



## Original Article

# Evaluation of Mean Platelet Volume Level as a Biomarker in Acute Appendicitis

Ayesha Rahman<sup>1</sup>, S.M. Syeed-UI-Alam<sup>2</sup>, Sanjana Sharmin Shashi<sup>3</sup>, A.Z.M. Mostaque Hossain<sup>4</sup>,  
Salma Sultana<sup>5</sup>

### ABSTRACT

**Background:** Acute appendicitis is one of the important causes of emergency surgeries. Diagnosis of acute appendicitis remains to be challenging with up to 30% negative exploration rates. In addition to careful clinical history and physical examination, we still need easily applicable, cheap and effective biomarker. Complete blood count is the primary investigation for any inflammatory condition. Total WBC count and neutrophil percentage are widely used biomarkers to diagnose acute appendicitis. Mean platelet volume (MPV) is an emerging biomarker that has been considered to be affected by inflammatory burden. MPV value is also estimated during complete blood count. This study may help to reveal the change of MPV in acute appendicitis.

**Study design:** This was a prospective observational type of study.

**Study setting and period:** The study was carried out in the Surgery In-patient Department of Dhaka Medical College Hospital, Dhaka from 15-11-2013 till 15-04-2014.

**Materials:** A total of 150 patients of both sex aged 15-65 years who got admitted in the surgery department for acute appendicitis were selected. Pediatric patients (aged less than 14years), patients with co morbid illness like ischemic heart disease, inflammatory bowel disease, general peritonitis and the patients having lack of necessary investigations were excluded from the study.

**Methods:** The variables like total WBC count, neutrophil percentage, platelet count and mean platelet volume (MPV) of all 150 selected patients were noted after admission by doing complete blood count and compared with normal value. The appendix samples obtained after surgery were sent for histopathological confirmation and reports were collected.

**Results:** A total of 150 patients with the mean age of 25.72 (ranging 15-65) years were studied. Among them 93(62%) were male and 57(38%) were female. Mean MPV value was  $11.7 \pm 0.183$  fL (p value 0.02). 122 patients have increased MPV value (81.33%). Among them 113 were eventually diagnosed as acute appendicitis. Negative exploration rate was 14%. Negative exploration was less among MPV raised patients (7.38%). Whereas negative exploration was more among normal MPV patients (21.42%). Total WBC count and neutrophil percentage are important biomarkers to diagnose acute appendicitis which is accepted. However this study revealed MPV value is an important biomarker in acute appendicitis also which is statistically significant and can reduce negative exploration.

**Conclusion:** In this study mean platelet volume increases in acute appendicitis. MPV can be used as a biomarker in diagnosis of acute appendicitis.

1. Junior Consultant (Surgery), Dhaka Medical College Hospital.
2. Junior Consultant (Surgery), National Institute of Kidney Diseases and Urology.
3. Assistant Professor (Surgery), Dr. Sirajul Islam Medical College and Hospital.
4. Professor of Surgery, Dhaka Medical College & Hospital.
5. Professor of Surgery, Dhaka Medical College & Hospital.

**Correspondence to:** Dr. Ayesha Rahman, Junior Consultant (Surgery), Dhaka Medical College Hospital. Mobile: 01711943600, E-mail: arjuthi43@gmail.com

**Received:** 20 April 2018

**Accepted:** 03 June 2018

### Introduction

Appendicitis is the most common abdominal emergency and accounts for more than 40,000 hospital admissions in England every year. The diagnosis of acute appendicitis is predominantly clinical one; many patients present with a typical history and examination findings. The cause of acute appendicitis is unknown but is probably multifactorial; luminal obstruction and dietary and familial factors have all been suggested<sup>1</sup>.

Acute appendicitis is a common surgical condition of the abdomen, the prompt diagnosis of which is rewarded by a marked decrease in morbidity and mortality<sup>2</sup>. Classically, the diagnosis of acute appendicitis is based on a brief history of abdominal pain, nausea, migration of pain to the right iliac fossa, and signs of local peritonitis; diagnostic accuracy based on these symptoms ranges from 70% to 80%<sup>2,3</sup>. Acute appendicitis is one of the most frequent causes of emergent exploration due to acute surgical abdomen. Despite, the improvements in diagnostic techniques, negative laparotomy or laparoscopy rates can be reached up to 30%<sup>4</sup>.

