

Role of Rebound Tenderness and Other Parameters in the Evaluation of Acute Appendicitis Using Alvarado Score

Rashid Iqbal Khan, Ayub Ashraf Malhi, Khalid Mehmood, Khurram Sarfaraz Bajwa, Uzma Javed Gul*, Bilal Ayaz

Combined Military Hospital/National University of Medical Sciences (NUMS) Rawalpindi, Pakistan, *Combined Military Hospital Gujrawanal/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To determine the role of rebound tenderness in Alvarado score compared to other parameters in evaluating acute appendicitis.

Study Design: Cross-sectional study.

Place and Duration of the Study: Surgical Emergency Unit, Combined Military Hospital, Rawalpindi Pakistan, from Jul 2021 to Jan 2022.

Methodology: All the patients aged 18-70 years suspected of acute appendicitis were consecutively enrolled. An appendectomy was conducted, and an appendix specimen was sent to confirm the histopathology diagnosis. Rebound tenderness and other Alvarado score parameters were noted. Alvarado score ≥ 7 was labelled as acute appendicitis.

Results: Of 165 patients, the mean age of the patients was 29.09 ± 6.63 years. The majority of the patients were males (119, 72.1%). Rebound tenderness was observed in 93 (56.4%) patients, migration of pain in 158 (95.8%), anorexia in 140 (84.8%), nausea/vomiting in 97 (58.8%), right lower quadrant tenderness in 54 (32.7%) cases, elevated temperature in 95 (57.6%), leukocytosis count $\geq 10 \times 10^3/\text{mm}^3$ in 105 (63.6%), and neutrophil count $>75\%$ in 67 (40.6%) patients. A significantly higher association of rebound tenderness was observed with histo pathological findings (p -value <0.001), Alvarado score of >7 (p -value <0.001), and its other parameters (p -value <0.05). The diagnostic accuracy of rebound tenderness and Alvarado score, taking histopathology as the gold standard, showed a sensitivity of 98.92%.

Conclusion: The study findings have shown that rebound tenderness is the most important sign of acute appendicitis compared with other Alvarado score parameters.

Keywords: Appendectomy, Diagnostic accuracy, Histopathology.

How to Cite This Article: Khan RI, Malhi AA, Mehmood K, Bajwa KS, Gul UJ, Ayaz B. Role of Rebound Tenderness and Other Parameters in the Evaluation of Acute Appendicitis Using Alvarado Score. *Pak Armed Forces Med J* 2022; 72(2): 384-388. DOI: <https://doi.org/10.51253/pafmj.v72i2.8079>

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

In emergency admissions, acute appendicitis is the most prevalent emergency condition needing surgery.¹ Despite its common incidence and technological advances in diagnostic modalities, acute appendicitis is challenging to diagnose by radiological and pathological investigations. The majority of the time, the diagnosis is based on a thorough clinical history and physical examination.² Though imaging modalities are widely used when acute appendicitis is suspected. However, there is a risk of excessive delay in entirely depending on imaging modalities to confirm the disease. Furthermore, diagnostic testing is a significant cost burden for people with low socioeconomic status or low budget health systems.^{1,3,4}

Several previously published studies have also reported false-positive appendectomy in 15-30% of

patients who had undergone surgery, and perforation was documented in 20%.^{5,6} Thus, perforation and a negative appendectomy can be avoided with the proper diagnosis. As a result, clinical research has focused on determining the appropriate non-invasive, easy-to-use, cost-effective diagnostic modality for acute appendicitis. Several grading systems for acute appendicitis have been proposed to achieve this goal.^{7,8}

The Alvarado score is by far the most extensively used scoring technique that has been clinically validated for accuracy.⁹ It assesses the presence of acute appendicitis primarily through clinical findings and laboratory values.² Moreover, the Alvarado score has been demonstrated to lower the risk of negative appendectomy and delay in therapy.¹⁰ Despite the high accuracy of the Alvarado score, there is little research on the significance of individual components in proper diagnosis, particularly in Pakistan. The goal of this study was to see how the rebound tenderness compares to other measures in determining the severity of acute appendicitis.

