Original Article

Complete Blood Count Parameters in The Diagnosis of Acute Appendicitis

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Abstract

Background: Acute appendicitis is the most encountered surgical dilemmas, this attributed to the lack of unique symptoms or signs and the low sensitivity of available laboratory tests.

Aim of study: to assess the ability of complete blood count parameters in diagnosing acute appendicitis.

Patients & methods: a case control study done at a general surgical hospital over 1 year during which all patients with clinical features of acute appendicitis and were candidates for appendectomy were enrolled. Diagnosis was confirmed by histopathological study and classified into inflamed appendix [group A], and normal appendix group [group B]. Control group [group C] included 50 healthy adults.

Results: A total of 115 patients were enrolled, group A (91 cases), group B (24 cases), and group C (50 cases). Mean platelet volume (MPV), neutrophil-to-lymphocyte ratio (NLR) and Platelet-Lymphocyte ratio (PLR) were significantly different from control and from cases of negative appendectomies with sensitivity (SN) and specificity (SP) as follow: MPV SN 90.1%, SP 79.7%, NLR SN 89%, SP 70.3%, PLR SN 83.5%, SP 74.3%

Conclusion: The use of the complete blood count parameters MPV, NLR and PLR sensitive and specific for diagnosis of acute appendicitis and can be used as an aid in difficult diagnoses to reduce the rate of negative appendectomies.

Keywords: AAppendicitis, lymphocyte, neutrophil, platelet, mean platelet volume, platicrit.

Introduction

Inflammation of the appendix is a common health problem affecting 8.6% of men and 6.7% of women, the age for peaked incidence is ranged from twenties to thirties. Although its rate decreased in developed countries, still considered as one of the most frequent emergent abdominal operations[1].

The cause of acute appendicitis (AA) is thought to be luminal obstruction, in pediatrics, lymphoid hyperplasia is blamed; while adults, intraluminal causes like fecaliths, fibrosis, foreign bodies, or neoplasia[1].

Acute appendicitis diagnosis is one of surgical dilemmas, this attributed to the lack of unique symptoms or signs and the low sensitivity of available laboratory tests[2].

Elevated white blood cells count (WBC) may give an idea on the diagnosis, but not always this applied as third of cases had no WBC elevation. A “left shift” with increased count of neutrophils (NEU) is more specific, nevertheless, not considered a general finding. Although C-reactive protein is increased in majority of cases again it is nonspecific to acute appendicitis[3].

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Access this article online

Quick Response Code:

Website: www.pnrjournal.com

DOI: 10.47750/pnr.2022.13.03.032

How to cite this article: Kamal Al-Jawdah, Zuhair Kamal, Complete Blood Count Parameters in The Diagnosis of Acute Appendicitis, J PHARM NEGATIVE RESULTS 2022;13:204-210.

The role of Interleukins and cytokines in diagnosis of AA shown to be effective in diagnosing AA[3, 4], yet the cost and availability are the limiting for their application.

For the reduction of unnecessary appendectomies, a more applicable markers need to be investigated. the red cell distribution width (RDW), was found to be associated with many inflammatory conditions, as such it could be a good candidate for detecting inflammation in case of AA[5].

Mean platelet volume changes reflect activation of platelet and presence of inflammatory response that linked to disease activity in many disorders such as preeclampsia, ischemic heart disease, inflammatory bowel disease and acute pancreatitis[5]. Recent studies have demonstrated that NLR, and PDW are promising markers for the diagnosis of inflammatory conditions including acute appendicitis [6].

The rate of negative appendectomy (NA) (appendectomy of normal appendix) was high in many studies (reach up to twenty-five percent)[7], this problem could be reduced by finding a test with high negative predictive ability to rule out such cases. As CBC is widely available cheap and fast test to be performed routinely in cases of acute appendicitis, a detailed evaluation for the parameters of this investigation is paramount, for reduction of the rate of NA.

Aim of the study is to assess the predictive ability of complete blood count parameters in diagnosing acute appendicitis and ruling out NA.

Methods

A case control study done at a general surgical hospital over 1 years (from September 2018 to September 2019). Study sample included all admitted patients with clinical diagnosis of AA during the before mentioned period. While cases with previous abdominal surgery, pregnant patients, chronic drug, or substance (alcohol and tobacco) users, those suffer from chronic diseases, and morbidly obese patients were excluded from the study.