Efforts to avoid unnecessary explorations were enforced surgeons to find reliable biomarkers for accurate diagnosis of acute appendicitis<sup>5-7</sup>. Although, the value of careful clinical history, physical examination and commonly used laboratory parameters (white blood cell count, neutrophil percentage and C-reactive protein) are utmost important, a reliable bio-marker could help the physician to make a clear final decision. Up to date, a lot of markers have been proposed, but none of them were commonly accepted, so we still need easily applicable, cheap and effective biomarker for help-ing the diagnosis of acute appendicitis<sup>4,8</sup>. Several parameters (i.e. C-reactive protein (CRP), white blood cell count, lymphocyte/ leukocyte rate, interleukin-6, interleukin-10, interleukin-4, interleukin-5, interleukin-12, tumor necrosis factor alpha endotoxin, erythrocyte sedimentation rate, procalcitonin, fibrinogen, alpha 2 -macroglobulin, alpha1-antitrypsin, D-Lactate for the diagnosis of acute appendicitis have been investigated in the literature<sup>3</sup>.

The mean platelet volume (MPV) is a routinely reported parameter in complete blood count. CBC was generally thought to unimportant by physicians for the diagnosis of acute appendicitis, except white blood cell (WBC) count and neutrophil predominance<sup>4</sup>.

Platelet count (PC) is a part of complete blood count (CBC) and one of the most commonly used laboratory tests. There are three CBC parameters related to platelets; plateletcrit (PCT), mean platelet volume (MPV) and platelet distribution width (PDW). MPV is the most well-known of these parameters and is a marker of platelet function and activation<sup>9</sup>. MPV has been shown to reflect inflammatory burden and disease activity in several diseases including pre-eclampsia,

acute pancreatitis, unstable angina, myocardial infarction, and systemic inflammation such as ulcerative colitis and Crohn's disease<sup>3</sup>.

There are only a few studies reporting that MPV levels may be valuable in the diagnosis of acute appendicitis and the results are controversial<sup>3,8</sup>. In the present study we aimed to seek whether MPV level is important in the diagnosis of acute appendicitis. This prospective study we will compare WBC count, neutrophil percentage, platelet count, and MPV values of a group of pathologically confirmed acute appendicitis with a group of healthy patients.

### Methods

This was a prospective observational type of study conducted in Surgery Department of Dhaka Medical College Hospital.

A total of 150 patients of both sex aged 15-65 years were selected who got admitted in the surgery in-patient department with suspected acute appendicitis. Pediatric patients (aged less than 14 years), patients with co-morbid illness like ischemic heart disease, inflammatory bowel disease, generalized peritonitis and the patients having lack of necessary investigations were excluded from the study. 150 patients were included.

Data was collected in a pre-designed data collection sheet. All patients of clinically suspected acute appendicitis were evaluated by complete blood count. Different variables like total WBC count, neutrophil percentage, platelet count and mean platelet volume (MPV) are to be noted. Appendix sample obtained after surgery are to be sent for histopathological study for confirmation. Data were processed and analyzed using computer software SPSS (Statistical Package for Social Sciences). After compilation these data were shifted to statistical analysis software for further analysis. Then the results were taken in bar chart and table format.

All the relevant data were compiled on a master chart first. Statistical analysis of the results is obtained by using windows based computer software and SPSS. The continuous data are expressed as mean  $\pm$  SD. The categorical data are expressed as number and percentage. The results are presented in tables and diagrams. Data were assessed using t test.

## Results

Over the 6 months of the study, 150 patients of age range 15-65 years were selected from different units of department of Surgery, DMCH. Among them 93(62%) were male and 57(38%) were female (Shown in Table 1).

**Table 1. Patients sex distribution (n=150)**

Sex	Number	Percentage (%)
Male	93	62%
Female	57	38%

Male: Female is 1.6: 1.

Mean age was  $25.72 \pm 4.6$  years that means younger males were more affected.