Correspondence: Dr Rashid Iqbal Khan, Resident General Surgery, Combined Military Hospital, Rawalpindi Pakistan
Received: 31 Jan 2022; revision received: 11 Mar 2022; accepted: 11 Mar 2022

METHODOLOGY

The cross-sectional study was conducted at Combined Military Hospital, Rawalpindi, Pakistan, from July 2021 to January 2022. Ethical approval was obtained from the IERB Board (letter no 234/12/21). Moreover, signed informed consent was obtained from the participants before enrolment in the study. The sample size was calculated taking confidence level of 95%, a margin of error of 6%, reported prevalence of rebound tenderness 74% 10, sensitivity 92.8% 10, and specificity 32.2% 10. The estimated sample size was 155. However, a total of 165 cases were enrolled in this study. All patients were enrolled through non-probability consecutive sampling.

Inclusion Criteria: All the patients aged between 18 to 70 years, of either gender, presenting in the Surgical Emergency Unit with pain in the right lower abdomen with or without vomiting and fever, and right lower abdominal tenderness on examination, were evaluated with appendicitis inflammatory response score to make a clinical diagnosis of acute appendicitis.

Exclusion Criteria: Patients with a clinical diagnosis other than acute appendicitis, having right lower abdominal pain of >1-week, uncontrolled chronic comorbidities such as uncontrolled diabetes, uncontrolled hypertension, ischemic heart disease, inflammatory bowel disease, abdominal tuberculosis, pelvic inflammatory disease, malignancy or patients with the previous history of abdominal surgery, radiotherapy or chemotherapy were excluded from the study.

After taking written informed consent, appendectomy was carried out under general anaesthesia, and a specimen of the appendix was sent for histopathology to look if histopathological findings were positive for acute appendicitis, i.e., the appendix has acute inflammation, suppuration, gangrene, perforation or negative, no inflammation.

The Alvarado score contains nine clinical/ laboratory parameters. These parameters include migratory right iliac fossa pain, anorexia, nausea/vomiting, rebound tenderness, tenderness right iliac fossa, elevated temperature ≥ 37.3 oC, leukocytosis $\geq 10 \times 10^9/L$, and neutrophils $\geq 75\%$.¹¹

The scoring of Alvarado was also performed. The total Alvarado score points were ten, including 1 point for each migratory right iliac fossa pain, anorexia, nausea/vomiting, rebound tenderness, elevated temperature ≥ 37.3 OC, and neutrophils $\geq 75\%$. Whereas 2 points each for tenderness of right iliac fossa and leukocytosis

$\geq 10 \times 10^9/L$. The presence of an Alvarado score of ≥ 7 was labelled as acute appendicitis.

Rebound Tenderness was elicited by applying light pressure on the area of tenderness in the right iliac fossa. When it becomes painful, the examining hand is held steady for a few seconds and then briskly removed. The test is deemed positive if the pain increases after removing the hand.

Statistical Package for the social sciences (SPSS) version 24 was used for data analysis. Mean and standard deviation were computed for quantitative variables like age, duration of symptoms, and Alvarado score. Frequency and percentages were computed for gender, migratory right iliac fossa pain, anorexia, nausea/vomiting, rebound tenderness, tenderness right iliac fossa, elevated temperature ≥ 37.3 oC, leukocytosis $\geq 10 \times 10^9/L$, and neutrophils $\geq 75\%$, Alvarado score of ≥ 7 , and histopathological finding. The comparison was made to see the association of rebound tenderness with ≥ 8 Alvarado score, other parameters of Alvarado score, and histopathological findings. Chi-square/Fisher-Exact test were applied. The *p*-value of ≤ 0.05 was considered significant. Furthermore, the diagnostic accuracy of rebound tenderness was evaluated with a ≥ 7 Alvarado score and histopathological findings. Sensitivity, specificity, positive predicted value, negative predicted value, and overall diagnostic accuracy were calculated.

RESULTS

Of 165 patients, the mean age of the patients was 29.09 ± 6.63 years. The majority of the patients were males (119, 72.1%).

