



E-ISSN: 2616-3470  
P-ISSN: 2616-3462  
© Surgery Science  
www.surgeryscience.com  
2019; 3(4): 157-160  
Received: 19-08-2019  
Accepted: 21-09-2019

**Dr. Mohammed Raza**  
Professor, Department of General  
Surgery, JSS Medical College,  
JSSAHER, Mysuru, Karnataka,  
India

**Dr. Mohit Gupta**  
Junior Resident, Department of  
General Surgery, JSS Medical  
College, JSSAHER, Mysuru,  
Karnataka, India

## Predictive value of hyperbilirubinemia, platelet distribution width and mean platelet volume in acute appendicitis and its complications

**Dr. Mohammed Raza and Dr. Mohit Gupta**

DOI: <https://doi.org/10.33545/surgery.2019.v3.i4c.235>

### Abstract

**Background:** Acute appendicitis is the most common abdominal emergency and its diagnosis and assessment of its severity remains challenging in many cases. This study aims at assessing the predictive value and credibility of elevated bilirubin, Platelet Distribution Width (PDW) and Mean Platelet Volume (MPV) as a diagnostic marker for acute appendicitis and its complications.

**Methods:** A prospective study of 150 patients, who underwent open or laparoscopic appendectomy were included in the study. Diagnosis was based on histopathological report of surgical specimen. Patients total serum bilirubin, PDW and MPV were analysed. Receiver operating characteristic curves were used assess these indices.

**Results:** The mean value of bilirubin and PDW was higher and for MPV was lower in uncomplicated and complicated acute appendicitis ( $p < 0.001$ ). The specificity and sensitivity of bilirubin, PDW and MPV for complicated acute appendicitis were 74.02% and 80%, 97.4% and 80%, 97.4% and 26% respectively.

**Conclusion:** Elevated bilirubin and PDW with decreased MPV are valuable markers of acute appendicitis and its complications and should be included in their assessment for effective and timely management.

**Keywords:** Acute appendicitis, Bilirubin, PDW, MPV

### 1. Introduction

Appendicitis is one of the most commonly diagnosed emergency surgical condition, but still its diagnosis remains challenging in many cases<sup>[1]</sup>. Hyperbilirubinemia has been studied in various infectious disease including intra-abdominal infections. Hyperbilirubinemia in cases of appendicitis is hypothesised to be due to bacteraemia or endotoxemia causing impaired excretion of bilirubin from the bile canaliculi<sup>[2]</sup>. MPV and PDW are markers of platelet function and have been studied in various inflammatory conditions. Alterations in these platelet indices in acute appendicitis can be probably due to inhibition of megakaryopoiesis<sup>[3, 4]</sup>. In literature there are few studies concerning association of platelet indices and acute appendicitis with inconsistent results.

According to thorough review of literature there are no studies comparing bilirubin, PDW and MPV in diagnosis of acute appendicitis. In this study we aim at analysing the individual predictive value of elevated serum bilirubin, PDW and MPV in diagnosis of acute and complicated appendicitis and comparing the three parameters to identify which is a better marker to assess the severity of appendicitis.

### 2. Materials and Methods

This is a prospective study of 150 patients admitted under various surgical units of JSS hospital from September 2017 to July 2019, who underwent open or laparoscopic appendectomy for clinical diagnosis of acute appendicitis. The study is done after obtaining detailed history and complete general physical examination of the patient. The patients are subjected to relevant laboratory investigations such as complete hemogram (includes PDW and MPV), Renal function tests, qualitative HBsAg test and Liver function tests. The patients were diagnosed as acute appendicitis based on clinical examination, laboratory examinations and ultrasonography report, and subjected to prompt surgical treatment in the form of open or laparoscopic appendectomy. The specimen thus removed is sent for histopathological examination, and the report obtained is treated as the definitive diagnosis.

**Corresponding Author:**  
**Dr. Mohit Gupta**  
Junior Resident, Department of  
General Surgery, JSS Medical  
College, JSSAHER, Mysuru,  
Karnataka, India

**2.1 Inclusion criteria**

- Age between 15 and 75 years.
- All patients diagnosed as acute appendicitis clinically on admission during the study period.

