




Precision of C-reactive protein in the diagnosis of acute appendicitis

Melody Omraninava^{1*} , Shaghayegh Javan² , Ghahraman Mahmodi³ 

¹ Medical Sciences College Sari Branch, Islamic Azad University, Sari, Iran.

² Sari Branch, Islamic Azad University, Sari, Iran.

³ Hospital Administration Research Center, Sari Branch, Islamic Azad University, Sari, Iran.

Corresponding author and reprints: Melody Omraninava, Medical Sciences College Sari Branch, Islamic Azad University, Sari, Iran.

Email: melodyomraninava@yahoo.com

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Abstract

Background: Appendicitis is known as inflammation in the appendix, and its treatment is merely through surgery. There is mistaken diagnosis according to clinical presentations. C-reactive protein is an annular pentameric protein found in blood plasma, whose circulating concentrations rise in response to inflammation. It is an acute-phase protein of hepatic origin. Therefore, the aim of this study was to evaluate the diagnostic effect of C-Reactive Protein (CRP) in the diagnosis of acute appendicitis in patients referring to Valiasr Hospital in Qaemshahr city, Iran in 2017-2018.

Methods: This study was a diagnostic study and blood samples were collected from patients with acute abdomen pain with suspected appendicitis in Qaemshahr Valiasr Hospital. Then CRP results were compared with pathological results as golden standard; then sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of this test were determined based on standardized test (pathologic result).

Results: The sensitivity and specificity of CRP test in diagnosis of acute appendicitis were 71.42% and 60.58%, respectively. In addition, PPV and NPV were 88.88% and 42.85%, respectively.

Conclusion: According to the results of this study, CRP can be considered as one of the predictive tests of acute appendicitis. Evaluation of CRP levels, alongside with other diagnostic approaches, can be used as an adjunctive diagnostic method in the diagnosis of acute appendicitis.

Keywords: Appendectomy; Appendicitis; C-Reactive Protein.

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Introduction

Acute appendicitis is the most common cause of acute abdominal pains that leads to surgery (1). For many years the appendix was mistakenly regarded as a non-functional organ. (2). Although appendicitis is an integral component of the intestinal lymphoid tissue system, its function is not essential, and appendectomy is not associated with

susceptibility to sepsis or other manifestations of immune deficiency (3).

Symptoms of acute appendicitis begin with generalized abdominal pain, nausea, vomiting and, after several hours, localized pain in the right lower quadrant of abdomen. The symptoms are classically present in only a third of patients (4). Due to the variety of symptoms with many abdominal diseases, the diagnosis of appendicitis can sometimes be difficult and

delayed in diagnosis can have fatal consequences (5).

Symptoms of appendicitis can be also found in other abdominal problems such as gastritis, abdominal lymphadenitis, complications of ovarian cysts, acute salpingitis, intestinal and parasitic infections, kidney stones, urinary tract infections (6).

Despite recent advances in medical science, the diagnosis of appendicitis in some cases is still in doubt (7). The diagnostic accuracy of appendicitis is estimated to be 76-92% (8). Some paraclinical measures can be helpful, including increasing the number of white blood cells (WBC) in circulation (9).

Laboratory findings, such as CRP are useful in contributing to diagnosis of acute appendicitis, but have low specificity (13). In some studies, increased CRP has been emphasized (14).

The active protein C or CRP is an acute phase protein that is also examined in case of acute appendicitis. CRP is involved in cellular immunity by stimulating phagocytosis, enhancing leukocyte chemotaxis, and activating platelets (10). Concentrations of CRP increase at 8 hours after tissue injury and then reach peak level within 24 to 48 hours and remain elevated until infection or tissue injury persists. After the subsiding the disease process, the serum concentration of this agent decreases within a short time, approximately 4-7 hours (11).