All cases were interviewed for obtaining demographical data, blood samples had been drawn from all participants for estimation of CBC parameters and after appendectomy all cases undergone histopathological (HP) examination and according to the result of the HP the study sample divided into those with HP diagnosis of appendicitis (group A) and those with HP diagnosis of normal appendix or NA (group B). A control group (group C) included 50 healthy individuals of comparable age attending for routine check-up.

Laboratory analysis: Before appendectomy, two milliliters of venous blood collected into EDTA tubes and analyzed using automated analyzer “ABX Micros ES 60 hematology analyzer, Horiba, France”.

The ranges of the reference intervals were as follows:

- Leukocyte counts (WBC) 3.70-10.1×103/µL,
- Neutrophil (NEU): 1.63-6.96x10³/µL (39.3-73.7%),
- Lymphocyte (LYM): 1.09-2.99x103/µL (18.0-48.3%)
- Red blood cells distribution width (RDW): 11.5%-14.5%,
- Mean platelet volume (MPV) 6.90-10.6 fL
- Platelet (PLT): 155-366×10³/µL,
- Plateletcrit= platelet count x MPV / 10000 (PCT): 0.21-0.35 %
- Platelet distribution width (PDW) 16-17.2 %

Histopathology: Cases were considered as acute appendicitis if had predominant neutrophil infiltration of some or all the wall of the appendix, with presence of mucosal erosion. While cases with peri-appendiceal inflammation with no mucosal erosion and non-predominant neutrophil infiltration were considered NA.

Ethical considerations: The proposal of the study was approved by the scientific and ethical committee of the same hospital and the surgical board.

Verbal consent was obtained from all participants.

Statistical analysis: Statistical Package for the Social Sciences (SPSS) V26 (IBM Corporation, Armonk, NY, USA) were used in statistical analysis.

Data presented as tables (counts and percentage, means & standard deviations); normality of data tested by Shapiro-Wilk test. One-way ANOVA test used to estimate the Univariate analysis and MANOVA test used to estimate Multivariate analysis. The significant results further undergone post hoc testing using Games-Howell test. P-value considered significant if it was less than 0.05.

The significant variables were further analyzed to find the predictive ability of acute appendicitis by running receiver operating characteristic (ROC) analysis and selection of best cutoff values of parameters using Youden's J test. At which, the predictive ability and accuracy with area under curve (AUC) estimated.

Results:

One hundred and fifteen cases were enrolled, 91 cases had HP diagnosis of AA (Figure 1) represent 79.13% of appendectomies (Group A), while the other 24 cases (20.87%) had HP diagnosis of NA (Figure 2). While group C included 50 samples.

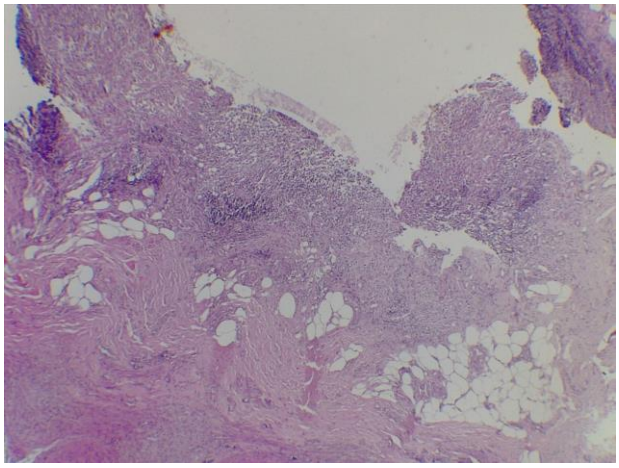

Figure 1: Example of AA cases.

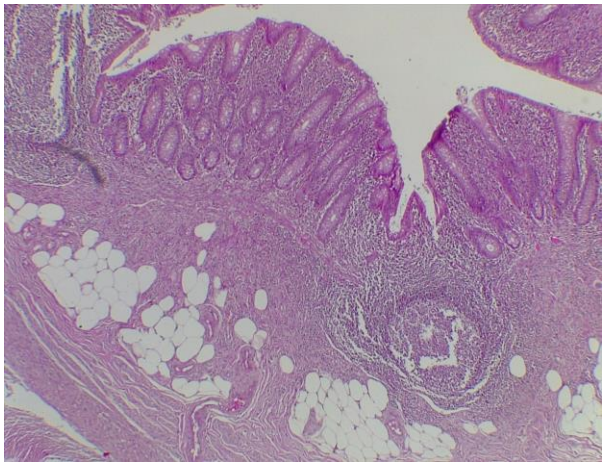

Figure 2: Example of NA cases

The mean age of patients was not different (group A: 23.2±7.2 years, group B: 20.3±5.1 years, and group C: 28.6±3.6 years).

