Int Surg 2015;**100:**1256–1261
DOI: 10.9738/INTSURG-D-14-00315.1

Mean Platelet Volume/Platelet Count Ratio: A New Diagnostic Parameter for Necrosis in Adhesive Small Bowel Obstruction—A Retrospective Cohort Study

Burak Veli Ulger[1], Halil Erbis[2], Ahmet Turkoglu[1], Metehan Gumus[1], Mesut Gul[1], Zulfu Arikanoglu,[1] Zubeyir Bozdag[1], Ibrahim Halil Taçyıldız[1]

[1]*Department of General Surgery, Dicle University Medical Faculty, Diyarbakır, Turkey*

[2]*Department of General Surgery, Akdeniz University Medical Faculty, Antalya, Turkey*

Abdominal adhesions are still one of the most common causes of intestinal obstruction. A major challenge in adhesive small bowel obstruction (SBO) management is to detect ischemia as early as possible to avoid necrosis and resection. Elevated mean platelet volume and decreased platelet count have been associated with worse disease course for various ischemic diseases in many clinical studies. The objective of the current study was to evaluate the predictive value of the mean platelet volume/platelet count ratio for patients with small bowel obstruction. Data for patients with adhesive small bowel obstruction, admitted to the general surgery department of Dicle University Hospital between November 2010 and March 2014, were reviewed retrospectively. Mean platelet volume (MPV)/platelet count (PC) ratio values, demographic data, vital signs, and laboratory blood test results of the patients were analyzed. Mean platelet volume/platelet count ratio was higher in bowel necrosis group, while there were no differences between the groups in terms of mean platelet volume values. Mean platelet volume and mean platelet volume/platelet count ratio was higher in patients who underwent surgical treatment. The cutoff value with the highest sensitivity and specificity for MPV/PC ratio was 0.02855 (sensitivity 68%, specificity 65%) for predicting bowel necrosis in patients with adhesive SBO. Mean platelet volume/platelet count ratio is associated with the

Corresponding author: Burak Veli Ulger, Dicle University Medical Faculty, Department of General Surgery, 21280, Diyarbakır, Turkey. Tel.: +90 412 248 8001; Fax: +90 412 248 8523; E-mail: bvulger@gmail.com

failure of the conservative management and the presence of bowel necrosis in patients with adhesive small bowel obstruction.

Key words: Small bowel obstruction – Bowel necrosis – MPV/PC ratio

Despite developments in surgical techniques and instruments, abdominal adhesions are still one of the most common causes of intestinal obstruction.[1–3] Small bowel obstruction (SBO) is associated with serious adverse events, such as bowel ischemia and necrosis. Small bowel obstruction is treated with conservative management with nasogastric tube suction or surgically.[4,5] Recognizing indications for nonoperative treatment, the length of nonoperative treatment, and appropriately timing surgery are all factors that may significantly affect disease course.[3] Deciding whether to operate on a patient with SBO or to manage the patient conservatively is difficult. Commonly, the decision to operate is given only after conservative management has failed or peritonitis has been detected. A major challenge in SBO management is to detect ischemia as early as possible to avoid necrosis and resection.[3]

Mean platelet volume (MPV) is a platelet volume index and was found to be elevated in patients with inflammatory disorders.[6,7] Recent studies have revealed that the MPV/platelet count (PC) ratio is also associated with predicting the outcomes of patients with various diseases, such as ischemic cardiovascular diseases and malignant tumors, and patients in intensive care units (ICUs).[6,8–10]

The objective of the current study was to evaluate the value of the MPV/PC ratio for predicting the need for surgery and intestinal necrosis in patients with postoperative adhesive SBO.

Patients and Methods

A total of 129 patients who were admitted to the general surgery department of Dicle University Hospital between November 2010 and March 2014 with postoperative adhesive SBO were included in the study. Demographic data and clinical and laboratory findings of the patients were reviewed retrospectively. This study was approved by the local ethics committee of Dicle University.