Basic research has been conducted on the diagnostic value of CRP in acute appendicitis, which its measurement in the diagnosis of cases with clinical suspicions can reduce negative appendectomy (12). Surveys show that only 50% of patients present with symptoms of appendicitis at the time of emergency diagnosed with delay. Thus, in this study the sensitivity and specificity of CRP test for the diagnosis of acute appendicitis were determined and the PPV and NPV were investigated.

Methods

Study subjects

This diagnostic study was performed on 73 patients who referred to the Emergency or Surgery Department of Valiasr Hospital in Qaemshaht city, Iran during 2017-2018. Blood samples were taken for CRP evaluation based on clinical history and clinical findings and appendicitis diagnosis or were included in their differential diagnosis. Values higher than 10 mg/l was considered as a positive test result. Quantitative levels of CRP were also determined. All tests were performed in the serology laboratory of Valiasr Hospital. All patients were examined and evaluated by the surgeon and if the patient was suspected to have appendicitis, the pathologic outcome of the sample was evaluated. The CRP results were then compared with the pathological results. Inclusion criteria were as follows: confirmed initial diagnosis of acute appendicitis by a respected surgical or emergency medicine specialist and prescription of appendectomy for the patient. However, the exclusion criteria were failure to perform appendectomy in patient with acute abdomen and unwillingness to participate in the study. The study protocol was approved by ethical committee of Mazandaran University and written informed consent forms was obtained from all participants.

Questionnaire design

In this study, demographic data (age, sex, family history, history of gastrointestinal disorders, etc.) were recorded in the first part of the checklist. In the second part of the checklist, CRP results were recorded and in the third part the patient pathology report was recorded.

Preparation of serum samples and CRP measurement

From all subjects, 5 ml of peripheral blood was collected in the EDTA-anticoagulated tubes using venipuncture. Afterwards, serums were collected from blood samples

through centrifugation at 3000 rpm. The serum samples were then sent to the paraclinical laboratory of Valiasr hospital in Ghaemshahr city for evaluation of CRP levels.

Data acquisition and statistical analysis

In this study, data were collected using patient records checklist and laboratory results and pathology reports were all entered into SPSS. After collecting the required data, the data were analyzed by SPSS v21 software (SPSS, Chicago, IL, USA).

Results

Demographic data and baseline characteristics

In this study, 73 subjects were evaluated and detailed demographic data and baseline characteristics are listed in Table 1. Most of

Table 1. Baseline characteristics of patients with acute appendicitis.

Characteristic	Frequency	Percentage
Age (Year)		
Less than 10	8	10.95%
10-20	21	28.76%
20-30	14	19.17%
30-40	18	24.7%
More than 40	12	16.43%
Gender		
Male	38	52.05%
Female	35	47.95%
Familial history of appendectomy		
Yes	40	54.79%
No	33	45.21%
Appendicitis type		
Perforated	2	2.73%
Infectious	54	73.97%
Normal	17	23.28%
C-reactive protein (CRP)		
Positive	45	61.6%
Negative	28	38.35%

Table 2. Laboratory findings of patients with acute appendicitis.

Item	Min	Max	Mean (SD)
CRP	1	62	23.73 (15.7)
WBC	1800	17000	11257.5 (13921.1)

SD, standard deviation; CRP, C-reactive protein; WBC, White blood cell

the patients were in the age group of 10-20 years and then in 30-40 years old. In terms of gender, males were a little more than females. In terms of family history of appendectomy, more than half of the patients had a family history of appendectomy. In terms of type of appendicitis, more than half of the cases had infectious appendicitis. It was observed that near two-third of cases had positive CRP.

The mean of CRP levels was 23.73 ± 15.67 and mean of WBC count was 11257.53 ± 13921.14 (Table 2).

PPV, NPV, specificity, and sensitivity

Sensitivity and specificity of CRP test in diagnosis of acute appendicitis were 71.42%, 60.58%, respectively. PPV and NPV were also calculated to be 88.88% and 42.85%, respectively (Table 3).