Descriptive analysis of groups A, B and C with significance of differences between these groups were shown in Table 1.

In brief a significant difference between the three groups A and C were found for WBC, LYM, NEU, PLT, RDW, MPV, PCT, PDW, NLR and PLR on both univariate and multivariate analysis.

On post HOC analysis mean WBC, NEU, MPV, PDW, NLR, and PLR were different from both cases with normal appendix by HP and control cases. While mean LYM, RDW, and PLT were different from control but not different from NA. on other hand mean PCT in case of AA was not different from control.

Table 1: Distribution of CBC parameters according to the groups with level of significance.

Variables	Group	Mean ±SD	P value				
			Univariate	Multivariate	A Vs B	A Vs C	B Vs C
WBC (10^3/µL)	**A**	13.35±3.23	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	0.625
	B	8.72±2.63					
	C	9.32±2.59					
LYM (10^3/µL)	**A**	2.76±1.13	**<0.0001**	**<0.0001**	0.206	**<0.0001**	0.085
	B	3.13±0.87					
	C	3.66±1.18					
NEU (10^3/µL)	**A**	13.16±3.47	**<0.0001**	**<0.0001**	**0.005**	**<0.001**	**0.009**
	B	10.52±3.4					
	C	8.05±2.52					
RDW (%)	**A**	14.17±1.99	**<0.0001**	**<0.0001**	0.717	**0.0001**	**0.0001**
	B	14.47±1.62					
	C	12.68±1.25					
PLT (10^3/µL)	**A**	315.56±92.45	**0.003**	**0.003**	0.112	**0.002**	0.833
	B	276.5±79.97					
	C	265.3±74.01					
MPV (fL)	**A**	5.78±1.94	**<0.0001**	**<0.0001**	**<0.001**	**<0.001**	0.535
	B	9.9±1.84					
	C	10.39±1.83					
PCT (%)	**A**	0.2±0.05	**<0.0001**	**<0.0001**	**0.004**	0.645	**0.001**
	B	0.25±0.06					
	C	0.19±0.05					
PDW (%)	**A**	15.88±3.92	**0.001**	**0.001**	**0.001**	**0.03**	0.272
	B	13.17±2.92					

	C	14.33±3.13					
NLR	**A**	5.65±3.09	**<0.0001**	**<0.0001**	**<0.001**	**<0.001**	0.988
	B	2.59±0.95					
	C	2.59±1.31					
PLR	**A**	209.46±67.65	**<0.0001**	**<0.0001**	**<0.001**	**<0.001**	0.057
	B	95.96±41.04					
	C	132.94±94.76					

*" LYM: Lymphocyte, MPV: Mean platelet volume, NEU: Neutrophil, NLR: Neutrophil-to-lymphocyte ratio, PCT: Plateletcrit, PDW: Platelet distribution width, PLR: Platelet-Lymphocyte ratio, RDW: Red cell distribution width, SD: standard deviation and WBC: White blood cells".

Receiver operating characteristic curve of the patient group (group A and group B) was shown in figures (3,4).

