Clinical study of strangulation obstruction of the small bowel

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Abstract: Early diagnosis of strangulation obstruction is very important for surgeons because delayed diagnosis often leads to severe complications. Thirty patients underwent an operation because of small bowel obstruction between April, 1993 and December, 1999. In the present study, we examined the differences in clinical findings between simple obstruction and strangulation obstruction. In addition, we examined the manifestation of systemic inflammatory response syndrome (SIRS) and whether it is useful for early diagnosis of strangulation obstruction, and whether it is correlated with the severity of ischemia due to strangulation. Tenderness was examined in all patients and signs such as abdominal irritation were detected more often in patients with strangulation obstruction than in the patients with simple obstruction. According to SIRS, the large number of the patients with strangulation obstruction showed SIRS before operation and the manifestation of SIRS correlated well with the length of the necrosis in the strangulated small bowel. We recognized the importance of anamnesis and clinical findings in examinations of small bowel obstruction, furthermore, it was suggested that SIRS should be the warning sign for strangulation obstruction. J. Med. Invest. 48 : 66-72, 2001

Keywords **:** *strangulation obstruction, simple obstruction, systemic inflammatory response syndrome (SIRS)*

INTRODUCTION

Strangulation obstruction of the small bowel is one of the most common diseases that surgeons treat in the emergency room in a clinical setting. Early diagnosis of strangulation obstruction is difficult and delayed diagnosis can often lead to severe complications, such as peritonitis, sepsis, or multiple organ failures (MOF). Therefore, surgeons should perform the operation immediately when strangulation obstruction is diagnosed. In contrast, a large number of patients with simple obstruction can be treated with non-operative decompression, using a short or long tube (1). Therefore, the differential diagnosis between simple obstruction and strangulation obstruction is very important. Recently, the early diagnosis of strangulation obstruction has markedly advanced, accompanied with the progression of radiological techniques, such as CT scanning (2) or abdominal ultra sound (3). However, the advantages of these devices are often restricted by the conditions at each clinical institute. In the diagnosis of strangulation obstruction, several studies have reported the importance of several physical findings which surgeons are able to easily evaluate at any time (4). However, systemic inflammatory response syndrome (SIRS) has recently been evaluated as an early indication for various diseases (5). This response is manifested by two or more of the following conditions:a) a body temperature of >38℃ or <36℃ ; b) a heart rate (HR) of 90 beats/min ; c) respiratory rate 20 breaths/min or $PaCO_2$ 32 torr (<4.3 kPa) ; d) WBC

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>12,000cells/mm^3, <4,000cells/mm^3, or >10% immature (band) forms (5). The evaluation of SIRS conditions can be easily performed at all clinics or emergency rooms at any time. In the present study, we examined the physical findings that should be the basis for the recognition of strangulation obstruction and studied the usefullness of the SIRS criteria for the purpose of early detection of strangulation obstruction.

MATERIALS AND METHODS

Thirty patients underwent an operation due to small bowel obstruction in Tokushima Prefectural Miyoshi Hospital between April, 1993 and December, 1999. These thirty patients were divided into simple obstruction and strangulation obstruction. According to the diagnosis of strangulation obstruction, we determined small bowel ischemic changes or necrosis by the intraoperative inspection of intestinal color, furthermore, we confirmed the ischemic and necrotic changes of the resected specimens. Patients in which the viability of the strangulated intestinal loop were judged as reversible after releasing from the strangulation of the ileus band or torusion, were also confirmed as strangulation obstruction. According to the indications for an operation for simple obstruction, we performed the operation when the patients could not be decompressed within ten days after initiating conservative procedures with short (nasogastric) tubes or long tubes. The patients who underwent operations for the purpose of prophylaxis for frequent obstruction, were excluded from the period study. We examined the differences in the clinical charicteristics between simple obstruction and strangulation obstruction with respect to age, gender, causes of the small bowel obstruction including episodes of laparotomy, complaints on admission, and physical findings in the abdomen before operation. According to the complaints on admission and physical findings, all statements and findings from the patient were described even if a patient made several statements and showed two or more findings. Next, we studied the duration before the operation, the manifestion of SIRS according to the presence or absence of the necrosis in the strangulated small bowel, and the relation between the manifestation of SIRS and the length of the small bowel necrosis in strangulation obstruction. In the diagnosis of SIRS, respiratory rate was excluded from the present study because of incomplete analysis, therefore, the SIRS criteria were evaluated by white blood cell counts of the venous blood, pulse rates, body temperature, and $PaCO_2$ of the blood which was sampled from the femoral artery. Statistical analysis was performed using Student's t test or χ^2 test, where appropriate. Statistical significance was assigned at $P<0.05$.

