Respiratory Disorder at the End of Surgery for Peritonitis Due to Colorectal Perforation Is a Critical Predictor of Postoperative Sepsis

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Abstract. *Background/Aim:* The aim of this study was to identify a critical predictor of postoperative sepsis in patients with peritonitis due to colorectal perforation. *Patients and Methods:* Between 2009 and 2014, fifty-three patients who underwent emergency surgery for peritonitis due to colorectal perforation in our hospital were examined retrospectively to identify the critical predictor of postoperative sepsis. Between 2016 and 2017, twelve patients with peritonitis due to colorectal perforation were enrolled in a prospective study to validate the critical predictor obtained by the previous retrospective study. *Results:* Mechanical ventilation for more than two days after surgery seemed to be a critical predictor of postoperative sepsis. In the prospective study, six patients who were withdrawn from mechanical ventilation within one day after surgery did not develop sepsis. *Conclusion:* Respiratory disorders at the end of surgery for peritonitis due to colorectal perforation seem to be a critical predictor of postoperative sepsis.

Emergency surgery is usually required for peritonitis due to colorectal perforation. The morbidity and mortality rates are high due to the performance of emergency surgery itself, incomplete bowel preparation, bacterial proliferation, and contamination (1, 2). Several factors, including the age of the patient, preoperative condition, complications, and disease type, have been reported to affect the mortality and

the morbidity rates (3, 4). Severe postoperative infection often results in serious life-threatening complications, such as sepsis, septic disseminated intravascular coagulation and septic shock (5-7). However, a critical predictor of postoperative sepsis remains unclear. The aim of this study was to identify a critical predictor of postoperative sepsis for patients with peritonitis due to colorectal perforation.

Patients and Methods

Patients. The Ethics Committee for Biomedical Research at the Jikei Institutional Review Board approved the protocol [30-221 (9242)], and all patients or their family members provided written informed consent for participation. Between 2009 and 2014, fifty-three patients (28 male, 25 female) who underwent emergency surgery for peritonitis due to colorectal perforation in our hospital were examined to identify a critical predictor of postoperative sepsis retrospectively. The mean age was 66.5 (range=26-90 years) years. The causes of colorectal perforation were constipation in 10 patients (19%), strangulation in 8 patients (15%), diverticula in 20 patients (38%), and cancer in 15 patients (28%) (Table I).

Between 2016 and 2017, twelve patients (7 male, 5 female) who underwent emergency surgery for peritonitis due to colorectal perforation in our hospital were included in a prospective study. The mean age was 64.9 years (range=42-86 years). The causes of colorectal perforation were constipation in one patient (8%), strangulation in three patients (25%), diverticula in 4 patients (33%), and cancer in 4 patients (33%) (Table II).

Treatment of patients included in the prospective study. After January 2016, 12 patients who underwent emergency surgery for peritonitis due to colorectal perforation in our hospital were divided into two groups according to postoperative treatment. One group included patients who were withdrawn from mechanical ventilation on the day of surgery or the next day, received only antibiotics for postoperative treatment, and did not perform any intensive treatments. The second group included patients who needed mechanical ventilation for more than two days after the operation and received intensive treatments, such as direct hemoperfusion with a polymyxin B-immobilized fiber column (PMX-DHP) (8, 9) or continuous hemodiafiltration (CHDF) (10, 11).

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Key Words: Sepsis, respiratory disorder, critical predictor, peritonitis.

Statistical analysis. Continuous variables are expressed as means and ranges. The Wilcoxon rank-sum test was used to compare continuous variables, and the chi-square test was used to compare categorical data. A *p*-value less than 0.05 indicated significance. All data were analyzed with IBM SPSS Statistics, version 24.0 (IBM Japan, Ltd., Tokyo, Japan).

Results

Results of the retrospective study

Relationship between treatment after surgery and postoperative hospital stay. Patients whose postoperative hospital stay was 14 days or less received only antibiotics for postoperative treatment. However, patients whose postoperative hospital stay was more than 2 weeks received several treatments including intensive therapy, such as PMX-DHP and CHDF (Figure 1).

Comparison of groups with a postoperative hospital stay of 2 weeks or less and longer than 2 weeks (Table III). No significant difference was identified in gender between the two groups. Patients whose postoperative hospital stay was longer than 2 weeks were older and had higher Sequential Organ Failure Assessment (SOFA) scores than patients whose postoperative hospital stay was 2 weeks or less. All seventeen patients whose postoperative hospital stay was 2 weeks or less received only antibiotics for postoperative treatment. They were withdrawn from mechanical ventilation on the day of surgery or the next day. However, all 36 patients who needed mechanical ventilation for more than two days after the operation required longer than 2 weeks postoperative hospital stay and several postoperative treatments.

Results of the prospective study

Comparison of groups requiring mechanical ventilation for one day and more than two days after surgery (Table IV). Significant differences were found in age, SOFA scores, treatment after surgery, and hospital stay after surgery between the two groups. The postoperative hospital stay of six patients who were withdrawn from mechanical ventilation on the day of the surgery or the next day were fourteen days or less. They received only antibiotics for postoperative treatment and did not require intensive therapy.

Discussion

Severe peritonitis due to colorectal perforation often results in serious life-threatening complications, such as sepsis, septic disseminated intravascular coagulation and septic shock (5-7). We often perform treatments for these complications (12), which result in increased medical costs. Because there is no critical predictor of postoperative sepsis, it was possible that patients with peritonitis due to colorectal perforation receive unnecessary treatments.