The frequency of the Alvarado score parameters showed that rebound tenderness was observed in 93 (56.4%) patients, migration of pain in 158 (95.8%), anorexia in 140 (84.8%), nausea/vomiting in 97 (58.8%), right lower quadrant tenderness in 54 (32.7%), elevated temperature (≥ 37.3 oC) in 95 (57.6%) patients, leukocytosis count $\geq 10 \times 10^3/mm^3$ in 105 (63.6%) and neutrophil count $>75\%$ in 67 (40.6%) patients.

The mean Alvarado score value was found to be 5.84 ± 3.29 . The frequency of Alvarado score ≥ 7 was observed in 100 (60.6%) patients. At the same time, histopathological findings showed positivity in 148 (89.7%) patients.

A significantly higher association of rebound tenderness was observed with histopathological findings (*p*-value < 0.001), Alvarado score > 7 (*p*-value < 0.001), migration of pain (*p*-value 0.002), anorexia

(-value 0.026), nausea/vomiting (*p*-value <0.001), right lower quadrant tenderness (*p*-value <0.001), elevation of temperature $\geq 37.3\%$ (*p*-value <0.001), leukocytosis $\geq 10 \times 10^3/\text{mm}^3$ (*p*-value <0.001), and polymorphonuclear neutrophilia $\geq 75\%$ (*p*-value <0.001) (Table-I).

Table-I: Comparison of rebound tenderness with histopathological findings, ALVARADO score and its other parameters (n=165).

	Rebound tenderness		
	Yes n=93	No n=72	<i>p</i> -value
Histopathological Findings			
Yes	92 (62.2)	56 (37.8)	<0.001
No	1 (5.9)	16 (94.1)	
Alvarado Score >7			
Yes	92 (92.0)	8 (8.0)	<0.001
No	1 (1.5)	64 (98.5)	
Alvarado Score Other Parameters			
Migration of Pain	93 (58.9)	65 (41.1)	0.002
Anorexia	84 (60.0)	56 (40.0)	0.026
Nausea/Vomiting	85 (87.6)	12 (12.4)	<0.001
Right Lower Quadrant Tenderness	46 (85.2)	8 (14.8)	<0.001
Elevation of Temperature $\geq 37.3^\circ\text{C}$	91 (95.8)	4 (4.2)	<0.001
Leukocytosis $\geq 10 \times 10^3/\text{mm}^3$	92 (87.6)	13 (12.4)	<0.001
Polymorphonuclear Neutrophilia $\geq 75\%$	59 (88.1)	8 (11.9)	<0.001

All data presented as number (%), Chi-square test applied, *p*-value <0.05 considered as significant

The diagnostic accuracy of rebound tenderness, taking histopathology as the gold standard, showed that sensitivity was 98.92%. A similar sensitivity pattern was observed for other parameters as well (Table-II).

Table-II: Rebound tenderness and other parameters diagnostic accuracy considering histopathology findings as gold standard.

	Histopathology				Overall Diagnostic Accuracy
	Se.	Sp.	PPV	NPV	
Rebound Tenderness	98.92	22.22	62.16	94.12	64.45
Migration of Pain	89.24	-	95.27	-	85.45
Anorexia		68	94.59	100	95.15
Nausea/Vomiting	100	25	65.54	100	69.09
Right Lower Quadrant Tenderness	100	15.32	36.49	100	43.3
Elevation of Temperature $\geq 37.3^\circ\text{C}$	100	24.29	64.19	100	67.78
Leukocytosis $\geq 10 \times 10^3/\text{mm}^3$	99.05	26.67	70.27	94.12	72.73
Polymorphonuclear Neutrophilia $\geq 75\%$	100	17.35	45.27	100	50.91

Se: Sensitivity, Sp: Specificity, PPV: Positive predicted value, NPV: Negative predicted value

The diagnostic accuracy of rebound tenderness, taking Alvarado score as the gold standard, showed that sensitivity was 98.92%. A similar sensitivity pattern was observed for other parameters as well (Table-III).

Table-III: Rebound tenderness and other parameters diagnostic accuracy considering ALVARADO score of >7 as gold standard.

