ACU Sağlık Bil Derg 2020; 11(4):696-700
https://doi.org/10.31067/0.2020.283

ARAŞTIRMA YAZISI / ORIGINAL ARTICLE

The Diagnostic Value of Complete Blood Test Parameters in Acute Appendicitis: We Should not Only Take into Account WBC

Sönmez Ocak, Ömer Faruk Bük, Ahmet Burak Çiftci

Department of General Surgery, Samsun Education and Training Hospital, Samsun, Turkey

Sönmez Ocak, M.D.
Ömer Faruk Bük, M.D.
Ahmet Burak Çiftci, M.D.

Correspondence:
M.D. Sönmez Ocak
Department of General Surgery, Samsun Education and Training Hospital, Samsun, Turkey
Phone: +90 506 531 48 29
E-mail: sonmezdr@gmail.com

Received : March 15, 2019
Revised : July 28, 2019
Accepted : August 02, 2019

ABSTRACT

Objective: Appendectomy is the most common urgent surgical procedure but a diagnosis of acute appendicitis still remains challenging. In this retrospective study, we aimed to evaluate the value of the complete blood count (CBC) test parameters in acute appendicitis.

Materials and methods: Data of 131 patients who underwent appendectomy between January 2016 – December 2016 were collected retrospectively. Demographic features, CBC parameters and final histopathological results of the patients were recorded. The patients were divided into two groups according to the final pathological results (Group 1: Acute appendicitis group, Group 2: Normal appendices group) and were compared in terms of WBC (white blood cell), platelet count, hemoglobin level, RDW (red cell distribution width), MPV (mean platelet volume) and NLR (neutrophil to lymphocyte ratio) values.

Results: 13 of 131 patients had normal appendices. WBC, platelet and NLR values were signifcantly higher in Group 1 compared to the Group 2 ($p<0.001$, $p<0.017$, $p<0.001$ respectively). MPV value was significantly lower in Group 1 compared to the Group 2 ($p<0.041$). The cut-off levels for WBC, platelet, MPV and NLR were ≥9200 µL (sensitivity: 84.7%, specificity: 69.2%), ≥244500 µL (sensitivity: 57.6% specificity: 84.6%), ≤8.15 fl (sensitivity: 69.2%, specificity: 64.4%) and ≥2.795 (sensitivity: 81.4% specificity: 76.9%) respectively.

Conclusion: In addition to WBC, NLR, platelet and MPV levels can be helpful for acute appendicitis diagnosis with no extra costs.

Keywords: Appendicitis, red cell distribution width, platelets, neutrophil, lymphocyte

AKUT APANDİSİT TANISINDA TAM KAN SAYIMI PARAMETRELERİNİN TANISAL DEĞERİ: SADECE BEYAZ KÜRE DEĞERİNİ DİKKATE ALMAMALIYIZ

ÖZET

Amaç: Appendektomi en sık yapılan acil cerrahi girişim olmasına rağmen akut apandisit tanısını koymakta zorluklar görülebilmektedir. Bu retrospektif çalışmada tam kan sayımı (TKS) parametrelerinin akut apandisit tanısındaki öneminin araştırması hedeflenmiştir.

Gereç ve Yöntem: Ocak 2016-Aralık 2016 yılları arasında appendektomi uygulanan 131 hastanın verileri retrospektif olarak incelenmiştir. Hastaların demografik özellikleri, TKS parametreleri ve histopatolojik inceleme sonuçları kaydedilmiştir. Hastalar patoloji sonuçlarına göre iki gruba ayrılmıştır (Grup 1: akut apandisit grubu, Grup 2: normal appendiks grubu). İki grubun beyaz küre, trombosit, hemoglobulin seviyeleri ile RDW (red cell distribution width), MPV (mean platelet volume) ve NLR (nötrofil/lenfosit oranı) değerleri karşılaştırılmıştır.