**2.2 Exclusion criteria**

- All patients documented to have a past history of jaundice or liver disease.
- Chronic alcoholism (i.e. intake of alcohol of >40g/day for Men and >20g/day in Women for 10 years) [5].
- Haemolytic disease.
- Acquired or Congenital biliary disease.
- All patients with positive HBsAg.
- All patients with cholelithiasis on USG.
- All patients with Cancer of hepato-biliary system.

**2.3 Data Analysis**

The study population was divided into three groups based on the histopathological report. Group 1- Patients with complicated acute appendicitis. Acute suppurative appendicitis, Perforated appendix, appendicular abscess and acute gangrenous appendicitis were included in this group. Group 2-Patients with uncomplicated acute appendicitis. Group 3- Patients with normal appendix, which included HPE report of reactive follicular hyperplasia and lymphoid hyperplasia. Serum bilirubin, PDW and MPV were studied amongst the three groups using statistical methods. Reference value used were 0.1-1mg/dl for serum total bilirubin, 12-16.5fl for PDW and 7.6-13.2fl for MPV [6]. Statistical methods used were- 1. Area under the receiver operating characteristic (ROC) curves. 2. Sensitivity, specificity, Positive predictive value (PPV) and Negative predictive value (NPV). 3. Diagnostic accuracy and odds. 4. P value of <0.05 with confidence interval of 95% was considered significant.

**3. Results**

**3.1 Age and gender distribution.**

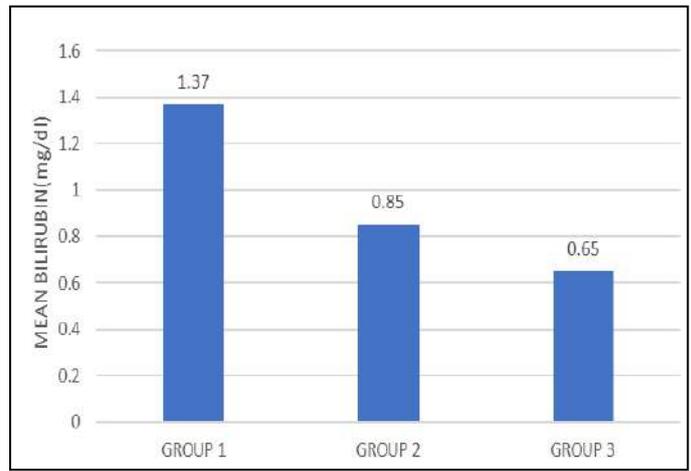
Out of 150 patients 98 were male and 52 were female. Mean age of male patients was 32.83 years and of female patients was 36.67 years. There was no significant difference of age and sex among the three groups.

**Table 1:** Age and Gender distribution of population

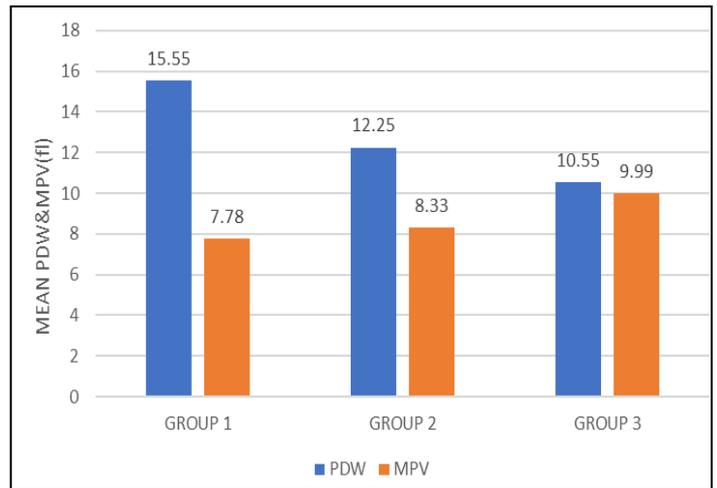
		Count	Mean Age(years)	Standard Deviation
SEX	Female	52	36.67	15.60
	Male	98	32.83	16.50
	Total	150	34.16	16.25