The patients were divided into 2 groups: patients in whom conservative treatment was successful [conservative group (CG); n = 43] and in whom conservative treatment had failed [surgery group (SG); n = 86]. The surgery group was further divided into 2 subgroups, according to the presence (BN+; n = 19) or absence (BN–; n = 67) of bowel necrosis, as determined intraoperatively and verified with histopathologic examination.

Small bowel obstruction was diagnosed on the basis of standard clinical signs (such as abdominal pain and distension, nausea or vomiting, and no passage of gas and/or stools) and radiologic findings. Patients with SBO who had a history of abdominal surgery were included in the study. Exclusion criteria were early postoperative obstruction, obstruction with neoplasia, obstruction with inflammatory bowel disease, incarcerated hernia, and colon obstruction.

Initially, each patient was managed conservatively with nasogastric tube suction and administration of diatrizoate meglumine and diatrizoate sodium solution via nasogastric tube. After each patient received diatrizoate meglumine and diatrizoate sodium solution, radiologic imaging was performed at 24-hour intervals. If diatrizoate meglumine and diatrizoate sodium solution was detected in the cecum, or if passage of gas and stools was observed, the nasogastric tube was clamped and removed, oral nutrition was resumed, and the conservative treatment was considered successful. If diatrizoate meglumine and diatrizoate sodium solution was absent from the cecum at the 48th hour or if peritonitis was detected, conservative treatment was considered to have failed and the patient underwent laparotomy.

The open surgical procedure consisted of gut adhesiolysis or adhesiolysis and bowel resection. An ostomy was established or an anastomosis was created depending on the specific bowel conditions. In each case, the presence or absence of bowel necrosis was noted.

Statistical Analysis

Statistical analysis was performed using statistical software (SPSS version 18; SPSS Inc, Chicago, Illinois). Data were expressed as mean ± SD. We used the χ^2 test for categorical variables, and the Mann-Whitney U test for continuous variables. We considered a P value of less than 0.05 significant.

Table 1 Data of the CG and SG groups

	Conservative group (n = 43)	Surgery group (n = 86)	P*
Age, y, mean ± SD	51.91 ± 20.7	47.88 ± 22.1	0.295
Sex			
Male, n (%)	32 (36.8)	55 (63.2)	0.232
Female, n (%)	11 (26.2)	31 (73.8)	
Platelet count, 10^3/mL, mean ± SD	362.16 ± 146.50	312.10 ± 135.40	**0.037**
MPV, fL, mean ± SD	7.44 ± 0.90	7.78 ± 1.2	0.327
MPV/PC, mean ± SD	0.02324 ± 0.00786	0.03044 ± 0.01639	**0.027**
SIRS			
Absent, n (%)	40 (40)	60 (60)	**0.003**
Present, n (%)	3 (10.3)	26 (89.7)	
Heart rate, mean ± SD	83.8 ± 11.7	91.7 ± 14.5	**0.001**
Comorbidity			
Absent, n (%)	33 (36.3)	58 (63.7)	0.275
Present, n (%)	10 (26.3)	28 (73.7)	
Duration of symptoms, h, mean ± SD	54.0 ± 29.3	57.6 ± 28.3	0.314
Hospital stay time, d, mean ± SD	5.05 ± 3.30	11.09 ± 14.90	**<0.001**
Need for ICU			
Absent, n (%)	35 (92.1)	3 (7.9)	**<0.001**
Present, n (%)	8 (8.8)	83 (91.2)	
ICU stay time, d, mean ± SD	4.75 ± 2.5	6.2 ± 13.4	0.466
Morbidity			
Absent, n (%)	42 (37.8)	69 (62.2)	**0.007**
Present, n (%)	1 (5.6)	17 (94.4)	
Mortality			
Absent, n (%)	42 (35.9)	75 (64.1)	0.060
Present, n (%)	1 (8.3)	11 (91.7)	

*Bold indicates numbers that are statistically significant.

Results

The mean age of the patients was 49.22 ± 21.65 years, and 87 patients (67.4%) were male. The conservative group consisted of 43 patients (33.3%), while 86 patients (66.7%) underwent surgery. The mean age was 53.53 ± 20.87 years in the CG and 47.07 ± 21.84 years in the SG ($P = 0.110$). Comorbid disease was present in 11 patients (25.6%) in the CG compared with 27 patients (31.4%) in the SG ($P = 0.495$). The most common comorbid disease was diabetes mellitus (n = 5, 11.6%) in the CG and hypertension (n = 10, 11.6%) in the SG ($P = 0.581$).