	Alvarado Score >7				
	Sensitivity	Specificity	Positive Predicted Value	Negative Predicted Value	Overall Diagnostic Accuracy
Rebound Tenderness	98.92	88.89	92	98.46	94.55
Migration of Pain	63.29	100	100	10.77	64.85
Anorexia	65.71	68	92	26.15	66.06
Nausea/Vomiting	95.88	89.71	93	93.85	93.33
Right Lower Quadrant Tenderness	100	58.65	54	100	72.12
Elevation of Temperature $\geq 37.3^\circ\text{C}$	100	92.86	95	100	96.97
Leukocytosis $\geq 10 \times 10^3/\text{mm}^3$	95.24	100	100	92.31	96.97
Polymorphonuclear Neutrophilia $\geq 75\%$	100	66.33	67	100	80

The area under the curve for rebound tenderness and other parameters in evaluating acute appendicitis using the ALVARADO score showed higher values for all parameters. In particular, the AUC value for rebound tenderness was 0.952 with 95% CI 0.92-0.99 (Table-IV).

Table-IV: Area under the curve values for rebound tenderness and other parameters in evaluation of acute appendicitis using ALVARADO score.

	Area	<i>p</i> -value (95% CI)
Rebound Tenderness	0.952	<0.001 (0.92-0.99)
Migration of Pain	0.554	0.243 (0.46-0.65)
Anorexia	0.591	0.049 (0.50-68)
Nausea/Vomiting	0.934	<0.001 (0.89-0.98)
Right lower quadrant tenderness	0.770	<0.001 (0.70-0.84)
Elevation of temperature $\geq 37.3^\circ\text{C}$	0.975	<0.001 (0.95-1.00)
Leukocytosis $\geq 10 \times 10^3/\text{mm}^3$	0.962	<0.001 (0.92-1.00)
Polymorphonuclear neutrophilia $\geq 75\%$	0.835	<0.001 (0.92-0.99)

DISCUSSION

The role of rebound tenderness in diagnosing acute appendicitis is of utmost importance. In the

current study, rebound tenderness was an important predictor for acute appendicitis compared with other Alvarado score parameters. Acute appendicitis is the most common cause of acute abdomen in people of all ages.^{11,12} History and physical examination are frequently enough to make a diagnosis. Imaging modalities are employed in suspected cases. Researchers are focusing on non-invasive and cost-effective techniques to diagnose acute appendicitis.³

Rebound tenderness is one of the most important signs predicting acute appendicitis.^{13,14} It is a discomfort caused by stretching or shifting the peritoneum layer. The frequency of the Alvarado score parameters showed that rebound tenderness was observed in more than half of the patients, while migration of pain and anorexia was observed in more than 80% of the patients. In a previous study, right lower quadrant tenderness was the most frequent component of the Alvarado score, followed by rebound tenderness.¹⁵ Another study reported that percussion tenderness, guarding, and rebound tenderness are the most reliable clinical findings indicating a diagnosis of acute appendicitis.¹⁶ A study conducted in India also reported that rebound tenderness is critical for ruling out complications such as perforation or peritonitis and confirming the diagnosis of acute appendicitis. It is of minor importance in diagnosing appendix perforation since the positive predictive value is low.¹⁷

According to the current study findings, the frequency of Alvarado score ≥ 7 was observed in 60.6% of patients. At the same time, histopathological findings showed positivity in 89.7% of patients. Moreover, a considerably high association of rebound tenderness was observed with histopathological findings, Alvarado score ≥ 7 , migration of pain, anorexia, nausea/vomiting, right lower quadrant tenderness, the elevation of temperature $\geq 37.3\%$, leukocytosis $\geq 10 \times 10^3 / \text{mm}^3$, and polymorphonuclear neutrophilia $\geq 75\%$.