**3.2 Comparison of mean values of Serum bilirubin, PDW and MPV among three groups.**

Mean value of bilirubin and PDW shows an increasing trend amongst the three categories with maximum being in complicated acute appendicitis (group 1) and minimum being in normal appendix (group 2). Mean value of MPV shows a decreasing trend amongst the three categories with minimum being in complicated acute appendicitis (group 1) and maximum being in normal appendix (group 3). This increasing trend in mean bilirubin and PDW values and decreasing trend of mean MPV values according to severity of appendicitis is statistically significant ( $p < 0.0001$ ).



**Graph 1:** Comparison of mean value of bilirubin among three groups



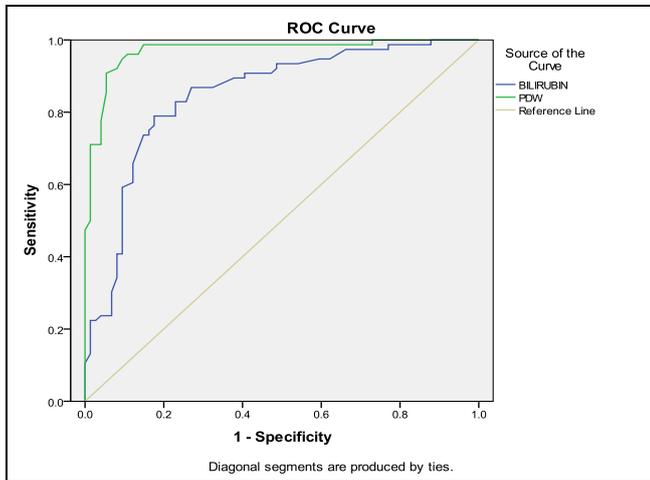
**Graph 2:** Comparison of mean value of PDW AND MPV among three groups

**3.3 Comparison between Complicated acute appendicitis (Group 1) and uncomplicated acute appendicitis (Group 2).**

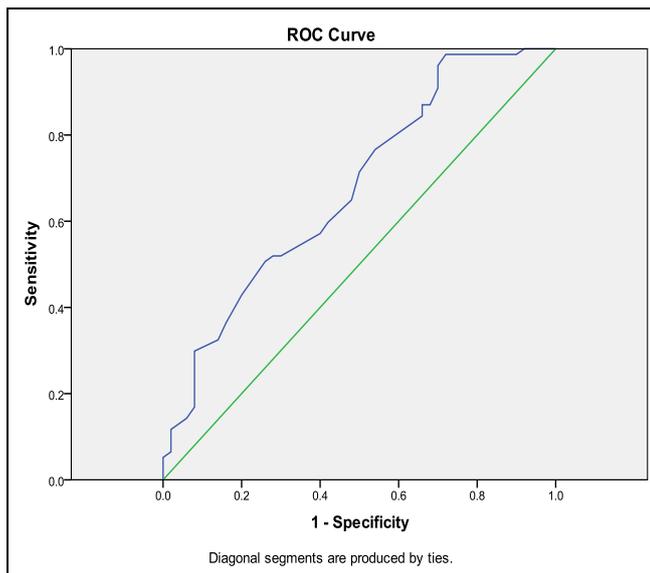
**Table 2:** Statistical test results comparing Group 1 and 2

Variables	Parameters.		
	Bilirubin	PDW	MPV
Cut off	1mg/dl	14fl	9fl
AUC	0.818	0.958	0.675
p value	<0.0001	<0.0001	<0.001
Sensitivity	74.02%	97.40%	97.40%
Specificity	80%	80%	26%
PPV	85.07%	88.21%	66.96%
NPV	66.67%	95.2%	86.67%
Diagnostic accuracy	76.37%	90.55%	69.29%
Diagnostic odds	12.3	272.7	28.38%

For all parameters, there were statistical difference between the two groups ( $p < 0.05$ ). PDW has the highest area under the curve (AUC), sensitivity, PPV and diagnostic accuracy followed by bilirubin and MPV to differentiate complicated and uncomplicated acute appendicitis. MPV has good sensitivity to differentiate between two groups but with poor specificity. Based on the results of table 2, all three parameters are significant diagnostic markers of complicated acute appendicitis, but PDW is the best marker among the three. Graph 3 and 4 depicts ROC curves for Bilirubin, PDW and MPV respectively.



