373.

<https://doi.org/10.1097/00000658-199003000-00009>

- [14] Hougaard, H.T. and Qvist, N. (2013) Elective Surgery after Successful Endoscopic Decompression of Sigmoid Volvulus May Be Considered. *Danish Medical Journal*, **60**, A4660.

- [15] Nuhu, A. and Jah, A. (2010) Acute Sigmoid Volvulus in a West African Population. *Annals of African Medicine*, **9**, 86-90. <https://doi.org/10.4103/1596-3519.64747>