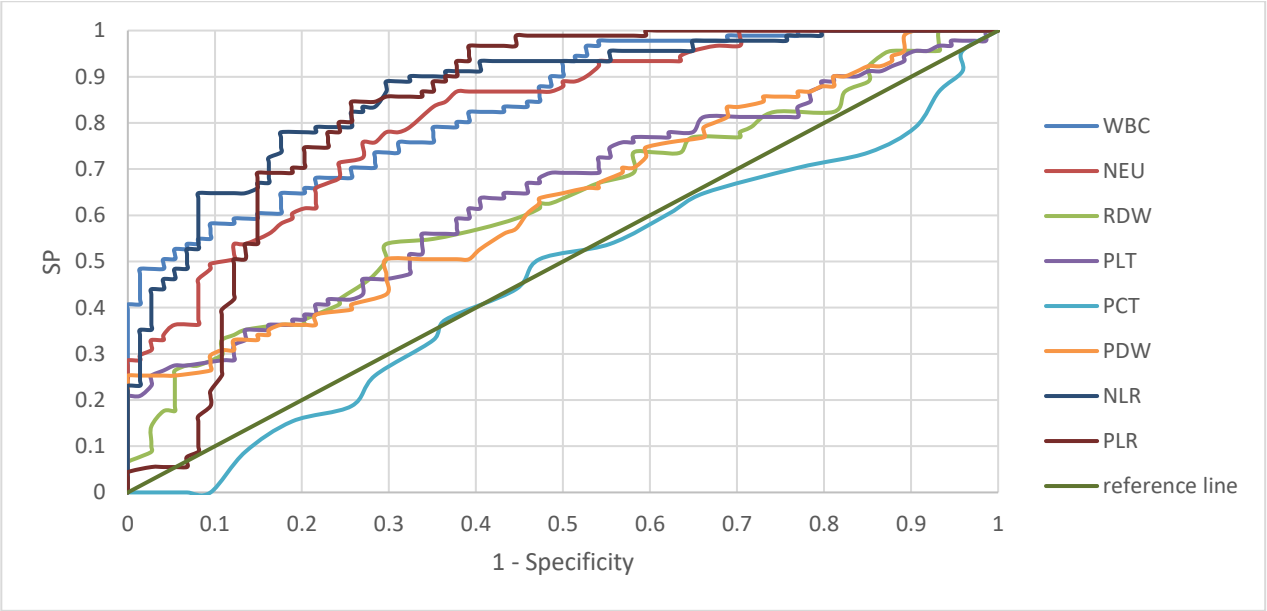

Figure (3) ROC curve of WBC, NEU, RDW, PCT, NLR and PLR

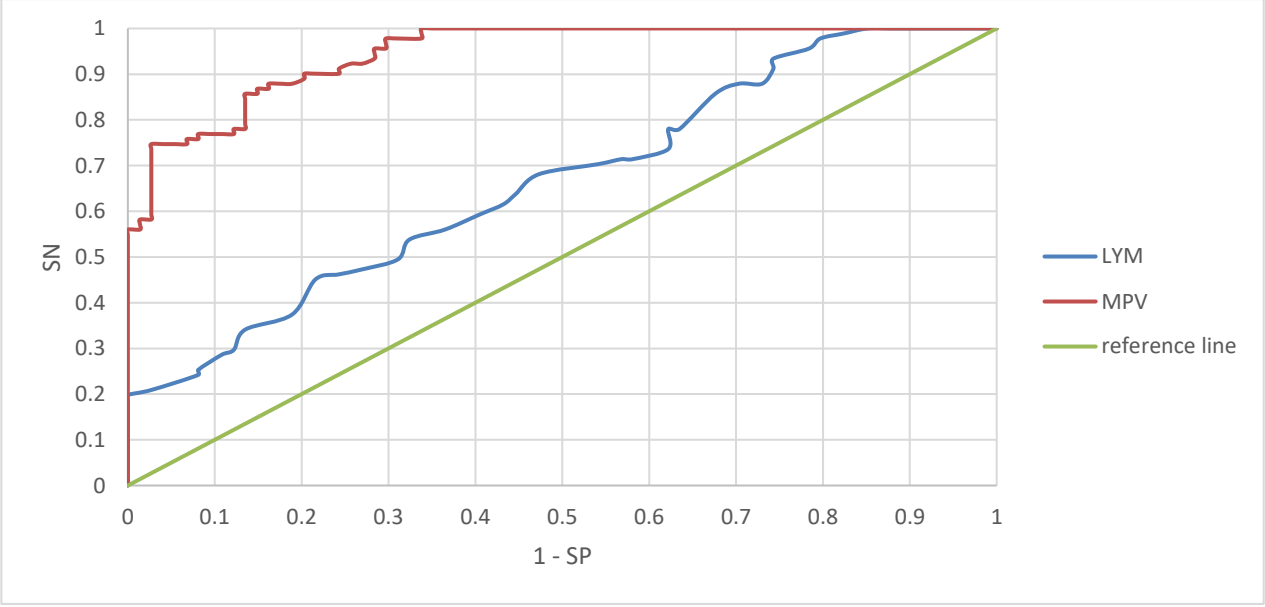

Figure (4) ROC curve of LYM and MPV

The predictive ability and AUC were shown in Table 2 with cutoff points above which the test considered positive regarding WBC, NEU, PLT, RDW, PCT, NLR and PLR and the cutoff points below which the test considered positive regarding LYM and MPV.