**Graph 3:** ROC curve with AUC for bilirubin and PDW



**Graph 4:** Roc Curves with AUC for MPV.

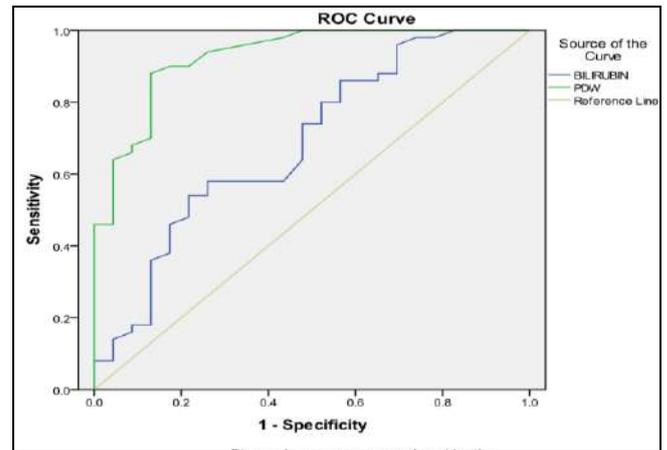
**3.4 Comparison between Uncomplicated acute appendicitis (Group 2) and Normal appendix (Group 3)**

**Table 3:** Statistical test results comparing Group 2 and 3

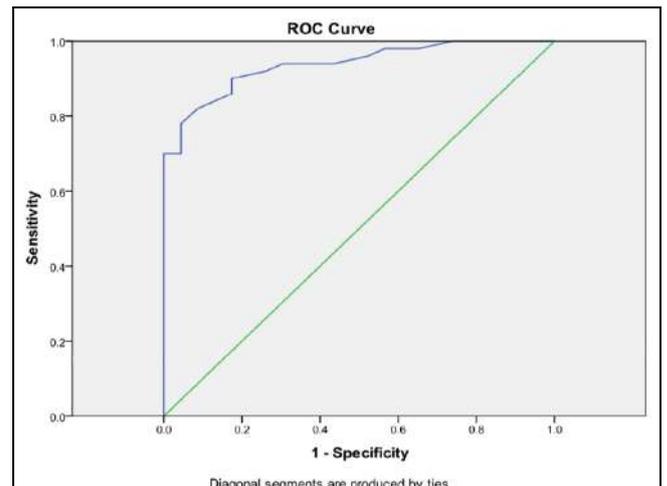
Variables	Parameters		
	Bilirubin	PDW	MPV
Cut off	0.65mg/dl	11fl	9.2fl
AUC	0.687	0.928	0.837
p value	<0.01	<0.0001	<0.0001
Sensitivity	74%	94%	82%
Specificity	47.83%	73.91%	91.3%
PPV	75.51%	88.68%	95.35%
NPV	45.83%	85%	70%
Diagnostic accuracy	65.75%	87.67%	84.93%
Diagnostic odds	13.17	44.3	47.8

For all parameters, there were statistical difference between the two groups ( $p < 0.05$ ). PDW has the highest AUC, Sensitivity and diagnostic accuracy followed by MPV and bilirubin to differentiate uncomplicated acute appendicitis from normal appendix. Bilirubin has a lower negative predictive value for diagnosis of uncomplicated acute appendicitis. Based on the results of table 3, elevated serum bilirubin and PDW along with decreased MPV are statistically significant diagnostic markers of uncomplicated acute appendicitis, but PDW is the best marker among the three. Graph 5 and 6 depicts the ROC curves for

bilirubin, PDW and MPV respectively.