In the surgery group, the average MPV/PC ratio was higher than in the CG ($P = 0.027$). Conversely, PC was lower in the SG ($P = 0.037$). Twenty-six patients (89.7%) in the SG developed systemic inflammatory response syndrome (SIRS) compared with only 3 patients (10.3%) in the CG ($P = 0.003$). Morbidity rates, mean hospital stay time, and the need for ICU admission were higher in the SG ($P = 0.007$, $P < 0.001$, and $P < 0.001$, respectively). Data for the CG and the SG are summarized in Table 1.

Of the 86 patients who underwent surgery, bowel necrosis was detected in 19 patients (BN+ group, 22.1%). There were 20 female patients (29.8%) in the BN– group and 10 female patients (52.6%) in the BN+ group ($P = 0.025$). The most common comorbid disease was diabetes mellitus (n = 5, 7.46%) in the BN– group and hypertension (n = 6, 31.7%) in the BN+ group ($P = 0.075$). The most common previous operation was colectomy (n = 15, 22.3%) in the BN– group, and gynecologic operations (n = 5, 26.3%) were most common in the BN+ group ($P = 0.174$). In the BN+ group, MPV and the MPV/PC ratio were significantly higher than in the BN– group ($P = 0.049$ and $P = 0.038$, respectively). Data for patients of the BN+ and BN– groups are summarized in Table 2.

The cutoff value with the highest sensitivity and specificity for MPV/PC ratio was 0.02855 (sensitivity 68%, specificity 65%) for predicting bowel necrosis in patients with adhesive SBO.

Discussion

Postoperative adhesion formation is the most common complication of abdominal and pelvic surgery. Unlike other postoperative complications, such as wound infection or anastomotic leakage, the consequences of adhesion formation comprise a

Table 2 Data of the BN– and BN+ groups

	BN– (n = 67)	BN+ (n = 19)	P*
Age, y, mean ± SD	46.24 ± 22.17	53.68 ± 21.45	0.148
Sex			
Male, n (%)	47 (85.5)	8 (14.5)	**0.025**
Female, n (%)	20 (64.5)	11 (35.5)	
Platelet count, 10^3/mL, mean ± SD	326.18 ± 139.75	262.44 ± 108.04	0.125
MPV, fL, mean ± SD	7.66 ± 1.23	8.20 ± 1.15	**0.049**
MPV/PC, mean ± SD	0.02822 ± 0.01367	0.03815 ± 0.02231	**0.038**
SIRS			
Absent, n (%)	49 (81.7)	11 (18.3)	0.202
Present, n (%)	18 (69.2)	8 (30.8)	
Heart rate, mean ± SD	92.36 ± 14.38	89.82 ± 15.17	0.745
Comorbidity			
Absent, n (%)	47 (81.0)	11 (19.0)	0.314
Present, n (%)	20 (71.4)	8 (28.6)	
Duration of the symptoms, h, mean ± SD	59.07 ± 29.09	52.42 ± 25.36	0.498
Time between admission and operation, h, mean ± SD	41.80 ± 38.90	24.94 ± 19.12	0.144
Hospital stay time, d, mean ± SD	11.02 ± 14.66	11.37 ± 16.43	0.836
Need for ICU			
Absent, n (%)	1 (33.3)	2 (66.7)	0.121
Present, n (%)	66 (79.5)	17 (20.5)	
ICU stay time, d, mean ± SD	6.77 ± 15.09	4.41 ± 1.69	0.168
Morbidity			
Absent, n (%)	52 (75.4)	17 (24.6)	0.340
Present, n (%)	15 (88.2)	2 (11.8)	
Mortality			
Absent, n (%)	59 (78.7)	16 (21.3)	0.701
Present, n (%)	8 (72.7)	3 (27.3)	

*Bold indicates numbers that are statistically significant.

lifelong risk for various clinical entities.[11–16] Ten Broek *et al*[17] reported that the incidence of adhesive small bowel obstruction was 2.4%.