**Table 2. Different Age Group of Patients (n=150)**

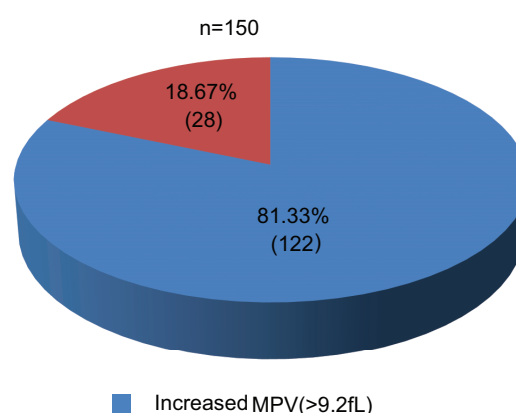
Age Group	Patient Number	Percentage (%)
0-10	—	—
11-20	22	14.67%
21-30	53	35.33%
31-40	45	30%
41-50	17	11.33%
51-60	10	6.67%
61-70	03	2%

Maximum number of patient age was within 21-30 years.

**Table 3. Clinical Presentation (n=150)**

Features	Present (%)	Absent (%)
Classical Pain	98 (65.33%)	52 (34.67%)
Nausea/ vomiting	99 (66%)	51 (34%)
Fever	103 (68.67%)	47(31.33%)
McBurney's Tenderness	127(84.67%)	23 (15.33%)
Rebound Tenderness	115 (76.67%)	35 (23.33%)
Pointing Sign	130 (86.67%)	20 (13.34%)
Rovsing's Sign	39 (26%)	111(74%)

Most of the patient complained of periumbilical pain (74.67%) and on examination McBurney's tenderness was the most frequent sign (84.67%).



**Figure 1. Mean Platelet Volume Distributions**

**Table 4. Complete blood count (CBC) Presentation (n=150)**

Biomarkers	Normal Range	Mean Value	P Value
Total WBC Count	4.0-11.0x 10 <sup>9</sup> /L	14. 5±0.4x10 <sup>9</sup> /L	0.04
Neutrophil (%)	50-70	79.12±1.08	0.014
Total platelet count	150-400x10 <sup>9</sup> /L	244.79± 12.64x10 <sup>9</sup> /L	0.4
MPV(fL)	7.2-9.2	11.7± 0.18	<b>0.02</b>

Among the biomarkers total WBC count, neutrophil percentage and MPV were increased than the normal range which were statistically significant.

**Table 5.** *Histopathological variations (n=150)*

<b>Histopathology</b>	<b>Number of patients</b>	<b>Percentage (%)</b>
Acute Appendicitis	68	45.33%
Acute Suppurative Appendicitis	39	26%
Acute Gangrenous Appendicitis	20	13.33%
Follicular Hyperplasia	9	06%
Normal Appendix	14	9.33%

14 patients diagnosed as acute appendicitis underwent exploration but eventually revealed having normal appendix on histopathological report. Overall negative exploration rate 9.33%.

**Table 6.** *Histopathological Confirmation of MPV Raised Patients*

<b>Histopathological Variations</b>	<b>Number of Patients</b>	<b>Percentage (%)</b>
Acute Appendicitis	113	92.62%
Normal Appendix	09	7.38%
Total	122	100%

**Table 7.** *Histopathological Confirmation of Normal MPV Patients*

<b>Histopathological Variations</b>	<b>Number of Patients</b>	<b>Percentage (%)</b>
Acute Appendicitis	22	78.58%
Normal Appendix	06	21.42%
Total	28	100%

Negative exploration rate among the patients who had normal MPV was 21.42%.

### Discussion:

The pathophysiology of acute appendicitis is characterized by the mucosal ischemia of the appendix that results from ongoing mucus secretion from the appendiceal mucosa distal to an obstruction of the lumen, elevating intraluminal and, in turn, venous pressures. Once luminal pressure exceeds 85 mmHg, venules that drain the appendix become thrombosed and, in the setting of continued arteriolar in flow,

vascular congestion and engorgement of the appendix become manifest<sup>10</sup>. Infection is added to the inflammation of appendicitis.

Acute appendicitis is one of the most frequent surgical problems encountered in hospitals. Acute appendicitis is common between the ages of 10 and 20 years, but no age is exempt. A male preponderance exists with a male to female ratio 1.4:1<sup>1</sup>. In this study, the study design was prospective and there was no control group. 150 patients of acute appendicitis were enrolled in this study. Their CBC reports were analyzed. The mean age was 25.72 years and most of them (62%) were male (Table 1). The maximum number of patient aged between 21 to 30 years. And male female ratio was 1.6:1.