**Graph 5:** Roc Curves with AUC FOR Bilirubin and PDW.



**Graph 6:** Roc Curves with AUC for MPV

**4. Discussion**

Acute appendicitis is the most common abdominal emergency [7]. The epitome of the management of acute appendicitis is early diagnosis and intervention to prevent complications. Despite the advent Computed tomography, its applicability in the diagnosis of acute appendicitis is limited by factors of availability and cost-effectiveness, leading to the need to develop faster and easily available tests for the early diagnosis of acute appendicitis and its complications. For our study we chose serum total bilirubin, PDW and MPV as they are readily available and cost-effective investigations along with quick results. In cases of acute and complicated appendicitis there is proinflammatory cytokine and nitric oxide induced cholestasis by hampering hepatocellular and ductal bile formation [8]. *E. coli* and *Bacteroides fragilis* are the commonly cultured organisms from appendix and they have been shown to interfere with hepatocyte microcirculation, inducing sinusoidal damage [9, 10]. The above two mentioned mechanism lead to hyperbilirubinemia in appendicitis case. Only few studies have been done to assess the association of hyperbilirubinemia with appendicitis in literature. Study done by Sand *et al.* showed that serum bilirubin >1mg/dl had sensitivity and specificity of 70% and 80% respectively for diagnosis of appendiceal perforation. In a similar study done by Estrada *et al.* showed sensitivity and specificity of 56% and 69% respectively [1, 11]. Our study had similar results for diagnosis of complicated acute appendicitis.

PDW is an index of thrombocyte volume heterogeneity and is also a marker of platelet function [12]. PDW has been evaluated

in some disease such as vascular dementia and Alzheimer's diseases in which its value was significantly lower, while in cases of recurrent abortions and severe pre-eclampsia its value was significantly lower [13, 14]. In acute appendicitis, the pathogenesis of elevated PDW could be due to more of young and immature platelets enter the circulation, but the exact mechanism remains unclear. Zhe Fan *et al.* studied association of PDW with acute gangrenous appendicitis, which showed a sensitivity of 76.3% and 93.1%. In a similar study by Bulent *et al.* showed a sensitivity and specificity of 97% and 93%. For the diagnosis of complicated appendicitis, elevated PDW in our study also showed similar results [7, 15].

MPV, a marker of platelet activation has been studied for its association with both inflammation and thrombosis. Cerebro-and cardiovascular diseases along with low grade inflammatory disorders shows an elevated MPV, while on the contrary high-grade inflammatory diseases shows a decrease in MPV [4]. In literature, results regarding association of MPV with acute appendicitis have been inconsistent. Erdem *et al.* reported that MPV was markedly lower than the control group, while Narci *et al.* concluded that MPV was markedly increased in acute appendicitis compared with the control group [16, 17]. Possibly these discrepancies could be due to ethnic and geographic influence. In our study, the sensitivity and specificity of decrease in MPV to differentiate acute appendicitis from normal appendix was 83% and 91.3% respectively being in tandem with Albayrak *et al.* which showed a sensitivity and specificity of 67.5% and 87.9% respectively. In our study the sensitivity and specificity of decrease in MPV to differentiate complicated acute appendicitis from acute appendicitis was 97.4% and 26% respectively, while Zhe Fan *et al.* reported a sensitivity of 66.25% and specificity of 91.19% [6]. Our results possibly varied from above study because they compared cases of AGA with healthy controls while we compared case of acute appendicitis with complicated appendicitis. The exact mechanism of lower MPV in cases of appendicitis is unclear, but could be possibly due to a mechanism similar to one suggested by Danese *et al.* i.e. consumption or sequestration of the large activated platelets in intestinal vasculature [18].

According to our through research of literature there are no studies comparing bilirubin with PDW and MPV in cases of appendicitis. Our study showed that all three parameters are significant markers for diagnosis of acute appendicitis and its complications but PDW was superior to serum bilirubin and MPV with highest sensitivity, specificity and diagnostic accuracy.