It is very important to diagnose bowel strangulation in adhesive small bowel obstruction patients in order to avoid bowel necrosis and associated complications. Therefore, strangulation predictors have been evaluated in a number of human studies.[18–24]

Mean platelet volume is a marker of the size and activation of platelets. Large platelets possess higher metabolic and enzymatic activity and show higher thrombogenic potential.[25] A direct association has been demonstrated between increased MPV and acute thrombotic events, such as acute myocardial infarction, unstable angina, and stroke.[26–28] Aliosmanoglu *et al*[29] reported that MPV was significantly higher in patients with portal venous thrombosis. Gul *et al*[30] reported that MPV was associated with sudden hearing loss due to ischemia. Similarly, our results demonstrated that the mean MPV was higher in patients who developed bowel necrosis; but we didn't find any significant difference between the conservative group and the surgery group.

However, recent studies have revealed an association between the MPV/PC ratio and the outcomes of patients with various ischemic diseases. Azab *et al*[8] reported that the MPV/PC ratio was superior to the MPV alone in predicting long-term mortality after non-STE myocardial infarction. Sezgi *et al*[10] reported that increasing MPV and decreasing platelet count may alert intensivists to the worse course of the disease in ICU patients. In accordance with these data, in our study, the MPV/PC ratio was greater in patients who developed bowel necrosis. Also, MPV/PC ratio was higher in surgery group than conservative group.

Tsumura *et al*[23] reported that the presence of SIRS was independently predictive of strangulation in acute small bowel obstruction. Miyauchi *et al*[24] reported that the large number of patients with strangulation obstruction exhibited SIRS before the operation, and the manifestation of SIRS correlated well with the length of the necrosis in the strangulated small bowel. Similarly, in the present study, the presence of SIRS was more common, and the mean heart rate was higher in SG patients. However, there was no statistically significant

difference between the BN+ and BN– groups in terms of the presence of SIRS or mean heart rate.

In a study by Cosse *et al*,[5] the mean age of the surgical management group was significantly higher than that of the conservative management group. In another study, Markogiannakis *et al*[31] revealed that there was no significant difference between the mean ages of the ischemia and nonischemia groups or the mean ages of the necrosis and non-necrosis groups. In our study, neither the CG or the SG, nor the BN+ and BN– groups were statistically significantly different in terms of mean age.

Both Cosse *et al*[5] and Markogiannakis *et al*[31] reported that patient sex distributions were not statistically different between groups, but Lo *et al*[18] observed an association between female sex and rate of strangulation in their series of 430 patients. In our study, patient sex distributions were not statistically different between the CG and the SG, but the proportion of female patients was higher in the BN+ group than in the BN– group.

Laparotomy was performed in 66.6% of our patients. This percentage seems to be higher than the rates reported in the literature, which range from 24% to 57%.[19–21,32,33] The operative treatment rates of SBO were likely high in the present study as it was conducted in a tertiary care hospital, and most of the patient population consists of patients who did not improve in previous hospitals. In the present study, patient bowel necrosis rates were as high as 14.7%, in accordance with the literature (range, 11%–29%).[18,22,32]

Although previously time from arrival to operation was determined to be significantly shorter in the necrosis group,[31] no significant difference was identified between the BN+ and BN– groups in our study. In the same study, postoperative complication rates, ICU admission rates, and mortality rates were reported to be higher in the necrosis group, while there were no significant differences in terms of ICU duration of stay or hospital stay time.[31] In our study, mean hospital stay time, need for ICU admission, and postoperative morbidity rates were higher in the SG. However, there were no statistically significant differences between the BN+ and BN- groups in terms of hospital stay, ICU admission and duration of ICU stay, or postoperative morbidity and mortality.

Conclusion

Mean platelet volume/platelet count ratio is associated with the failure of the conservative management and the presence of bowel necrosis in patients with adhesive small bowel obstruction. Further studies are needed to determine the importance of MPV/PC in adhesive SBO.