Association of CRP with clinical characteristics

The data in Table 4 shows the frequency distribution of CRP positivity in patients according to the gender. It was observed that 45 (61.64%) subjects had positive CRP levels. Moreover, CRP was positive in 30 (41.1%) men and 15 (20.54%) women. With respect to age of the individuals, the highest number of CRP positivity was observed in the 20-30 years age group and it was 12 (16.4%). However, the lowest frequency of CRP positivity was detected in the age group less than 10 years, containing 4 persons (5.47%). Finally, 2 (2.7%), 38 (52.05%), and 5 (6.84%) individuals with perforated, infectious, and normal pathology of appendicitis type had positive levels of CRP.

Table 3. Sensitivity and specificity of CRP test in diagnosis of acute appendicitis.

CRP test result	Positive pathology N (%)	Normal pathology N (%)	Accumulation N (%)
Positive	40 (54.79%)	5 (6.48%)	45 (61.64%)
Negative	16 (21.91%)	12 (16.43%)	28 (38.35%)
Overall accumulation	56 (76.71)	17 (23.28%)	73 (100%)

CRP, C-reactive protein

Discussion

According to the results of this study, CRP can be considered as one of the predictive tests of acute appendicitis. Evaluation of CRP levels, alongside with other diagnostic approaches, can be used as an adjunctive diagnostic method in the diagnosis of acute appendicitis. A study by Izadi et al., on 81 patients with acute appendicitis and 24 subjects with normal appendicitis revealed that 65 cases with acute appendicitis had elevated CRP levels and 16 had normal CRP levels. In this study, sensitivity and specificity of CRP were 80% and 63%, respectively (15) Which is consistent with the present study .

It can be stated that although CRP levels are significantly different in individuals with acute appendicitis compared to normal individuals, these laboratory tests cannot and should not replace clinical examination skills. Our investigations indicated that the sensitivity and specificity of CRP test in diagnosis of acute appendicitis were 71.42%, 60.58%, respectively. PPV and NPV were also measured to be 88.88% and 42.85%, respectively. In our study, sensitivity and specificity of CRP test in pathology diagnosis were 71.42%, 60.58%, respectively. The results of research by Afshari Safavi et al., the sensitivity of the neural network model was 97.59% and the sensitivity of CRP and WBC tests was 92.77% and 85.54%, respectively (16).

The results of our study showed that the sensitivity of CRP test in pathology diagnosis was 71.42% respectively. The sensitivity of CRP in the study of Javadi et

al., was higher than our study. In a 2013 study (17), which comprised of 74.3% male and 25.7% female, the most common symptom was anorexia (95.2%), followed by local tenderness (95.8%). It was detected that 13.08% of the patients had normal appendectomy. The sensitivity and specificity of WBC, CRP and neutrophils were 98.1%, 61.5%, 84.8%, 50%, 93.3% and 19.2%, respectively. The prevalence of appendicitis was 54% (73.97%) with infectious appendicitis and the least prevalence was 2%, while 73.2% had perforated appendicitis. The sensitivity and specificity of CRP in pathology diagnosis were 71.42% and 60.58%, respectively (17). Studies by Rouzrokh et al., (18), Hosseinpour et al., (19), Afshari Safavi et al., (16), showed that CRP along with rigorous clinical and ultrasound examinations was effective in the diagnosis of acute appendicitis.

Table 4. CRP positivity in accordance with demographic data.