## 5. Conclusion

In our opinion hyperbilirubinemia, increased PDW and decrease in MPV are good predictors for diagnosis of acute appendicitis and assessing its severity and hence can guide surgeons for appropriate and timely intervention and reduce the morbidity and mortality rates and on the other hand reduce the rate of negative appendectomies as well. They act as cost-effective, easily available adjuncts to clinical evaluation and other routine laboratory investigations like WBC count in diagnosis of acute appendicitis. PDW is superior to bilirubin and MPV in prediction of acute appendicitis and its complications.

## 6. References

- Estrada JJ, Petrosyan M, Barnhart J, Tao M, Sohn H, Towfigh S *et al.* Hyperbilirubinemia in appendicitis: a new predictor of perforation. *Journal of gastrointestinal surgery.* 2007; 11(6):714-8.
- Franson TR, Hierholzer Jr WJ, LaBrecque DR. Frequency and characteristics of hyperbilirubinemia associated with bacteremia. *Reviews of infectious diseases.* 1985; 7(1):1-9.
- Thachil J. Platelets in inflammatory disorders: a pathophysiological and clinical perspective. In *Seminars in thrombosis and hemostasis* Thieme Medical Publishers, 2015; 41(06):572-581.
- Yuri Gasparyan A, Ayyvazyan L, Mikhailidis P, Kitis DG. Mean platelet volume: a link between thrombosis and inflammation. *Current pharmaceutical design.* 2011; 17(1):47-58.
- Subramanian A, Liang MK. A 60-year literature review of stump appendicitis: the need for a critical view. *The American Journal of Surgery.* 2012; 203(4):503-7.
- 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. *Disease markers.* 2015.
- Petroianu A. Diagnosis of acute appendicitis. *International Journal of Surgery.* 2012; 10(3):115-9.
- Geier A, Fickert P, Trauner M. Mechanisms of disease: mechanisms and clinical implications of cholestasis in sepsis. *Nature Reviews Gastroenterology & Hepatology.* 2006; 3(10):574.
- Baron EJ, Bennion R, Thompson J, Strong C, Summanen P, McTeague M *et al.* A microbiological comparison between acute and complicated appendicitis. *Clinical Infectious Diseases.* 1992; 14(1):227-31.
- Rink RD, Kaelin CR, Giammara B, Fry DE. Effects of live *Escherichia coli* and *Bacteroides fragilis* on metabolism and hepatic pO<sub>2</sub>. *Circulatory shock.* 1981; 8(5):601-11.
- Sand M, Bechara FG, Holland-Letz T, Sand D, Mehnert G, Mann B. Diagnostic value of hyperbilirubinemia as a predictive factor for appendiceal perforation in acute appendicitis. *The American journal of surgery.* 2009; 198(2):193-8.
- Aydogan A, Akkucuk S, Arica S, Motor S, Karakus A, Ozkan OV *et al.* The analysis of mean platelet volume and platelet distribution width levels in appendicitis. *Indian Journal of Surgery.* 2015; 77(2):495-500.
- Liang QC, Jin D, Li Y, Wang RT. Mean platelet volume and platelet distribution width in vascular dementia and Alzheimer's disease. *Platelets.* 2014; 25(6):433-8.
- Ural ÜM, Tekin YB, Balik G, Şahin FK, Çolak S. Could platelet distribution width be a predictive marker for unexplained recurrent miscarriage?. *Archives of gynecology and obstetrics.* 2014; 290(2):233-6.
- Dinc B, Oskay A, Dinc SE, Bas B, Tekin S. New parameter in diagnosis of acute appendicitis: platelet distribution width. *World Journal of Gastroenterology: WJG.* 2015; 21(6):1821.
- Erdem H, Aktimur R, Cetinkunar S, Reyhan E, Gokler C, Irkorucu O, Sozen S. Evaluation of mean platelet volume as a diagnostic biomarker in acute appendicitis. *International journal of clinical and experimental medicine.* 2015; 8(1):1291.
- 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. *Iranian Red Crescent Medical Journal.* 2013; 15(12).
- Danese S, De La Motte C, Fiocchi C. Platelets in inflammatory bowel disease: clinical, pathogenic, and therapeutic implications. *The American journal of gastroenterology.* 2004; 99(5):938.