

## The role of D-dimer in the diagnosis of strangulated small-bowel obstruction

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**Key words:** small-bowel obstruction; strangulated obstruction; diagnosis; D-dimer level.

**Summary.** Background. Various diagnostic utilities have been used in the diagnosis of strangulated obstruction. Despite this, there is no simple and reliable marker for it, and diagnosis in most cases is based on clinical, laboratory, and radiological investigations. The purpose of the present study was to assess D-dimer value in the diagnosis of strangulated obstruction.

**Methods.** A prospective study of 53 patients with small-bowel obstruction was conducted. Strangulated obstruction was present in 15 (28.3%) patients. Eight (53%) had intestinal necrosis, while 7 (47%) reversible ischemia. The blood samples were taken and analyzed with NycoCard Reader method with monoclonal antibodies specific for D-dimer neoantigens.

**Results.** In the presence of intestinal necrosis, there was a higher D-dimer level found than in the cases with reversible ischemia or simple small-bowel obstruction, although this difference did not reach statistically significant level. The D-dimer test had a sensitivity of 60%, specificity of 68%, positive predictive value of 43%, and negative predictive value of 81% in diagnosing strangulated obstruction.

**Conclusion.** In present series, D-dimer test was neither sensitive nor specific in diagnosing strangulation.

### Introduction

Strangulated obstruction is associated with bowel ischemia and is found in 5–23% of patients with small-bowel obstruction (SBO) (1–3). Mortality rate of 15–30% has been reported in most series, and this is substantially higher than mortality rate of 5–8% after simple, nonstrangulated obstruction (4–8). In approximately 30% of cases with strangulation, reversible ischemia may be present (9), and early diagnosis and operation may be vital in such situation. By contrast, operation may be unnecessary in patients with simple SBO as in 46–66% of cases it may resolve after a trial of conservative treatment (4, 10–14). Therefore, differentiation between simple and strangulated obstruction is important.

Various clinical and laboratory indicators were used for the diagnosis of strangulated obstruction and were not found to be sensitive, specific, or accurate (9, 15). Ultrasonography (US) and computer tomography (CT) are promising tools, but their definitive role in the diagnosis of strangulated obstruction has still to be established (16–19). Some biochemical markers have been used for the diagnosis of mesenteric ischemia (20–22). However, further studies are needed to confirm validity of these markers in cases with

strangulated obstruction. Recently, fibrinolytic marker D-dimer was found to be elevated in patients with strangulated obstruction suggesting that it can be a useful indicator of bowel ischemia associated with strangulation (23). The aim of the present prospective study was to determine the diagnostic performance of D-dimer test in the cases of SBO with strangulation.

### Materials and methods

Fifty-three patients with acute small-bowel obstruction admitted to the Department Surgery at Kaunas University of Medicine during the period of 2001–2002 participated in the prospective study. The diagnosis was based on clinical signs and symptoms consistent with SBO and findings of distended loops of small bowel with air-fluid levels on upright plain abdominal radiographs. Patients with early postoperative SBO (occurring less than 30 days after laparotomy) or SBO in conjunction with malignancy, incarcerated hernia, or mesenteric vascular disease were excluded from the study. Informed consent was obtained from all of the patients.

Venous blood samples for the investigation of D-dimer level were taken immediately after the diagnosis of SBO had been established. The samples were

analyzed with NycoCard Reader method with monoclonal antibodies specific for D-dimer neoantigens. D-dimer concentration up to 0.5 mg/L was considered normal; if the concentration exceeded this level, it was considered pathologic.

All patients were treated by rehydration with intravenous fluids and tube decompression of the stomach. Early operation was indicated if continuous pain, tachycardia, fever, signs of peritoneal irritation, and leukocytosis were present. Patients without these signs had small-bowel follow-through x-ray contrast study. Radiographs were taken 2, 4, and 8 hours after contrast medium ingestion, thereafter as needed until contrast reached the cecum, or until operation was performed. Partial acute SBO was diagnosed if the contrast medium reached the colon, and at clinical follow-up, the symptoms of bowel obstruction disappeared and normal intake of food was restored. Complete acute SBO was defined if dilated small-bowel loops were found and contrast flow stopped within 8 hours. In these cases, patients were operated immediately.

Strangulation was considered when signs of vascular compromise such as hypoxic discoloration, loss of arterial pulsation, subserosal hemorrhage, and the appearance of impending or actual infarction were present during operation (9). Reversible ischemia was present if release of the obstruction was followed by improvement in color and function and eventually by full recovery of the intestinal segment. Bowel necrosis was determined by histological examination that revealed the presence of transmural necrosis of the muscularis (9).

Calculations were performed using Statistica software package for Windows ('99 edition). Student's *t* test was used for comparison of means. Categorical

variables were compared using chi-square test and Fisher's exact test when appropriate. Differences with *P* value of <0.05 were considered statistically significant in all analysis.