Sonuçlar: Yüz otuz bir hastanın 13'ü normal appendikse sahipti. Beyaz küre, platelet ve NLR değerleri Grup 1'de anlamlı olarak daha yüksek bulundu ($p<0,001$, $p<0,017$, $p<0,001$). MPV değeri Grup 1'de anlamlı olarak daha düşük saptandı ($p<0,041$). Beyaz küre, platelet, MPV ve NLR değerleri için cutt-off değerleri sırası ile were ≥9200 µL (sensitivite: %84,7, spesifisite: 69,2%), ≥244500 µL (sensitivite: %57,6, spesifisite: %84,6), ≤8,15 fl (sensitivite: %69,2, spesifisite: %64,4) ve ≥2,795 (sensitivite: %81,4 spesifisite: %76,9) olarak bulundu.

Sonuç: Beyaz küre değerine ek olarak NLR, platelet ve MPV değerleri de herhangi bir maliyete neden olmadan akut apandisit tanısında faydalı olabilir.

Anahtar sözcükler: Apandisit, RDW, platelet, nötrofil, lenfosit

Acute appendicitis is the most common cause of acute abdominal pain and appendectomy is the most common urgent surgical procedure throughout the world (1). The overall lifetime risk is 8.6% for males and 6.4% for females (2). Negative appendectomy rates decreased from 15–25% to 2–6% in parallel with the improvements in diagnostic methods (1, 3, 4). Although mortality rates are 1–2% in various series, severe mortality rates were reported, especially in patients older than 65 years old (5, 6). Despite the low negative appendectomy rates, accurate preoperative diagnosis of acute appendicitis is still very important to prevent unnecessary appendectomies because of the cumulative number of cases.

A complete blood count (CBC) test is widely used for the diagnosis of acute appendicitis. An increase in white blood cell (WBC) count is significant for acute appendicitis, however, it has low specificity and can be misleading particularly in the geriatric population (7, 8). Recently some authors suggested that parameters in CBC could be helpful for the diagnosis of acute appendicitis (9). In this retrospective analysis, it was aimed to evaluate the diagnostic role of the CBC parameters in acute appendicitis including red cell distribution width (RDW), neutrophil-lymphocyte ratio (NLR) and mean platelet volume (MPV).

Materials and Methods

This single-center retrospective and cross-sectional study were conducted on patients who were admitted to the emergency room of the Samsun Education and Research Hospital between January 2016 – December 2016 and underwent appendectomy for acute appendicitis. Samsun Education and Research Hospital is the biggest city of the northern region of Turkey and this center is a referral governmental hospital of the region. Patients younger than 16 years old who had undergone additional surgical procedures or interval appendectomy were excluded from the study. Venous blood samples were taken from the patients into EDTA tubes within 12 hours in the preoperative period to analyze the WBC, RDW, MPV parameters by an automatic hematology analyzer (Coulter LH 780 Hematology Analyzer, Beckman Coulter Inc, CA, USA). Demographic features and CBC parameters were recorded. The patients were divided into two groups according to the final histopathological results. Group 1; acute appendicitis (including; complicated appendicitis such as gangrenous, perforated or phlegmon appendicitis (AA) and Group 2: normal appendix.

Statistical analysis

SPSS 24.0 (IBM Corporation, Armonk, New York, United States) software was used for statistical analysis. Shapiro-Wilk test was used to determine the normal distribution of the data. Quantitative data of two independent groups were compared by Independent-Samples t-test with Bootsrap results. Mann-Whitney U test was used with Monte Carlo simulation. Parametric variables of multiple independent groups were compared by One –Way Anova test (Brown-Forsythe) and non-parametric variables were compared by the Kruskal-Wallis H test with Monte Carlo simulation. Fisher Exact test was used to compare categorical variables and the Fisher-Freeman-Halton test was given with Monte Carlo simulation. Receiver Operating Curve (ROC) analysis was used to determine the cut-off values of the parameters. Variables were analyzed with a 95% confidence interval and a p-value of less than 0.005 was considered significant.