In recent studies, a relationship between the rise of leukocyte count and appendicitis diagnosis have been shown. It has been reported that in patients with acute appendicitis, the sensitivity of leukocyte is between 60–87%, and specificity 53–100%. Its increase with CRP can assist diagnosis with a sensitivity reaching 98%. It has been shown that leukocyte count increases during the early stages of the disease and prior to perforation, but no statistically significant difference exists between leukocyte counts of patients with perforated appendicitis and those without perforation<sup>8</sup>.

Several scoring systems are used to reach diagnosis in acute appendicitis. In every scoring system biomarkers are used. MPV is an inflammatory marker hence it might have role in diagnosis of acute appendicitis.

MPV is easily measured in CBC analysis and it presumably reflects the functional and activation status of platelets and their production rate from megakaryocytes as well. In the literature, MPV value was shown to be significantly higher in patients with sepsis, myocardial ischemia and cerebrovascular diseases compared to MPV values in healthy individuals<sup>14-16</sup>. Similarly, high MPV values were found to be independent risk factor in patients with coronary artery disease and cerebrovascular pathology<sup>8,9</sup>.

Slavka et al reported a 1.5 fold higher mortality rate in patients with high MPV (> 11.01 fL) compared to patients with lower MPV (< 8.7 fL) and they concluded that an increase in MPV reflected increased platelet activity<sup>19</sup>.

Erdem H et al in a retrospective case control study reported MPV value as an important parameter in the diagnosis of acute appendicitis. However, ROC analysis showed that MPV as a biomarker was a less superior marker in terms of sensitivity and specificity compared to leukocyte count and/or neutrophil percentage in diagnosis of acute appendicitis<sup>4</sup>.

Albayrak et al showed low MPV to be statistically significant in their study which compares adult acute appendicitis cases with healthy adult control group<sup>5</sup>. They have reported that MPV should not be ignored during the diagnostic stages of patients with suspected acute appendicitis.

Bilici et al have reported significant reduction in MPV in pediatric age group acute appendicitis events in comparison to the control group<sup>10</sup>.

Narci H et al study revealed increase MPV value in patients of acute appendicitis<sup>3</sup>. Whereas Tanrikulu CS et al found that MPV is significantly decreased in acute appendicitis, having a greater sensitivity<sup>9</sup>. Both the study was retrospective case control study. Regarding the relation of MPV with acute appendicitis most of the studies were retrospective.

In this study most of the patient complained of periumbilical pain (74.67%) and on examination McBurney's tenderness was the most frequent sign (84.67%). Among the cases 81.33% showed increased MPV and normal in 18.67% cases.

All three variables such as total WBC count, neutrophil percentage and MPV were increased than the normal range and statistically significant also as the p value was 0.04, 0.01 and 0.02 respectively, whereas platelet count had no significant variation.

14 patients diagnosed as acute appendicitis underwent exploration but eventually revealed having normal appendix on histopathological report. Negative exploration rate was 9.33%. Hasan E et al mentioned negative laparotomy or laparoscopy rate is 30%<sup>4</sup>.

As is observed in this present study, in 122 patients MPV is significantly raised (p value 0.02). 28 patients had normal MPV value. Among MPV raised patients 9 patients underwent negative exploration (7.38%). On the other hand among patients with normal MPV, 6 patients underwent negative exploration (21.42%). That means MPV raised group had lesser negative exploration.

Hence, Mean Platelet Volume may be an important biomarker in diagnosis of acute appendicitis. This study may help to design more study to compare MPV among acute appendicitis patients and healthy individuals with larger sample size.

### Conclusion

This was an observational and prospective type of study conducted at Dhaka Medical College Hospital, for a period of 6 months from November 2015 to April 2016. Total 150 patients of acute appendicitis were selected purposively fulfilling the selection criteria. This study revealed that mean platelet volume significantly (P value < 0.05) increase in acute appendicitis. Mean platelet volume can be an important biomarker in acute appendicitis.

### Recommendation

Further study is required to evaluate the change of mean platelet volume in acute appendicitis and to establish it as a diagnostic biomarker. May be in future MPV would be used to help diagnosis of acute appendicitis.