Table 2: cut off points, AUC, SN and SP determined from ROC curve, according to the cutoff points PPV, NPV and accuracy of the test estimated.

Variables	Cutoff Point	AUC 95% CI	SN (%) 95% CI	SP (%) 95% CI	PPV (%) 95% CI	NPV (%) 95% CI	Acc (%)
WBC 10^3/µL	11.2	0.862 (0.784-0.939)	70.3 (60.4-79.)	71.6 (60.7-80.9)	75.3 (65.4-83.5)	66.3 (55.5-75.9)	70.9%
LYM 10^3/µL	3.35	0.595 (0.481-0.709)	68.1 (58.1-77.)	52.7 (41.4-63.8)	63.9 (54.1-73.)	57.4 (45.5-68.6)	61.2%
NEU 10^3/µL	8.5	0.699 (0.584-0.815)	89.0 (81.4-94.2)	50. (38.8-61.2)	68.6 (59.9-76.5)	78.7 (65.5-88.5)	71.5%
PLT 10^3/µL	272	0.622 (0.504-0.74)	64.8 (54.7-74.1)	55.4 (44.1-66.3)	64.1 (54.-73.4)	56.2 (44.7-67.1)	60.6%
RDW (%)	13.2	0.444 (0.327-0.561)	62.6 (52.4-72.1)	52.7 (41.4-63.8)	62. (51.8-71.4)	53.4 (42.-64.5)	58.2%
MPV (fL)	8.38	0.933 (0.886-0.98)	90.1 (82.7-95.)	79.7 (69.5-87.6)	84.5 (76.4-90.7)	86.8 (77.2-93.2)	85.5%
PCT (%)	0.195	0.288 (0.169-0.407)	53.8 (43.6-63.8)	44.6 (33.7-55.9)	54.4 (44.2-64.5)	44.0 (33.2-55.3)	49.7%
PDW (%)	14.35	0.696 (0.585-0.806)	62.6 (52.4-72.1)	52.7 (41.4-63.8)	62.0 (51.8-71.4)	53.4 (42.-64.5)	58.2%
NLR	2.96	0.874 (0.805-0.943)	89.0 (81.4-94.2)	70.3 (59.2-79.8)	78.6 (70.0-85.7)	83.9 (73.3-91.4)	80.6%
PLR	130.7	0.933 (0.883-0.983)	83.5 (74.9-90.)	74.3 (63.6-83.2)	80.0 (71.1-87.1)	78.6 (67.9-86.9)	79.4%

*" Acc: Accuracy, AUC: Area under the curve, CI: Confidence interval, LYM: Lymphocyte, MPV: Mean platelet volume, NEU: Neutrophil, NLR: Neutrophil-to-lymphocyte ratio, NPV: Negative predictive value, PCT: Plateletcrit, PDW: Platelet distribution width, PLR: Platelet-Lymphocyte ratio, PPV: Positive predictive value, RDW: Red cell distribution width, SN: Sensitivity, SP: Specificity, and WBC: White blood cells".

Discussion:

Increased leucocytes count is widely used test to diagnose acute appendicitis. Also it is considered as an early marker of appendicular inflammation [8]. The rate of NA in this study was 20.87%, comparable result found by Chan et al[7] with NA rate of 22.09%.

WBC count was significantly different from groups B and C and at a cutoff point of more than 11.2x103/µL, the SN and SP of leukocyte level were 70.3% and 71.6%, respectively. A comparable results found by Narci et al[5] found cutoff value of 10.4×103/ µL with a 91% SN and 74% SP. Dinc et al[9] found slightly lower cutoff value but with comparable SN and SP (10.6×103/µL, 73.1% and 94% respectively).

A decreased LYM count was significantly associated with clinical diagnosis of acute appendicitis, nevertheless on comparison with HP diagnosis, no difference from NA was found. A cutoff value of 3.35 x103/µL, associated with low SN and SP (68.1%, and 52.7% respectively) in this study, while Virmani et al[10] reported a significant difference between cases of simple appendicitis and complicated one with a cutoff value of 1.89 x103/µL, thus they found that low lymphocyte count associated with increased complication rate, this result may highlight the usefulness of lymphocyte count in the prediction of complicated appendicitis but less accurate in prediction the histopathological result of appendectomies.