Results

131 patients who underwent appendectomy were included in the study. 96 (73.3%) patients were male and 35 (26.7%) were female. The median age was 32 (16–83). 13 (9.9%) patients had pathologically normal appendices according to the final histopathological results. There was no significant difference between acute appendicitis (Group 1) and negative appendectomy (Group 2) group in terms of age and gender (p=0.603 and p=0.512 respectively). Hemoglobin, RDW and lymphocyte values did not show a significant difference between the two groups (p=0.670, p=0.736 and p=0.370 respectively). WBC values were significantly higher in Group 1. The median value of WBC was 13350 µL (4700–30700) in group 1 and 7400 µL (4800–15400) in Group 2 (p<0.001). Median thrombocyte counts were 255000 µL (120000–681000) in Group 1 and 201000 µL (176000–316000) in Group 2 and the difference was statistically significant (p=0.017). Median MPV value was 7.9 fl (5.6–13.9) in Group 1 and 8.5 fl (7.3–9.9) in Group 2 and the difference was statistically significant (p=0.041). There was a significant difference between the groups when comparing the NLR values (p=0.001). The median NLR value was 5.05 (0.76–45.33) in Group 1 and 2.25 (1.05–25) in Group 2 (Table 1).

For WBC count, the best cut-off value was 9200 µL and sensitivity and specificity of the value was 84.7% and 69.2% respectively (AUC ± SE: 0.811±0.059). For the platelet level, the best cut-off value was 244500 µL and sensitivity and specificity of the value was 57.6% and 84.6% respectively (AUC ± SE: 0.699±0.071). For MPV value 8.15

Table 1. Comparison of demographic and CBC parameters of the groups

	Group 1	*Group 2*	*Total*	
	(n=118)	*(n=13)*	*(N=131)*	*P Value*
	n (%)	*n (%)*	*n (%)*	
Sex				
Female	33 (28.0)	33 (28.0)	35 (26.7)	0.512
Male	85 (72.0)	85 (72.0)	96 (73.3)	
	Median (Min. –Max.)	*Median (Min. –Max.)*	*Median (Min. –Max.)*	
Age	32 (16–83)	28 (16–79)	32 (16–83)	0.603
WBC	13350 (4700–30700)	7400 (4800–15400)	13100 (4700–30700)	<0.001
Hgb	14.6 (7.4–17.1)	14 (12–16)	14.5 (7.4–17.1)	0.670
PLT x1000	255 (120–681)	201 (176–316)	252 (120–681)	0.017
Neutrophil	10800 (1100–27900)	4400 (2200–11800)	10000 (1100–27900)	<0.001
Lymphocyte	1900 (300–11300)	2100 (400–3900)	1900 (300–11300)	0.370
RDW	13.3 (11.9–18.3)	13.5 (12–17.5)	13.3 (11.9–18.3)	0.736
MPV	7.9 (5.6–13.9)	8.5 (7.3–9.9)	7.9 (5.6–13.9)	0.041
NLR	5.05 (0.76–45.33)	2.25 (1.05–25)	4.76 (0.76–45.33)	0.001

Mann Whitney U test (Monte Carlo); Fisher Exact test (Exact); **WBC,** white blood cell; **Hgb,** hemoglobin; **PLT,** platelet; **RDW,** red cell distribution width, MPV: mean platelet volume, **NLR:** neutrophil to lymphocyte ratio; **Max.,** maximum; **Min.,** Minimum.

fl was the best cut-off value with 69.2% sensitivity and 64.4% specificity (AUC. ± SE: 0.672±0.072). Finally, 2.795 was the best cut-off value of NLR with 81.4% sensitivity and 76.9% specificity (AUC ± SE: 0.773±0.075) (Table 2, Figure 1). The negative and positive predictive values of the parameters were given in Table 3.

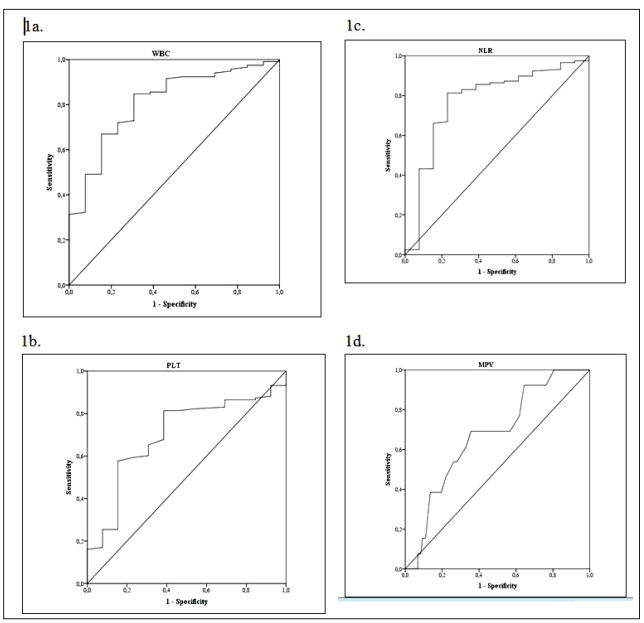

Figure 1. A–D. ROC curves of CBC parameters; WBC (A), PLT (B), NLR (C), MPV (D).