## Results

The mean ( $\pm$ SD) age of the 53 patients was 49.9 ( $\pm$ 17.0) years. There were 25 females (47.2%) and 28 males (52.8%). Complete bowel obstruction was diagnosed in 21 patients (39.6%) and partial in 32 patients. Causes of SBO are listed in Table 1. Strangulated obstruction was present in 15 (28.3%) patients. Eight (53%) had intestinal necrosis while 7 (47%) reversible ischemia.

Twenty-six (49%) patients underwent surgery: adhesions were cut in 17 (68%) cases; resection of the intestine was performed in 8 (32%). One patient died due to medical complications; there were no surgical complications. The morbidity rate was 15.4%.

Patients with simple and strangulated obstruction were comparable according to age, sex, and duration of symptoms before admission to hospital. Continuous pain, tachycardia, and leukocytosis were significantly more common in strangulated obstruction group (Table 2). However, diagnostic performance of these

**Table 1. Causes of small-bowel obstruction**

Cause of obstruction	n
Adhesions	48
Volvulus	3
Torsion	1
Intussusception	1
Total	53

**Table 2. Patients, disease characteristics, and diagnostic parameters**

Characteristic	Simple small-bowel obstruction n=38	Strangulated obstruction n=15	P value
Age, mean (SD), years	48.3 (17.1)	53.8 (16.5)	0.294
M/F	18/20	10/5	0.205
Duration of symptoms (before admission), mean (SD), h	19.6 (18.8)	25.0 (32.2)	0.610
Continuous pain, Y/N	10/28	10/5	0.006
Peritoneal signs, Y/N	2/36	2/13	0.316
Temperature, °C >38 or <36	1/37	2/13	0.129
Pulse, >100 or lower (beats/min)	1/37	3/12	0.031
Leukocyte count, >12×10 <sup>9</sup> /L or <4×10 <sup>9</sup> /L	14/24	10/5	0.049
D-dimer level >0.5 mg/L, Y/N	12/26	9/6	0.057

SD – standard deviation; Y/N – yes/no.

parameters did not reach acceptable level (Table 3).

In the presence of intestinal necrosis, there were more D-dimers found than in the cases with reversible ischemia or simple SBO, although this difference did not reach statistically significant level (Table 4). D-dimer level of  $>0.5$  mg/L had a sensitivity of 60%, specificity of 68%, positive predictive value (PPV) of 43%, and negative predictive value (NPV) of 81% in diagnosing strangulated obstruction (Table 3). When the same level of D-dimers was used for the diagnosis of bowel necrosis, sensitivity, specificity, PPV, and NPV were 71%, 65%, 24%, and 94%, respectively.

### Discussion

Strangulated obstruction is a life-threatening complication of SBO, and its prompt and accurate diagnosis is very important. Better understanding of pathophysiology may provide some clues to earlier diagnosis. The main coexisting phenomenon in this situation is closed-loop obstruction of the involved segment with its vascular compromise (24). Obstruction to venous outflow is a triggering mechanism that induces a reflex arterial vasospasm with secondary tissue anoxia that is further converted to ischemia when plasma loss and blood sequestration in the closed loop cause increased intraluminal pressure (25). This is followed by necrosis and perforation. The diagnosis at the end stage of the development of this pathological process is rather easy, and a few physicians would fail to recognize the presence of peritonitis and shock. However, the diagnosis of reversible ischemia still poses a diffi-

cult question.

The “classic signs” of strangulated obstruction have been variously cited to include continuous abdominal pain, fever, tachycardia, peritoneal signs, leukocytosis, acidosis, the presence of the painful mass, the absence of bowel sounds, and blood in the stool (15). In the present prospective study, continuous abdominal pain, fever, tachycardia, peritoneal signs, and leukocytosis were evaluated in the diagnosis of strangulated obstruction. All these parameters were more prevalent in patients with strangulation. However, discriminate analysis revealed that they lack sensitivity, specificity, or predictive value and are unreliable clinical determinants of strangulation. This is in agreement with the results of prospective study by Sarr and colleagues (9). Miyauchi and colleagues (26) examined manifestation of systemic inflammatory response syndrome (SIRS) among the patients with small-bowel obstruction. The syndrome was present in 78.9% of cases with strangulation and only in 27.3% of cases with simple SBO. The overall accuracy of SIRS in diagnosing strangulation in their series was 76.7%, not much higher than individual performance of clinical signs in our study.