RESULTS

Gender and age of the patients

Nineteen cases underwent laparotomy for strangulation obstruction. Ten patients (52.6%) were male and nine patients (47.4%) were female. The average age at operation of the 10 male patients was 68.4±4.5 years old and that of the 9 female patients was 69.8±17.1 years old. Eleven patients underwent laparotomy for simple obstruction. Six patients (54.5%) were male and five patients (45.5%) were female. The average age at operation of the 6 male patients was 65.3±11.2 years old and that of the 5 females was 69.4±12.8 years old. There was no significant difference between the patients with simple obstruction and those with strangulation obstruction with regards age at operation for small bowel obstruction (Table 1).

Causes of the small bowel obstruction

Sixteen of 19 patients with strangulation obstruction were postoperative ileus. Nine of 16 patients underwent upper gastrointestinal surgery, four of 16 patients underwent lower gastrointestinal surgery, and 3 patients underwent gynecological surgery. The other three patients were non-postoperative ileus. Two of three patients had an internal hernia which caused the strangulation obstruction and the other case had volbulus of the mesenterium which caused the strangulation obstruction. Ten of 11 patients with simple obstruction were postoperative ileus. Four patients underwent upper gastrointestinal surgery, three patients underwent

Table 1. Gender and age of the patients

	strangulation (n=19)		simple (n=11)	
Gender	male	10 (52.6%)	male	6 (54.5%)
	female	9 (47.4%)	female	5 (45.5%)
Age	male	68.4±4.5	male	65.3±11.2
(years)	female	69.8±17.1	female	69.8±17.1

lower gastrointestinal surgery and the other three underwent gynecological surgery. One patient underwent a laparotomy for simple ileus due to tuberuculosis of the mesenterium (Table 2).

Complaints on admissionn

Eighteen (94.7%) of 19 patients with strangulation obstruction complained of abdominal pain, in contrast to only five (45.5%) of 11 patients with simple obstruction. Nausea and/or vomiting was a common complaint for patients in both two groups (strangulation ; 52.7% vs simple ; 72.7%). Abdominal fullness was a common complaint in the patients (81.8%) with simple obstruction, however, only two (10.5%) of 19 patients complained in the strangulation obstruction group. Hiccup was rarely a complaint in the patients of both groups (strangulation ; 5.7% vs simple ; 18.2%)(Table 3).

Physical findings in the abdomen

The patients with strangulation showed peritoneal irritation signs, such as tenderness, rebound tenderness and muscle guarding more often than in patients with simple obstruction. Tenderness was detected in patients with strangulation obstruction. Increased bowel sound was noted more often in patients with simple obstruction (72.7%) than in patients with strangulation obstruction (42.1%). Absense or decrease in bowel sound was more often noted in patients with strangulation obstruction (57.9%) than in patients with simple obstruction (27.3%). In the present study, Wahl's sign was only detected in two (10.5%) of 19 patients with strangulation obstruction, although this sign has often been described as the classical sign of strangulation obstruction (Table 4).

The ratio of the manifestation of SIRS and small bowel necrosis according to SIRS

Fifteen (78.9%) of 19 patients with strangulation obstruction manifested SIRS before the operation, however, four (21.1%) did not fill the SIRS criteria. In contrast, only three (27.3%) of 11 patients with simple obstruction manifested SIRS preoperatively. The other eight patients (72.7%) with simple obstruction did not manifest SIRS. Fifteen (83.3%) of 18 SIRS positive cases and four (33.3%) of 12 SIRS negative cases were confirmed as strangulation obstruction at operation (sensitivity 78.9% ; specificity 72.7% ; accuracy 76.7%. χ^2test, P=0.0054). According to small bowel necrosis, ten (66.7%) of 15 SIRS positive patients with strangulation obstruction showed necrosis of the strangulated small bowel and the other five SIRS positive patients with strangulation obstruction had a viable small bowel after releasing the obstruction. Two (50.0%) of 4 SIRS negative patients had no necrotic change despite showing strangulation. In all patients, ten (55.6%) of 18 SIRS positive patients and two (16.7%) of 12 SIRS negative patients showed necrosis (sensitivity 83.3% ; specificity 55.6% ; accuracy 66.7%. χ^2test, P= 0.0331)(Table 5).