Neutrophil count was elevated in cases of acute appendicitis and was significantly different from group C and B and the cutoff point was 8.5 x103/µL with a SN and SP of 89% and 50% respectively. A comparable result was found by Bilici et al[11] also a significant difference was found with a cutoff point 8x103/µL had a SN and SP of 84% and 77% respectively.

Although platelet count was higher in group A, yet no difference from group B was found, also this elevation was not specific for acute appendicitis (SP 55.4%). This result poorly investigated by other studies.

In this study we found that RDW of group A not significantly different from group B, yet statistical significance found between groups B and C, this results highlight the effect of other pathologies (other than appendicitis) on RDW level, as suggested by Wang et al[12] that elevated RDW is a marker for urinary tract infection. Narci et al[5] also stated no significant association of RDW and appendicitis.

Mean platelet volume was decreased in cases of AA and it was significantly different from control group and at best

cutoff point of <8.38fL SN and SP were 90.1% and 79.7% respectively in this study. Bilici et al[11] (n=100) in their study on children (1-15 years) that included cases of clinical diagnosis of acute appendicitis and healthy control, found that MPV lower than 7.4 fL was associated with 73% SN and 84% SP for diagnosing pediatrics appendicitis in children, yet did not investigate the role of MCV on the histopathological diagnosis of appendicitis (that what was done in this study). On another hand Albayrak et al[13] (n=432) in their study that included HP approved appendicitis and healthy control, found that MPV <7.6 fL was associated 54% SN, and 84% SP in differentiating appendicitis from healthy control (not included negative appendectomies that had included in the current study).

Plateletcrit was higher in cases of histopathological diagnosis of non-inflamed appendix, while true appendicitis was not different from control. A comparable result found by Gu Nes et al[14] (n=165), in their study found that higher PCT was associated with negative appendectomies yet did not compare this result to a healthy control (as done in the current study), thus this elevation was not specific to appendicitis.

PDW was higher in cases of appendicitis, and level higher than 14.35% was associated with 62.6% SN and 52.7% SP. Dinc et al[9] (n=495) found a significant difference also but with higher a cutoff point of 32.15% associated with higher SN and SP were 97.1% and 93% respectively. These differences in results may be attributed to the type of the sample collected in their study, as they compare cases with clinical diagnosis of appendicitis with cases with intra-abdominal inflammatory conditions other than appendicitis, and this did not give idea about the histopathological diagnosis that investigated in the current study.

Neutrophils to lymphocytes ratio was significantly different from control group with SN and SP 89% and 70.3% respectively at a cutoff point of 2.96. A significant difference found by Kahramanca et al[6] (n=1067) who stated that a cutoff point of 4.68 is associated with SN and SP were 65.3% and 54.7%, respectively. Sevinç et al[15] (n=3392) found that at cutoff point of 3 SN was 81.2%, and SP of 53.1%. while the systematic review and meta-analysis conducted by Hajibandeh et al[16] showed that significant difference in NLR level was found between cases of true appendicitis and negative appendectomies with cutoff point of 4.7 associated with SN of 88.89% and SP of 90.91%.

Platelet to lymphocyte ratio was higher in cases of acute appendicitis, at cutoff point of 122.18 SN and SP were 83.5 % and 74.3 %. Cinar et al[17] estimated that at >155.20 cutoff point SN and SP would be 77.5% and 74.5% respectively.

The limitations of our study were the small sample size that was attributed to study period only, also this study did not include cases of conservatively treated appendicitis, no inclusion of CT scan with appendicitis investigation as it may further reduce the NA rate.

Conclusion:

The use of the complete blood count parameters MPV, NLR and PLR sensitive and specific for diagnosis of acute appendicitis and can be used as an aid in difficult diagnoses to reduce the rate of negative appendectomies

Recommendations:

This study could be regarded as a pilot study for a larger study that use MPV, NLR and PLR as diagnostic tools for appendicitis and assess its role in reduction of the burden on surgical team and surgeries cost. This study may aid new studies to investigate the conservative treatment of appendicitis by being a test to rule out appendicitis.