Most of the “classic signs” are associated with severe bowel ischemia or even necrosis and represent already advanced disease. Subtle pathological changes that occur during reversible ischemia phase are clinically silent, but may be revealed by radiological investigations. CT signs indicative of strangulation pertain to abnormalities in the small-bowel wall and charac-

**Table 3. Diagnostic performance of various clinical and laboratory parameters**

Parameter	Sensitivity	Specificity	PPV	NPV	Accuracy
Leukocyte count	66.7	63.2	41.7	82.8	64.2
Pulse	20.0	97.4	75.0	75.5	73.6
Temperature	13.3	97.4	66.7	74.0	73.6
Continuous pain	66.7	73.7	50.0	84.8	71.7
Peritoneal signs	13.3	94.7	50.0	73.5	71.7
D-dimer level	60.0	68.4	42.9	81.3	66.0

PPV – positive predictive value; NPV – negative predictive value.

**Table 4. Mean level of D-dimers in plasma**

Diagnosis	n	Mean	SD	Min-max
Bowel necrosis present	7	2.6	2.7	0.5–8.0
Reversible ischemia	8	1.09	1.2	0.5–4.0
Simple small-bowel obstruction	37	0.81	1.0	0.5–6.0

SD – standard deviation.

teristic changes in attached mesentery. Frager *et al.* (19) have reached a sensitivity of 100% in diagnosing strangulated obstruction with CT in a series of 60 patients. The specificity in this study was only 61%. Balthazar *et al.* (17) reported higher specificity of 93% that was accompanied with a sensitivity of 83% for strangulation. This variation in CT diagnostic performance may be due to subtle findings that are often only suspected and can be interpreted differently by various investigators (17). Ultrasonography is another investigation prone to interobserver bias. Ogata and colleagues (27) found akinetic dilated loop to have a sensitivity of 90% and a specificity of 93% for small-bowel strangulation. However, more studies are needed to prove usefulness of this sign in the diagnosis of strangulated obstruction in different settings.

Difficulty in interpreting clinical as well as radiological symptoms of strangulated obstruction emphasizes the need for simple and reliable predictor. D-dimer is fibrinolytic marker most commonly used in the diagnosis of deep vein thrombosis of the lower extremity and embolism of the pulmonary artery (28).

Recently, Acosta and colleagues (23) reported increased D-dimer levels in four patients with strangulated obstruction suggesting that this might be a valuable tool in diagnosing strangulation. In present study, 60% of patients with strangulated obstruction and 32% of patients with simple small-bowel obstruction had elevated D-dimer levels. When patients with strangulated obstruction were divided into bowel necrosis and reversible ischemia groups, abnormal D-dimer level was found in 71% and 43% of patients, respectively.

D-dimer level was found to be elevated in severely injured patients without thromboembolic complications immediately after trauma (29) suggesting that systemic hypercoagulable state might be responsible for this elevation. Similarly, D-dimer level in SBO may rise due to systemic reaction of the organism to the acute illness and overshadow reaction of the organism to the localized thrombosis of the involved mesenteric vessels, which occur in strangulated obstruction. This may be the cause why D-dimer test was neither sensitive nor specific in diagnosing strangulation in our series.

## D-dimerų svarba destrukciniam plonosios žarnos nepraeinamumui nustatyti

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**Raktažodžiai:** plonosios žarnos nepraeinamumas, stranguliacinis nepraeinamumas, diagnozė, D-dimerų kiekis.

**Santrauka.** Destrukciniam plonosios žarnos nepraeinamumui nustatyti naudojamos įvairios diagnostikos priemonės. Tačiau patikimo ir paprasto instrumento tam nėra. Daugeliu atveju diagnozė nustatoma remiantis klinikiniu ir radiologiniu tyrimu.

**Darbo tikslas.** Nustatyti D-dimerų svarbą nustatant destrukcinį plonosios žarnos nepraeinamumą.

**Medžiaga ir metodai.** Perspektyvusis 53 pacientų, sirgusių plonosios žarnos nepraeinamumu, tyrimas. Destrukcinis stranguliacinis nepraeinamumas rastas 15 (28,3 proc.) pacientų. Aštuoniems (53 proc.) buvo žarnos nekrozė, 7 (47 proc.) – grįžtamoji išemija. D-dimerų neoantigenai buvo tiriami pacientų veninio kraujo plazmoje naudojant monokloninius antikūnus, specifinius D-dimerams, „Nycocard Reader“ metodu.

**Rezultatai.** Esant žarnyno nekrozei, rasti didesni D-dimerų kiekiai palyginti su grįžtamoja išemija ar paprastu nepraeinamumu. Skirtumas statistiškai nereikšmingas. Nustatant destrukcinio plonosios žarnos nepraeinamumo diagnozę, D-dimerų tyrimo jautrumas – 60 proc., specifiskumas – 68 proc. Teigiama prognozinė reikšmė – 43 proc., neigiama – 81 proc.

**Išvada.** D-dimerų kiekio tyrimas buvo nejautrus ir nespecifiškas destrukciniam plonosios žarnos nepraeinamumui nustatyti.

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