Characteristic	Positive CRP N (%)	Negative CRP N (%)
Age (Year)		
Less than 10	4 (5.5%)	4 (5.5%)
10-20	9 (12.3%)	12 (16.4%)
20-30	12 (16.4%)	2 (2.7%)
30-40	10 (13.7%)	8 (10.9%)
More than 40	10 (13.7%)	2 (2.7%)
Gender		
Male	30 (41.0%)	8 (10.9%)
Female	15 (20.5%)	20 (27.4%)
Familial history of appendectomy		
Yes	40(54.79%)	
No	33(45.21%)	
Appendicitis type		
Perforated	2 (2.70%)	0 (0.00%)
Infectious	38 (52.0%)	16 (21.9%)
Normal	5 (6.90%)	12 (16.4%)

CRP, C-reactive protein

As a result of Mohebbi et al., study, diagnosis of acute appendicitis should be based on history and clinical examinations, and other laboratory findings were helpful. CRPs can also be helpful in diagnosing acute appendicitis in difficult cases, similar to the results of the present study (20).

According to the study of Hosseinpour et al., 86.9% cases had positive appendectomy and 13.1% had negative appendectomy, which was in agreement with our findings with respect to positive appendectomy percentage. According to the findings of this study, CRP is highly sensitive and can be used in the clinical diagnosis of appendicitis and can reduce negative appendectomy cases (19).

The PPV was 90%, and NPV was 20%. In our study, the PPV was 88.88% and NPV was 42.85%. The conflicting results in PPV and NPV might stem from differences in experimenting and sample size. In the study of Baghi, sensitivity, specificity, PPV, and NPV for CRP were 79.4%, 25%, 92.8% and 9.9%, respectively. Given the high sensitivity and PPV of WBC, CRP, and erythrocyte sedimentation rate (ESR) tests, it was concluded that positive tests in patients with suspected appendicitis may improve clinical diagnosis. The highest frequency of appendicitis type was infectious appendicitis with 54 (73.97%) cases of and the lowest frequency was perforated appendicitis with 2 (2.73%) cases (21).

Results of these studies indicate the beneficial value of serum CRP determination in correct diagnosis of patients with appendicitis, and also in our results, determination of CRP level in patients was considered to be a useful method for correct diagnosis.

Conclusion

All in all, our investigations indicated that the sensitivity and specificity of CRP test in diagnosis of acute appendicitis were 71.42%, 60.58%, respectively. PPV and NPV were also measured to be 88.88% and

42.85%, respectively. The results of CRP can be helpful in diagnosing or rejecting the diagnosis in cases with suspected appendectomy. It can be concluded that CRP evaluation can be used as a supplementary diagnostic method along with other methods in the diagnosis of acute appendicitis. Further studies are warranted with respect to evaluate the sensitivity and specificity of CRP and leukocytosis in the diagnosis of acute appendicitis and its variants in larger sample sizes.

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Author's contribution

Melody Omraninava and Shaghayegh Javan developed the study concept and design. Ghahraman Mahmodi acquired the data. Melody Omraninava and Shaghayegh Javan analyzed and interpreted the data, and wrote the first draft of the manuscript. All authors contributed to the intellectual content, manuscript editing and read and approved the final manuscript.

Informed consent

Questionnaires were filled with the participants' satisfaction and written consent was obtained from the participants in this study.

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Conflict of interest

The authors declare that they have no conflict of interests.

References

1. Humes D, Simpson J. Acute appendicitis. *Bmj*. 2006;333(7567):530-4.
2. Sutherland DE, Archer OK, Good RA. Role of the Appendix in Development of Immunologic Capacity. *Proceedings of the Society for Experimental Biology and Medicine*. 1964;115(3):673-6.