Table 2. Cause of small bowel obstruction

stangulation	
postoperative ileus (n=16)	
upper gastrointestinal surgery	n=9
lower gastrointestinal surgery	n=4
gynecological surgery	n=3
non-postoperative ileus (n=3)	
internal hernia	n=2
volbulus of mesenterium	n=1
simple	
postoperative ileus (n=10)	
upper gastrointestinal surgery	n=4
lower gastrointestinal surgery	n=3
gynecological surgery	n=3
non-postoperative ileus (n=1)	
tuberuculosis of mesenteric lymph node	n=1

Table 3. Complaints on admission

	Strangulation (n=19)	simple (n=11)
Abdominal pain	18 (94.7%)	5 (45.5%)
Nausea, Vomiting	10 (52.7%)	8 (72.7%)
Abdominal fullness	2 (10.5%)	9 (81.8%)
Hiccup	1 (5.7%)	2 (18.2%)

Table 4. Physical findings in the abdomen

	Strangulation (n=19)	simple (n=11)
Tenderness	19 (100%)	7 (63.6%)
Rebound tenderness	12 (63.2%)	1 (9.1%)
Musucular guarding	14 (73.6%)	3 (27.3%)
Increase in bowel sound	8 (42.1%)	8 (72.7%)
Decrease in bowel sound	11 (57.9%)	3 (27.3%)
Wahl's sign	2 (10.5%)	0 (0%)

Table 5. The ratio of the manifestation of SIRS and the small bowel necrosis according to SIRS

	Number of patients	Patients with small bowel necrosis
stranguation (n=19)		
SIRS positive	15/19 (78.9%)	10/15 (66.7%)
SIRS negative	4 /19 (21.1%)	2 / 4 (50.0%)
simple (n=11)		
SIRS positive	3 /11 (27.3%)	0 / 3 (0%)
SIRS negative	8 /11 (72.7%)	0 / 8 (0%)

Comparison between strangulation obstruction and simple obstruction according to SIRS factors

White blood cell counts showed significantly higher levels in patients with strangulation obstruction than in the patients with simple obstruction (12,166.9±3,729.6/mm^3 vs 8,887.3±3,905.2/mm^3,P =0.0303). Pulse rate was significantly higher in patients with strangulation obstruction than in patients with simple obstruction (101.2±22.3 beats / min vs 81.7±14.0 beats / min, P=0.0144). Body temperature and $PaCO_2$ showed no significant differences between the two groups (Table 6).

Duration before operation and SIRS factors in strangulation obstruction according to small bowel necrosis

The duration before the operation did not reflect significantly on the small bowel necrosis. According to the SIRS conditions, only white blood cell counts were significantly higher in patients with small bowel necrosis than in those without small bowel necrosis (13,286.7±3,143.1 vs 9,890.0±1,957.0, P=0.02). The other three SIRS conditions showed no significant differences according to small bowel necrosis (Table 7).

Relationship between the manifestation of SIRS and the length of small bowel necrosis in strangulation obstruction

The length of the necrotic small bowel in SIRS positive patients was significantly longer than that of SIRS negative patients (126.5±30.3 cm vs 48.5± 58.7 cm, P<0.05)(Table 8).

DISCUSSION

Strangulation obstruction of the small bowel is characterized by three coexisting factors ; 1) proximal mechanical obstruction of an involved segment of the bowel ; 2) closed loop obstruction of the involved segment ; and 3) venous congestion of the involved loop. The last two factors made strangulation obstruction more serious than simple obstruction (6). The delayed diagnosis for strangulation obstruction often leads to severe, lethal complications, such as endotoxic shock, sepsis, and multiple organ failure (MOF)(2,3) Therefore, early detection of this disease and early differ-

Table 6. comparison of SIRS factors between strangulation obstruction and adhesive obstruction

	strangulation (n=19)	simple(n=11)	P value
White blood cell counts (/mm^3)	12,166.9±3,729.6	8,887.3±3,905.2	P=0.0303
Pulse rate (beats/min)	101.2±22.3	81.7±14.0	P=0.0144
Body temperature (°C)	36.9±0.7	36.6±0.6	NS
$PaCo_2$ (mmHg)	35.1±7.2	36.8±9.2	NS

Table 7. Duration before operation and SIRS factors in strangulation obstraction according to small bowel necrosis