References

1. F.Charles Brunicardi, Dana K.Andersen, Timothy R.Billiar, David L.Dunn, John G.Hunter, Lillian S.Kao, et al. The Appendix;. In: Fadi S.Dahdaleh, David Heid, K.Turaga K, editors. Schwartz's Principles of Surgery. New York: McGraw-Hill; 2019. p. 1331.
2. Pinto F, Pinto A, Russo A, Coppolino F, Bracale R, Fonio P, et al. Accuracy of ultrasonography in the diagnosis of acute appendicitis in adult patients: review of the literature. Critical ultrasound journal. 2013;5(1):1-3 DOI: https://doi.org/10.1186/2036-7902-5-S1-S2.
3. Imad Wajeh AS, Zuhair Bashir K, Laith Naief H. Comparison between the diagnostic values of serum inflammatory markers, interleukin-6 and C-reactive protein in detection the severity of acute appendicitis. Journal of the Arab Board of Medical Specializations. 2010;11(2):36-44.
4. Al-Shahwany IW, Kamal ZB, h Hindoos LN. Evaluation of Serum Interleukin-6 Levels in Correlation to the Severity of Acute Appendicitis. AL-Kindy College Medical Journal. 2009;5(1):66-71.
5. 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 Journal of Emergency Surgery. 2013;8(1):1-5 DOI: https://doi.org/10.1186/1749-7922-8-46.
6. Kahramanca Ş, Özgehan G, Şeker D, Gökce Eİ, Şeker G, Tunç G, et al. Neutrophil-to-lymphocyte ratio as a predictor of acute appendicitis. Turkish Journal of Trauma and Emergency Surgery. 2014;20(1):19-22 DOI: 10.5505/tjtes.2014.20688.
7. Chan J, Fan KS, Mak TLA, Loh SY, Ng SWY, Adapala R. Pre-Operative Imaging can Reduce Negative Appendectomy Rate in Acute Appendicitis. Ulster Med J. 2020;89(1):25-8.
8. Birchley D. Patients with clinical acute appendicitis should have pre-operative full blood count and C-reactive protein assays. The Annals of The Royal College of Surgeons of England. 2006;88(1):27-32 DOI: https://doi.org/10.1308/003588406X83041.
9. 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 DOI: 10.3748/wjg.v21.i6.1821.
10. Virmani S, Prabhu PS, Sundeep P, Kumar V. Role of laboratory markers in predicting severity of acute appendicitis. African Journal of Paediatric Surgery: AJPS. 2018;15(1):1 DOI: 10.4103/ajps.AJPS_47_16.
11. Bilici S, Sekmenli T, Göksu M, Melek M, Avci V. Mean platelet volume in diagnosis of acute appendicitis in children. African health sciences. 2011;11(3).
12. Wang W, Xie P, Zhang J, Cai W. A risk prediction model of urinary tract infections for patients with neurogenic bladder. International Journal of Neuroscience. 2021;131(1):31-9 DOI: 10.1080/00207454.2020.1732973.
13. 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. Clinical and Applied Thrombosis/Hemostasis.

2011;17(4):362-6 DOI: https://doi.org/10.1177/1076029610364520.
14. Gu Nes ME, Deniz MM, Yilmaz S. Diagnostic value of platelet indices in acute appendicitis and comparison with histopathology. Ann Ital Chir. 2017;88:222-8.
15. Sevinç MM, Kınacı E, Çakar E, Bayrak S, Özakay A, Aren A, et al. Diagnostic value of basic laboratory parameters for simple and perforated acute appendicitis: an analysis of 3392 cases. Turkish Journal of Trauma and Emergency Surgery. 2016;22(2):155-62 DOI: 10.5505/tjtes.2016.54388.
16. Hajibandeh S, Hajibandeh S, Hobbs N, Mansour M. Neutrophil-to-lymphocyte ratio predicts acute appendicitis and distinguishes between complicated and uncomplicated appendicitis: a systematic review and meta-analysis. The American Journal of Surgery. 2020;219(1):154-63 DOI: https://doi.org/10.1016/j.amjsurg.2019.04.018.
17. Cinar H, Aygun A, Derebey M, Tarim IA, Akalin C, Buyukakincak S, et al. Significance of hemogram on diagnosis of acute appendicitis during pregnancy. Turkish Journal of Trauma and Emergency Surgery. 2018;24(5):423-8 DOI: 10.5505/tjtes.2018.62753.