3. Khan MN, Fayyad T, Cecil TD, Moran BJ. Laparoscopic versus open appendectomy: the risk of postoperative infectious complications. *JSLs: Journal of the Society of Laparoendoscopic Surgeons*. 2007;11(3):363.
4. Rasmussen O, Hoffmann J. Assessment of the reliability of the symptoms and signs of acute appendicitis. *Journal of the Royal College of Surgeons of Edinburgh*. 1991;36(6):372-7.
5. Mittal VK, Choudhury SP, Cortez JA. Endometriosis of the appendix presenting as acute appendicitis. *The American Journal of Surgery*. 1981;142(4):519-21.
6. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Annals of emergency medicine*. 1986;15(5):557-64.
7. Andersson R. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. *British journal of surgery*. 2004;91(1):28-37.
8. Shakhathreh H. The accuracy of C-reactive protein in the diagnosis of acute appendicitis compared with that of clinical diagnosis. *Medicinski arhiv*. 2000;54(2):109-10.
9. Dahmardehei M, Khazaei A, Vahab M, Sargazimoghadam M. Diagnostic Value of Leukocytosis, ESR and CRP in Patients with Suspected Acute Appendicitis. *Zahedan j Res Med Sci*. 2013;15(7):59-63.
10. Zimmerman MA, Selzman CH, Cothren C, Sorensen AC, Raeburn CD, Harken AH. Diagnostic implications of C-reactive protein. *Archives of surgery*. 2003;138(2):220-4.
11. Bhopal FG, Ahmed B, Ahmed M, Ahmed M, Khan JS, Mehmood N, et al. Role of TLC and C-Reactive Protein in the diagnosis of acute appendicitis. *J Surg Pak Int*. 2003;8:2-7.
12. Tepel J, Sommerfeld A, Klomp H-J, Kapischke M, Eggert A, Kremer B. Prospective evaluation of diagnostic modalities in suspected acute appendicitis. *Langenbeck's archives of surgery*. 2004;389(3):219-24.
13. Kessler N, Cyteval C, Gallix Bt, Lesnik A, Blayac P-M, Pujol J, et al. Appendicitis: evaluation of sensitivity, specificity, and predictive values of US, Doppler US, and laboratory findings. *Radiology*. 2004;230(2):472-8.
14. Beltrán MA, Almonacid J, Vicencio A, Gutiérrez J, Cruces KS, Cumsille MA. Predictive value of white blood cell count and C-reactive protein in children with appendicitis. *Journal of pediatric surgery*. 2007;42(7):1208-14.
15. Izadi B, Mousavi N, Askary kachoosangy R. Relationship Between Serum Levels of C-Reactive Protein and Symptoms of Acute Appendicitis in Patients with Acute Appendicitis. *Journal of Sabzevar University of Medical Sciences*. 2016;23(5):782-787. doi: 10.21859/sums-2305782
16. Afshari Safavi A, Zand Karimi E, Rezaei M, Mohebi H, Mehrvarz S, Khorrami MR. Comparing the Accuracy of Neural Network Models and Conventional Tests in Diagnosis of Suspected Acute Appendicitis. *Journal of Mazandaran University of Medical Sciences*. 2015;25(128):58-65.
17. Javadi M, Moradi Y, Behnoud S, Rostampour F. Evaluation of the Sensitivity and Specificity C-reactive protein, and leukocyte count in the diagnosis of acute appendicitis and its types. *Pajouhan Scientific Journal*. 2013;11(2):9-14.
18. Rouzrokh M, Fard FE, Momeni N, Tavassoli A. Diagnostic role of ESR, CRP, leukocytosis and Neutrophil/Lymphocyte in peripheral blood smear in children under 14 with acute appendicitis. *Pajoohandeh Journal*. 2011;16(1):42-6.
19. Hosseinpour M, Shahab Aldin M, Babaei F. Evaluation of the Diagnostic Value of High Sensitive Crp for the Diagnosis of 84 Case of Acute Appendicitis in Shahid Beheshti Hospital (Kashan). *Iranian Journal of Surgery*. 2009;17(2):39-46. <https://www.sid.ir/en/journal/ViewPaper.aspx?id=166946>
20. Mohebbi H, MEHRVARZ S, Khorrami M. Evaluation of serum CRP, procalcitonin and WBC in the diagnosis of acute appendicitis. 2011.
21. Baghi I. Association Rate of Leukocytosis, Increased CRP and ESR With Acute Appendicitis. *Journal of Guilan University of Medical Sciences*. 2006;15(57):54-58. <http://journal.gums.ac.ir/article-1-481-en.html>.