Limitations

The limitations of this study include the retrospective, single-center study format and the small size of the study group. For example, we think that the ratio of patients who need surgery would be lower if we include all patients who were admitted to the hospital, but because we are a tertiary referral hospital, the need for surgery is relatively higher. So, prospective, multicentric studies should be performed in order to evaluate the predictive value of MPV/PC ratio in adhesive SBO.

Acknowledgments

The authors declare no conflicts of interest.

References

1. Parker MC, Ellis H, Moran BJ, Thompson JN, Wilson MS, Menzies D *et al*. Postoperative adhesions: ten-year follow-up of 12,584 patients undergoing lower abdominal surgery. *Dis Colon Rectum* 2001;**44**(6):822–830
2. Ellis H. The magnitude of adhesion related problems. *Ann Chir Gynaecol* 1998;**87**(1):9–11
3. Di Saverio S, Coccolini F, Galati M, Smerieri N, Biffl WL, Ansaloni L *et al*. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2013 update of the evidence-based guidelines from the world society of emergency surgery ASBO working group. *World J Emerg Surg* 2013;**8**(1):42
4. Tanaka S, Yamamoto T, Kubota D, Matsuyama M, Uenishi T, Kubo S *et al*. Predictive factors for surgical indication in adhesive small bowel obstruction. *Am J Surg* 2008;**196**(1):23–27
5. Cosse C, Regimbeau JM, Fuks D, Mauvais F, Scotte M. Serum procalcitonin for predicting the failure of conservative management and the need for bowel resection in patients with small bowel obstruction. *J Am Coll Surg* 2013;**216**(5):997–1004
6. Inagaki N, Kibata K, Tamaki T, Shimizu T, Nomura S. Prognostic impact of the mean platelet volume/platelet count ratio in terms of survival in advanced non-small cell lung cancer. *Lung Cancer* 2014;**83**(1):97–101
7. Gasparyan AY, Ayvazyan L, Mikhailidis DP, Kitas GD. Mean platelet volume: a link between thrombosis and inflammation? *Curr Pharm Des* 2011;**17**(1):47–58