### References

1. Humes D J, Simpson J. Acute appendicitis. *BMJ* 2006; 333:530–4.
2. Andersson R E. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. *Br J Surg* 2004; **91**(1):28–37.
3. Narci H, Turk E, Karagulle E, Togan T, Karabulut K. The Role of Mean Platelet Volume in the Diagnosis of Acute Appendicitis: A retrospective case-controlled study. *Iran Red Crescent Med J* 2013 December; **15**(12): e11934.
4. Hasan E, Aktimur R, Centinkunar S, Gokler R C, Irkorucu O, Sozen S. Evaluation of mean platelet volume as a diagnostic biomarker in acute appendicitis. *Int J Clin Exp Med* 2015; **8**(1): 1291–1295.
5. Albayrak Y, Albayrak A, Albayrak F, Yildirim R, Aylu B, Uyanik A et al. Mean platelet volume: a new predictor in confirming acute appendicitis diagnosis. *Clin Appl Thromb Hemost* 2011; **17**: 362-366.
6. Schellekens D H, Hulsewe K W, van Acker B A, van Bijan AA, de Jaegere T M, Sastrowijito S H et al. Evaluation of the diagnostic accuracy of plasma markers for early diagnosis in patients



- suspected for acute ap-pendicitis. *Acad Emerg Med* 2013; 20: 703-710.
7. Kaya B, Sana B, Eris C, Karabulut K, Bat O, Kutanis R, The diagnostic value of of D-dimer, procalcitonin and CRP in acute appendicitis. *Int J Med Sci* 2012; 9: 909-915.
  8. Uyaenik B, Kavalci C, Arslan E D, Yilmaz F, Aslan O, Dede S et al. Role of mean platelet volume in diagnosis of childhood acute appendicitis *Emerg Med Int* 2012; 2012:823095.
  9. Tanrikulu C S, Tanrikulu Y, Sabuncuoglu M Z, Karamercan MA, Akkapulu N, Coskun F. Mean Platelet Volume and Red Cell Distribution Width as a Diagnostic Marker in Acute Appendicitis. *Iran Red Crescent Med J.* 2014 May; 16(5): e10211
  10. Bilici S, Sekmenli T, Göksu M, Melek M, Avci V, Mean platelet volume in diagnosis of acute ap-pendicitis in children *Afr Health Sci* 2011; 11: 427-432.
  11. Bozkurt S, Köse A, Erdogan S, Bozali G I, Ayrik C, Bozdogan R et al, MPV and other inflammatory markers in diagnosing acute appendicitis *J Pak Med Assoc.*2015 ;65: 637-641.
  12. Fan.Z, Pan J, Zhang Y, Wang Z, Zhu M, Yang B et al. Mean Platelet Volume and Platelet Distribution Width as Markers in the Diagnosis of Acute Gangrenous Appendicitis. *Hindawi Publishing Corporation Disease Markers* 2015; Article ID 542013.
  13. Tanrikulu C S, Tanrikulu Y, Sabuncuoglu M Z, Karamercan MA, Akkapulu N, Coskun F. Mean platelet volume and red cell distribution width as a diagnostic marker in acute appendicitis *Iran Red Crescent Med J* 2014; 16: e10211
  14. Karagulle E, Turk E, Ezer A, Nursal T Z, Kulaksýzoglu S, Moray G. Value of Plasma Viscosity in Acute Appendicitis: a Preliminary Study *J Med Med Sci.* 2010;1(9):423–425.
  15. Bilci S, Sekmenli T, Goksu M, Melek M, Avci V, Mean platelet volume in diagnosis of acute appendicitis in children *African Health Science* (2011). Vol 11 (3): 427-432.
  16. Beyazit Y, Sayilir A, Torun S, Suvak B, Yesil Y, Purnak T et al. Mean platelet volume as an indicator of disease severity in patients with acute pancreatitis *Clin Res Hepatol Gastroenterol* 2012; 36: 162-168.
  17. Sarikaya S, Sahin S, Akyol L, Borekci E, Yilmaz Y K, Altunkas F et al. Mean platelet volume is associated with myocardial perfusion defect in diabetic patients *Cardiovasc JAfr* 2014; 25: 110-113.
  18. Li B, Liu X, Cao Z G, Li Y, Liu T M, Wang R T. Elevated mean platelet volume is associated with silent cerebral infarction *Intern Med J* 2014; 44: 653-657.
  19. Slavka G, Perkmann T, Haslachner H, Greisenegger S, Marsik C, Wagner O F et al. Mean platelet volume may represent a predictive parameter for overall vascular mortality and ischemic heart disease *Arterioscler Thromb Vasc Biol* 2011; 31: 1215-1218.