	Small bowel necrosis		P value
	Positive (n=12)	Negative (n=7)	
Duration before operation (day)	1.3±1.6	2.9±2.4	NS
White blood cell counts (/mm^3)	13,286.7±3,143.1	9,890.0±1,957.0	P=0.02
Pulse rate (beats/min)	104.5±26.7	98.1±23.3	NS
Body temperature (°C)	36.9±0.8	36.9±0.5	NS
$PaCo_2$ (mmHg)	30.9±7.1	36.9±6.1	NS

Table 8. Relationship between the manifestation of SIRS and the length of the small bowel necrosis in strangulation obstruction

	Number of patients with necrotic small bowel	Average length of the necrotic small bowel
SIRS positive (n=15)	10 (66.7%)	126.5±30.3 cm
		P=0.0148
SIRS negative (n=4)	2 (50.0%)	48.5±58.7 cm

ential diagnosis is very important because patients with strangulation obstruction should be treated by surgical procedures. Many studies have reported that early detection of simple obstruction from strangulation obstruction was difficult and often impossible using clinical or laboratory means (1,6,7). As indicators of strangulation obstruction, elevation of temperature, tachycardia, leukocytosis, and rigidity to the abdominal wall are all traditionally described (4). However, Bizel *et al*. previously reported that there was no association between strangulation obstruction and administration temperature, tachycardia, or the presence or absence of abdominal wall rigidity (7). Sarr *et al*. reported that the combination of five classic signs of strangulation, consisting of continuous abdominal pain, fever, tachycardia, peritoneal signs, and leukocytosis could not differ strangulation obstruction from simple obstruction (1). Shatilla *et al*. also reported that the incidence of these classical findings was low and the presence indicated a very advanced stage of strangulation, so they could be used for early diagnosis (6). According to laboratory tests, many studies have tried to evaluate various enzymes which were taken from blood samples in experimental or clinical studies. Among these enzymes, serum creatinine phosphokinase (CPK) has been evaluated and might be a reliable marker as an early indication of intestinal strangulation obstruction (8,9). However, Sarr *et al*. reported that in their clinical study, neither the CPK nor the phosphate concentration proved reliable for predicting the presence or absence of strangulation obstruction (1). They also suggested that substantial tissue injury is required to allow the release of such phosphate and CPK into the blood, it may be unreliable to expect such elements to appear in the serum before irreversible injury.

Leffall *et al*. described signs and symptoms of strangulation obstruction as reliable and should indicate the proper diagnosis in most cases when careful examination of the physical findings is performed (4). They also stated strangulation obstruction should be suspected when any one or more of the following are present : 1) severe, constant abdominal pain that often radiates to the back, 2) fever, 3) subnormal temperature, 4) tachycardia, 5) hypotension or shock, 6) abdominal tenderness, 7) muscle guarding, 8) abdominal mass or irreducible hernia, 9) bloody diarrhea, or 10) leukocytosis. Therefore, we also evaluated carefully the complaints on admission and physical findings in the abdomen.

In the present study, 94.7% (18/19) of patients with strangulation obstruction complained of abdominal pain to varying degrees which was often accompanied with back pain. Tenderness at the abdominal wall was found in all patients with strangulation obstruction and these patients often showed other signs of peritoneal irritation such as rebound tenderness (63.2%) or muscular guarding (73.6%). Leffall *et al*. also reported that the most common finding in patients with strangulation obstruction was abdominal tenderness which was shown at the rate of 82% (4). Wahl's signs have been traditionally considered important signs of strangulation obstruction, however, we detected these signs in only two (10.5%) of 19 patients with strangulation obstruction. Fever has also been described as a main feature of strangulation obstruction, however, few of the present patients with strangulation obstruction had fever before the operation. Shatilla *et al*. reported the classical signs as unreliable in elderly patients because they may not respond systemically to gangrenous processes in comparison with younger patients (6). A large number of the present patients were 60 years old or older, so they did not often manifest the classical signs of strangulation obstruction. It was suggested that careful examination of the abdominal findings is espcially important for detection of the minimal peritoneal irritation signs.

SIRS has recently been evaluated as an early indication for various diseases. Localized inflamma-

tion is a physical protective response, which is generally tightly controlled by the body at the site of injury. Loss of this local control or an overly activated response results in an exaggerated systemic response which is clinically identified as SIRS. SIRS may be initiated by infection or by non-infectious causes such as trauma, autoimmune reactions, cirrhosis or pancreatitis (5). It was suggested that the mediator in SIRS was caused by the cytokine/cellular response (10). Of the multitude of mediators operating in SIRS/sepsis, the three most influential appear to be TNF-α, IL-1 and IL-6 (10).