8. Azab B, Torbey E, Singh J, Akerman M, Khoueiry G, McGinn JT *et al*. Mean platelet volume/platelet count ratio as a predictor of long-term mortality after non-ST-elevation myocardial infarction. *Platelets* 2011;**22**(8):557–566
9. Slavka G, Perkmann T, Haslacher H, Greisenegger S, Marsik C, Wagner OF *et al*. Mean platelet volume may represent a predictive parameter for overall vascular mortality and ischemic heart disease. *Arterioscler Thromb Vasc Biol* 2011; **31**(5):1215–1218
10. Sezgi C, Taylan M, Kaya H, Selimoglu Sen H, Abakay O, Demir M *et al*. Alterations in platelet count and mean platelet volume as predictors of patient outcome in the respiratory intensive care unit. *Clin Respir J* (in press)
11. Van Goor H. Consequences and complications of peritoneal adhesions. *Colorectal Dis* 2007;**9**(2):25–34
12. Taylor GW, Jayne DG, Brown SR, Thorpe H, Brown JM, Dewberry SC *et al*. Adhesions and incisional hernias following laparoscopic versus open surgery for colorectal cancer in the CLASICC trial. *Br J Surg* 2010;**97**(1):70–78
13. Nieuwenhuijzen M, Reijnen MMPJ, Kuijpers JHC, van Goor H. Small bowel obstruction after total or subtotal colectomy: a 10-year retrospective review. *Br J Surg* 1998;**85**(9):1242–1245
14. Ellis H, Moran BJ, Thompson JN, Parker MC, Wilson MS, Menzies D *et al*. Adhesion-related hospital readmissions after abdominal and pelvic surgery: a retrospective cohort study. *Lancet* 1999;**353**(9163):1476–1480
15. Ten Broek RP, Strik C, Issa Y, Bleichrodt RP, van Goor H. Adhesiolysis-related morbidity in abdominal surgery. *Ann Surg* 2013;**258**(1):98–106
16. Ording Olsen K, Juul S, Berndtsson I, Oresland T, Laurberg S. Ulcerative colitis: female fecundity before diagnosis, during disease, and after surgery compared with a population sample. *Gastroenterology* 2002;**122**(1):15–19
17. Ten Broek RP, Issa Y, Van Santbrink EJ, Bouvy ND, Kruitwagen RF, Jeekel J *et al*. Burden of adhesions in abdominal and pelvic surgery: systematic review and met-analysis. *BMJ* 2013;**347**: f5588
18. Lo OS, Law WL, Choi HK, Lee YM, Ho JW, Seto CL. Early outcomes of surgery for small bowel obstruction: analysis of risk factors. *Langenbecks Arch Surg* 2007;**392**(2):173–178
19. Firoozmand E, Fairman N, Sklar J, Waxman K. Intravenous interleukin-6 levels predict need for laparotomy in patients with bowel obstruction. *Am Surg* 2001;**67**(12):1145–1149
20. Takeuchi K, Tsuzuki Y, Ando T, Sekihara M, Hara T, Yoshikawa M *et al*. Clinical studies of strangulating small bowel obstruction. *Am Surg* 2004;**70**(1):40–44
21. Yamamoto T, Umegae S, Kitagawa T, Matsumoto K. The value of plasma cytokine measurement for the detection of strangulation in patients with bowel obstruction: a prospective, pilot study. *Dis Colon Rectum* 2005;**48**(7):1451–1459
22. Fevang BT, Fevang J, Stangeland L, Soreide O, Svanes K, Viste A. Complications and death after surgical treatment of small bowel obstruction: a 35-year institutional experience. *Ann Surg* 2000;**231**(4):529–537
23. Tsumura H, Ichikawa T, Hiyama E, Murakami Y, Sueda T. Systemic inflammatory response syndrome (SIRS) as a predictor of strangulated small bowel obstruction. *Hepatogastroenterology* 2004;**51**(59):1393–1396
24. Miyauchi T, Kuroda T, Nisioka M, Hashimoto T, Kasamatu T, Kuratate S *et al*. Clinical study of strangulation obstruction of the small bowel. *J Med Invest* 2001;**48**(1–2):66–72
25. Kamath S, Blann AD, Lip GY. Platelet activation: assessment and quantification. *Eur Heart J* 2001;**22**(17):1561–1571
26. Isik T, Ayhan E, Uyarel H, Ergelen M, Tanboga IH, Kurt M *et al*. Increased mean platelet volume associated with extent of slow coronary flow. *Cardiol J* 2012;**19**(4):355–362
27. Unal EU, Ozen A, Kocabeyoglu S, Durukan AB, Tak S, Songur M *et al*. Mean platelet volume may predict early clinical outcome after coronary artery bypass grafting. *J Cardiothorac Surg* 2013;**8**(1):91
28. Slavka G, Perkmann T, Haslacher H, Greisenegger S, Marsik C, Wagner OF *et al*. Mean platelet volume may represent a predictive parameter for overall vascular mortality and ischemic heart disease. *Arterioscler Thromb Vasc Biol* 2011; **31**(5):1215–1218
29. Aliosmanoglu I, Gul M, Oguz A, Basol O, Uslukaya O, Keles C. Can mean platelet volume be a new risk factor in portal venous thrombosis? *Clin Appl Thromb Hemost* 2013;**19**(4):433–436
30. Gul A, Bakir S, Akdag M, Ozkurt FE, Ozbay M, Kinis V. The investigation of the prognostic value of mean platelet volume in patients with sudden hearing loss. *Clin Ter* 2014;**165**(2):71–74
31. Markogiannakis H, Memos M, Messaris E, Dardamanis D, Larentzakis A, Papanikolaou D *et al*. Predictive value of procalcitonin for bowel ischemia and necrosis in bowel obstruction. *Surgery* 2011;**149**(3):394–403
32. Fevang BT, Jensen D, Svanes K, Viste A. Early operation or conservative management of patients with small bowel obstruction? *Eur J Surg* 2002;**168**(8–9):475–481
33. Williams SB, Greenspon J, Young HA, Orkin BA. Small bowel obstruction: conservative vs. surgical management. *Dis Colon Rectum* 2005;**48**(6):1140–1146