Table I. *Clinical features of the patients in the retrospective study.*

Variable	n=53
Age (years)	66.5 (26-90)
Gender	
Male	28 (53)
Female	25 (47)
SOFA score	1.8 (0-8)
Cause of perforation	
Constipation	10 (19)
Strangulation	8 (15)
Colon diverticula	20 (38)
Cancer	15 (28)
Surgical procedure	
Partial colectomy	14 (26)
Hartmann's operation	14 (26)
Partial colectomy + ileostomy	21 (40)
Only colostomy or ileostomy	4 (8)

The data are presented as mean (range) or as n (%). SOFA: Sequential organ failure assessment.

Table II. *Clinical features of patients in the prospective study.*

Variable	n=12
Age (years)	64.9 (42-86)
Gender	
Male	7 (58)
Female	5 (42)
SOFA score	2.8 (0-8)
Cause of perforation	
Constipation	1 (8)
Strangulation	3 (25)
Colon diverticula	4 (33)
Cancer	4 (33)
Surgical procedure	
Partial colectomy	3 (25)
Hartmann's operation	4 (33)
Partial colectomy + ileostomy	5 (42)
Only colostomy or ileostomy	0 (0)

The data are presented as mean (range) or as n (%). SOFA: Sequential organ failure assessment.

In our retrospective study, we found that patients who were withdrawn from mechanical ventilation on the day of surgery or the next day received only antibiotics for postoperative treatment and did not require any intensive therapy. Their postoperative hospital stay was fourteen days or less. Accordingly, we evaluated the value of respiratory disorders at the end of surgery for peritonitis due to colorectal perforation as a critical predictor of postoperative sepsis in the prospective study.

Figure 1. Relationship between treatment after surgery and postoperative hospital stay. Patients whose postoperative hospital stay was within 2 weeks received only antibiotics as postoperative treatment.

Table III. Comparison of groups with a postoperative hospital stay of 2 weeks or less and longer than 2 weeks.

Variable	Within 2 weeks (n=17)	Over 2 weeks (n=36)	p-Value
Age (years)	51.9 (26-89)	73.5 (50-90)	<0.01
Gender			
Male	9 (53)	19 (53)	1.000
Female	8 (47)	17 (47)	
SOFA score	0.05 (0-1)	2.3 (0-8)	<0.01
Cause of perforation			<0.01
Constipation	0 (0)	10 (28)	
Strangulation	4 (24)	3 (8)	
Diverticulum	11 (65)	10 (28)	
Colon cancer	2 (11)	13 (36)	
Surgical procedure			<0.01
Partial colectomy	11 (65)	3 (8)	
Hartmann's operation	2 (11)	12 (33)	
Partial colectomy + ileostomy	4 (24)	17 (47)	
Stoma	0 (0)	4 (12)	
Treatment after surgery			<0.01
Only antibiotic	17 (100)	0 (0)	
With other treatment	0 (0)	36 (100)	
The day of extubation			<0.01
The day or next day of operation	17 (100)	0 (0)	
More than 2 days after operation	0 (0)	36 (100)	

The data are presented as mean (range) or as n (%). SOFA: Sequential organ failure assessment.

Table IV. Comparison of groups requiring mechanical ventilation within one day and more than two days after surgery.

Variable	Within one day (n=6)	More than 2 days (n=6)	p-Value
Age (years)	59.5 (42-86)	70.3 (49-81)	<0.01
Gender			
Male	5 (83)	2 (33)	0.242
Female	1 (17)	4 (67)	
SOFA score	1.2 (0-5)	4.5(1-8)	<0.01
Cause of perforation			0.721
Constipation	0 (0)	1 (17)	
Strangulation	2 (33)	1 (17)	
Diverticulum	2 (33)	2 (33)	
Colon cancer	2 (33)	2 (33)	
Surgical procedure			0.452
Partial colectomy	1 (17)	2 (33)	
Hartmann's operation	3 (50)	1 (17)	
Partial colectomy + ileostomy	2 (33)	3 (50)	
Stoma	0 (0)	0 (0)	
Treatment after surgery			0.030
Only antibiotic	6 (100)	2 (33)	
With other treatment	0 (0)	4 (67)	
Hospital stay after surgery			0.030
Within 14 days	6 (100)	2 (33)	
Over 14 days	0 (0)	4 (67)	

The data are presented as mean (range) or as n (%). SOFA: Sequential organ failure assessment.

The criteria of withdrawal from mechanical ventilation in our hospital consist of the following three items; 1) Systolic blood pressure higher than 100 mmHg without the use of vasopressors, 2) PaO₂ greater than 100 under 40% oxygenation, 3) Clear consciousness after anesthesia is withdrawn.

In the prospective study, the postoperative hospital stay of six patients who could be withdrawn from mechanical ventilation on the day of surgery or the next day was fourteen days or less. They received only antibiotics for postoperative treatment and did not require intensive therapy. Therefore, patients who could be withdrawn from mechanical ventilation within one day after surgery may not require any intensive treatments because they do not develop sepsis or septic shock. Sepsis-3 is defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection. Organ dysfunction can be identified as an acute change in the total SOFA score of 2 points consequent to infection (13). Respiratory failure was the most common cause of intensive care unit (ICU) admission, followed by acute myocardial ischemia or worsening heart failure, sepsis, gastrointestinal disease, and neurological disease (14). Patients who underwent emergency surgery for peritonitis due to colorectal perforation, did not develop respiratory disorders and required short-term mechanical ventilation after surgery, did not develop sepsis.

In conclusion, respiratory disorders following surgery for peritonitis due to colorectal perforation seems to be a critical predictor of postoperative sepsis; however, a large-scale prospective study is needed to clarify this issue.

Conflicts of Interest

The Authors declare no conflict of interest regarding this study.

Authors' Contributions

All Authors performed operations, analyzed the data of patients regarding their clinical features, and have been involved in drafting the manuscript. KY had given final approval of the version to be published. All Authors read and approved the final manuscript.

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