Table 2. Cut-off values of the parameters

	Cut-Off	*Sensitivity*	*Specificity*	*AUC ± SE.*	*P Value*
WBC	9200	84.7%	69.2%	0.811±0.059	<0.001
PLT	244500	57.6%	84.6%	0.699±0.071	0.019
NEU	6900	78.8%	76.9%	0.818±0.054	<0.001
MPV	8.15	69.2%	64.4%	0.672±0.072	0.042
NLR	2.795	81.4%	76.9%	0.773±0.075	0.001

WBC, white blood cell; **PLT,** platelet; **NEU,** neutrophil; **MPV,** mean platelet volume; **NLR,** neutrophil to lymphocyte ratio; **AUC,** area under curve; **SE,** standart error.

Table 3. Overall acurracy rates of the parameters

	PPV%	*NPV%*	*Acurracy%*
WBC	96.2	36	84.7
PLT	97.1	18	60.3
MPV	95	17.6	64.8
NLR	96.9	31.2	90.9

WBC, white blood cell; **PLT,** platelet; **MPV,** mean platelet volume; **NLR,** Neutrophil to lymphocyte ratio; **PPV,** positive predictive value; **NPV,** negative predictive value.

Discussion

Negative appendectomies are causing an increase in mortality and morbidity, as well as causing an additional financial burden on health care systems. In addition to clinical findings, laboratory and imaging studies are

helpful for the diagnosis of acute appendicitis. Especially computed tomography scan has high rates of specificity and sensitivity but also has some disadvantages including high dose radiation, requiring experienced radiologist and high costs (10). CBC is a cheap test, quick and easy to apply and is used routinely for the diagnosis of acute appendicitis. Recently, various studies have been published regarding some parameters that can be used with WBC count for the diagnosis of acute appendicitis, acute pancreatitis and mesenteric vascular diseases (7,9,11,12). RDW value is a part of CBC count and mostly used for differential diagnosis of hematological diseases. Moreover, some authors suggested that increased RDW values were related with poor prognosis in heart failure, coronary artery diseases, pulmonary hypertension, diabetes mellitus and stroke (13–17). Also, it has been shown that in acute inflammatory diseases such as acute pancreatitis and acute mesenteric ischemia, RDW values were increased (11, 18). There are contradictory results on the value of RDW and acute appendicitis in the literature. In 2013 Narci et al. compared 590 patients whom operated for acute appendicitis with the control group of 121 individuals and showed that RDW value is lower in the acute appendicitis group than in the control group (19). Similar results were reported by Toktaş et al. (20). 344 pediatric acute appendicitis cases were compared with 200 healthy control cases by Bozlu et al. and it had been reported that RDW values were higher in the acute appendicitis group than in the control group. But in subgroup analysis, there was no significant difference between simple appendicitis and complicated appendicitis groups in terms of RDW value (21). Ulukent et al. and Tanrikulu et al. did not find any association between RDW value and acute appendicitis in their studies (9, 22). We also did not find any significant difference between the occurrence of acute appendicitis and RDW values (p=0.736).

There are some studies about the relationship between acute appendicitis and MPV values. Albayrak et al. reported lower MPV values in their 226 AA (Acute Appendicitis) patients than in the control group (p<0.001) and they found 7.6 fl as the best cut-off value (23). Similar results had been reported by Fan et al. and Erdem et al (24, 25). In our study, like the authors above, we found lower MPV rates in the AA group. But unlike these studies, we compared AA patients with negative appendectomy (NA) patients, not healthy control groups. Also, results incompatible with our study have been reported in the literature. Narci et al. evaluated 503 AA patients and 121 healthy individuals and reported that AA patients had higher MPV values than in the control group (26). Uyanik et al. did not find any significant difference between AA and the control group in their pediatric cohort (27).