Bacterial translocation is defined as the passage of viable bacteria or endotoxins which exist in the bowel lumen, through the epithelial mucosa into the lamina propria and then to the mesenteric lymph nodes, and from there to the extranodule sites, such as spleen, liver, intra-abdominal cavity and systemic circulation. Three mechanisms that promote bacterial translocation have been identified : 1) intestinal bacterial overgrowth ; 2) increased permeability of the intestinal mucosal barrier ; and 3) deficiencies in host immune defenses (11). Many experimental and clinical studies have independantly proposed the hypothesis that the loss of gut barrier function and the consequent bacterial translocation, and then their product may play an important role in the development of multiple organ failure (MOF) in critical illness (10, 11). Gut associated lymphatic tissue (GALT) is the body's largest collection of lymphoid cells, therefore, the gut has specific immunogeneity. Many studies have recently indicated the possibility that the loss of gut barrier function to bacteria and or endotoxins might induce a local intestinal inflammatory response and lead to the subsequent release of cytokines (TNF, IL-1, 1 L-6, IL-8 etc.) from the GALT (12-14). Many studies have reported that bacterial translocation was reported at a high rate in simple obstruction of the small bowel or colon (15, 16). In strangulation obstruction, the loss of gut barrier function should occur more readily and severely, compared with simple obstruction because the ischemia should promote the rapid destruction of the intestinal epithelium. Therefore, we suggest that in strangulation obstruction, bacterial translocation should advance more progressively than in simple obstruction and initiate GALT, and then may produce the various inflammatory cytokines which manifest SIRS.

A total of 78.9% of the present patients with strangulation obstruction manifested SIRS before the operation. In contrast, only 27.3% of patients with simple obstruction showed SIRS. In the 15 SIRS positive patients with strangulation obstruction, ten of 15 patients (66.7%) showed necrosis of the strangulated small bowel at operation. In the diagnosis of strangulation obstruction, the sensitivity was 78.9%, and in association with bowel necrosis, the sensitivity was 83.3%. Therefore, it is suggested the SIRS positive paients with small bowel obstruction might be complicated with the ischemic or necrotic changes of the strangulated bowel. The present findings suggest that the SIRS criteria should be the warning sign of strangulation obstruction and the subsequent complications of strangulated bowel necrosis. In patients with necrotic bowel due to strangulation, the length of the necrosis was markedly longer in the SIRS positive patients than in the SIRS negative patients, so, the SIRS criteria should correlate with the severity of strangulation obstruction. When examining SIRS positive patients suspected of strangulation obstruction, an additional examination and treatment should be rapidly performed, considering the progression of the bowel necrosis. In the evaluation of each SIRS condition, white blood cell counts and the pulse rates were significantly higher in strangulation obstruction than in simple obstruction, body temperature and $PaCO_2$ were not significantly different between the two groups. A large number of the present patients with strangulation obstruction had previously shown irreversible necrotic changes of the strangulated bowel, so the severity of the inflammation might be reflected in the high counts of the white blood cells. According to the high pulse rate, it is suggested that progressive dehydration could occur in more elderly patients and the rapid changes in circulation might cause the high pulse rates. For body temperature and $PaCO_2$, the averages of older patients might be different from those of younger patients. For body temperature, patients with strangulation obstruction did not differ from that of the patients with simple obstruction, and most patients remained within the normal range. Since a large number of the present patients were rather elderly, their average body temperature might have remained at relatively low levels. For $PaCO_2$, the present patients remained in the normal range. A large number of the present patients were aged 65 years or older, so the average level of $PaCO_2$ might be higher than that of younger patients for congenital lung complications or disorders of pulmonary function. Therefore, the $PaCO_2$

of these older patients might have remained despite tachypnea under SIRS.

In conculusion, we also recognized the importance of anamnesis and the physical findings that were evaluated in the diagnosis of bowel obstruction in a previous study (4). Tenderness is a nonspecific sign in the acute abdomen, however, all the present patients with strangulation obstruction showed this sign. We stress that tenderness in the abdominal wall may be a warning which may indicate the irreversible ischemic changes in the intestine. The manifestation of SIRS was examined at a high rate and its sensitivity for strangulation obstruction was high, and in additions, the evaluation of SIRS was very simple. It was suggested that the SIRS criteria should be useful as a warning sign for strangulation obstruction. Surgeons should quickly perform additional examinations, including detailed laboratory analyses and radiological examination, when patients show abdominal findings and SIRS criteria.

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