In geriatric patients, WBC levels may be completely at normal ranges due to the attenuated immune response (7). Some authors suggested that high NLR levels may indicate acute appendicitis. Kahramanca et al. evaluated 1067 AA cases and found a significant difference between AA and NA group. In that paper 4.68 and higher levels of NLR significantly differentiate a normal appendix and AA. They also suggest that higher levels of NLR are an indicator of complicated AA. However, specificity and sensitivity of NLR were found low (28). Similar results were obtained by several authors (21, 29–31). In our study, we found the cut-off value of 2.795 and we suggested that NLR values ≥2.795 indicates AA with an 81.4% sensitivity and 76.9% specificity (AUC ± SE: 0.773±0.075)

As an uncommon finding, platelet count was significantly higher in the AA group than in the NA group (p=0.017) in our study. Several studies showed that platelets have a critical role in the inflammatory process by interacting with other inflammatory cells and/or secreting mediators (31–33). But to our knowledge, there is no study in the literature about the relationship between the platelet count and AA. The mediators secreted in the acute inflammatory process induce stem cell stimulation in the bone marrow and other hematopoietic organs which may result in a high platelet count. But further studies are needed to confirm this hypothesis.

Our study has some limitations. Firstly, the number of cases particularly in the NA group is low. In addition, this study is a retrospective analysis and studies such as ultrasonography and computed tomography have not been included in the study which reduces the power of the article.

In conclusion, CBC, as a simple test, can help in the diagnosis of AA by the NLR and MPV parameters, in addition to the WBC count. We suggest that, with using a larger number of cases, more accurate cut-off values will be obtained and a new scoring system can be created or will be integrated into the available scoring systems.

Conflict of Interest

The authors have no conflict of interest to declare.

References

1. Seetahal SA, Bolorunduro OB, Sookdeo TC, Oyetunji TA, Greene WR, Frederick W, et al. Negative appendectomy: a 10-year review of a nationally representative sample. Am J Surg 2011;201 4:433–7. [CrossRef]
2. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol 1990;132:910–25. [CrossRef]
3. Raja AS, Wright C, Sodickson AD, Zane RD, Schiff GD, Hanson R, et al. Negative appendectomy rate in the era of CT. an 18-year perspective. Radiology 2010;256:460–5. [CrossRef]
4. Harswick C, Uyenishi AA, Kordick MF, Chan SB. Clinical guidelines, computed tomography scan, and negative appendectomies: a case series. The Am J Emerg Med 2006;24:68–72. [CrossRef]
5. Kotaluoto S, Ukkonen M, Pauniaho SL, Helminen M, Sand J, Rantanen T. Mortality Related to Appendectomy; a Population Based Analysis over Two Decades in Finland. World J Surg 2017;41:64–9. [CrossRef]
6. Andersson MN, Andersson RE. Causes of short-term mortality after appendectomy: a population-based case-controlled study. Ann Surg 2011;254:103–7. [CrossRef]
7. Yang HR, Wang YC, Chung PK, Chen WK, Jeng LB, Chen RJ. Role of leukocyte count, neutrophil percentage, and C-reactive protein in the diagnosis of acute appendicitis in the elderly. Am Surg 2005;71:344–7.
8. Saleem MM, Pervaiz M, Chaudhary IA. Predictive Value of Leukocytosis for Diagnosing Acute Appendicitis. PAFM 2007;67:292.
9. Ulukent SC, Sarıcı IS, Ulutas KT. All CBC parameters in diagnosis of acute appendicitis. Int J Clin Exp Med 2016;9:11871–6.
10. Van Randen A, Bipat S, Zwinderman AH, Ubbink DT, Stoker J, Boermeester MA. Acute appendicitis: meta-analysis of diagnostic performance of CT and graded compression US related to prevalence of disease. Radiology 2008;249:97–106. [CrossRef]
11. Çetinkaya, E, Şenol, K, Saylam B, Tez M. Red cell distribution width to platelet ratio: New and promising prognostic marker in acute pancreatitis. World J Gastroenterol 2004;20:14450–4. [CrossRef]
12. Aktimur R, Cetinkunar S, Yildirim K, Aktimur SH, Ugurlucan M, Ozlem N. Neutrophil-to-lymphocyte ratio as a diagnostic biomarker for the diagnosis of acute mesenteric ischemia. Eur J Trauma Emerg Surg 2016;42:363–8. [CrossRef]
13. Felker GM, Allen LA, Pocock SJ, Shaw LK, McMurray JJV, Pfeffer MA, et al. Red cell distribution width as a novel prognostic marker in heart failure: data from the CHARM Program and the Duke Databank. J Am Coll Cardiol 2007;50:40–7. [CrossRef]
14. Hampole CV, Mehrotra AK, Thenappan T, Gomberg-Maitland M, Shah SJ. Usefulness of red cell distribution width as a prognostic marker in pulmonary hypertension. Am J Cardiol 2009;104:868–72. [CrossRef]
15. Tonelli M, Sacks F, Arnold M, Moye L, Davis B, Pfeffer M. Relation between red blood cell distribution width and cardiovascular event rate in people with coronary disease. Circulation 2008;117:163–8. [CrossRef]
16. Ani C, Ovbiagele B. Elevated red blood cell distribution width predicts mortality in persons with known stroke. J Neurol Sci 2009;277:103–8. [CrossRef]
17. Malandrino N, Wu WC, Taveira TH, Whitlatch HB, Smith RJ. Association between red blood cell distribution width and macrovascular and microvascular complications in diabetes. Diabetologia 2012;55:226–35. [CrossRef]
18. Senol K, Saylam B, Kocaay F, Tez M. Red cell distribution width as a predictor of mortality in acute pancreatitis. Am J Emerg Med 2013;31:687–9. [CrossRef]
19. Narci H, Turk E, Karagulle E, Togan T, Karabulut K. The role of red cell distribution width in the diagnosis of acute appendicitis: A retrospective case-controlled study. World J Emerg Surg 2013;8:46. [CrossRef]
20. Toktas O, Aslan M. Mean platelet volume, red cell distribution width, neutrophil to lymphocyte ratio and platelet to lymphocyte ratio in the diagnosis of acute appendicitis. East J Med 2017;22:5–9. [CrossRef]
21. Bozlu G, Taskinlar H, Unal S, Alakaya M, Naycı A, Kuyucu N. Diagnostic value of red blood cell distribution width in pediatric acute appendicitis. Pediatr Int 2016;58:202–5. [CrossRef]
22. Tanrikulu CS, Tanrikulu Y, Sabuncuoglu MZ, 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. [CrossRef]
23. 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;17:362–6. [CrossRef]
24. 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. Dis Markers 2015;2015:542013. [CrossRef]
25. 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. Int J Clin Exp Med 2015;8:1291–5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4358583/
26. Narcı 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;15:e11934. [CrossRef]
27. Uyanik B, Kavalci C, Arslan ED, Yilmaz F, Aslan O, Dede S, Bakir F. Role of mean platelet volume in diagnosis of childhood acute appendicitis. Emerg Med Int 2012;2012:823095. [CrossRef]
28. Kahramanca S, Ozgehan G, Seker D, Gokce E I, Seker G, Tunç G, et al. Neutrophil-to-lymphocyte ratio as a predictor of acute appendicitis. Ulus Travma Acil Cerrahi Derg 2014;20:19–22. [CrossRef]
29. Goodman DA, Goodman CB, Monk JS. Use of the neutrophil: lymphocyte ratio in the diagnosis of appendicitis. Am Surg 1995;61:257–9.
30. Markar SR, Karthikesalingam A, Falzon A, Kan Y. The diagnostic value of neutrophil: lymphocyte ratio in adults with suspected acute appendicitis. Acta Chir Belg 2010;110:543–7. [CrossRef]
31. Weyrich AS, Lindemann S, Zimmerman GA. The evolving role of platelets in inflammation. J Thromb Haemost 2003;1:1897–105. [CrossRef]
32. Gawaz M, Langer H, May AE. Platelets in inflammation and atherogenesis. J Clin Invest 2005;115:3378–84. [CrossRef]
33. Zarbock A, Polanowska-Grabowska RK, Ley K. Platelet-neutrophil-interactions: linking hemostasis and inflammation. Blood Rev 2007;21:99–111. [CrossRef]