The diagnostic accuracy of rebound tenderness, taking histopathology as the gold standard, showed that sensitivity was 98.92% in the current study. A similar sensitivity pattern was observed for other parameters as well. As far as the diagnostic accuracy of rebound tenderness taking Alvarado score as the gold standard is concerned, a higher sensitivity was also found. A similar sensitivity pattern was observed for other parameters as well. Higher specificity of rebound tenderness was also observed in a previous study. However, sensitivity was not found to be higher.¹⁰ Even in the most experienced hands, diagnosing appendicitis

can be difficult, and it is mostly a clinical diagnosis.^{18,19} To minimize unneeded surgery and consequences, a thorough anamnesis and physical examination are essential.²⁰ In addition, according to Bundy *et al*, rebound tenderness triples the risk of appendicitis, similar to perforation peritonitis in certain groups of individuals who have an appendicitis diagnosis and examination, although its absence lessens the risk.²¹

This study was important as most patients with acute appendicitis presented with pain and muscular rigidity in the right iliac fossa. The rebound tenderness is one of the main components of the Alvarado score and would likely indicate the presence of acute appendicitis. Even though acute appendicitis is a common surgical emergency, it presents a considerable diagnostic challenge to young trainee surgeons, who are often the first to detect it. It is critical not to miss a diagnosis because the illness might lead to severe problems. It is also critical to prevent unnecessary surgery on an otherwise healthy appendix. Future studies are recommended to preclude the findings of this study.

LIMITATIONS OF STUDY

The limitation of this study was that it was conducted on limited sample size.

CONCLUSION

The study findings have shown that rebound tenderness is the most important sign of acute appendicitis compared with other Alvarado score parameters.

Conflict of Interest: None.

Authors' Contribution

RIK: Data collection, AAM: Conceptualization, supervision, KM: Proof reading, KSB: Study plan, UJG: Statistical analysis, BA: Manuscript writing.

REFERENCES

1. Di-Saverio S, Podda M, De-Simone B, Ceresoli M. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. *World J Emerg Surg* 2020; 15(1): 41-42.
2. Snyder MJ, Guthrie M, Cagle SD. Acute appendicitis: efficient diagnosis and management. *Am Fam Physician* 2018; 98(1): 25-33.
3. Sartelli M, Baiocchi GL, Di Saverio S, Ferrara F, Labricciosa FM. Prospective observational study on acute appendicitis worldwide (POSAW). *World J Emerg Surg* 2018; 13(1): 1-10.
4. Eng KA, Abadeh A, Ligocki C, Lee YK, Moineddin R, Adams-Webber T, et al. Acute appendicitis: a meta-analysis of the diagnostic accuracy of US, CT, and MRI as second-line imaging tests after an initial US. *Radiology* 2018; 288(3): 717-727.
5. Chia ML, Justin K, Hong HTC, Vishal GS. Computerized tomography scan in acute appendicitis with eventual negative appendectomy. *J Clin Transl Res* 2021; 7(3): 326-332.
6. Gökçe AH, Aren A, Gökçe FS, Dursun N, Barut AY. Reliability of ultrasonography for diagnosing acute appendicitis. *Ulus Travma Acil Cerrahi Derg* 2011; 17(1): 19-22.

Rebound Tenderness

7. Karami MY, Niakan H, Zadebagheri N, Mardani P, Shayan Z, Deilami I. Which one is better? Comparison of the acute inflammatory response, raja isteri pengiran anak saleha appendicitis and alvarado scoring systems. *Ann Coloproctol* 2017; 33(6): 227.
8. Korkut M, Bedel C, Karancı Y, Avcı A, Duyan M. Accuracy of Alvarado, Eskelinen, Ohmann, RIPASA and Tzanakis scores in diagnosis of acute appendicitis; a cross-sectional study. *Arch Acad Emerg Med* 2020; 8(1): e20.
9. Al Awayshih MM, Nofal MN. Evaluation of Alvarado score in diagnosing acute appendicitis. *Pan Afr Med J* 2019; 34(1): 15.
10. Özsoy Z, Yenidoğan E. Evaluation of the Alvarado scoring system in the management of acute appendicitis. *Turk J Surg* 2017; 33(3): 200.
11. Téoule P, de Laffolie J, Rolle U, Reissfelder C. Acute Appendicitis in Childhood and Adulthood: An Everyday Clinical Challenge. *Dtsch Arztebl Int* 2020; 117(45): 764.
12. Rahman M, Serna-Trejos JS, Ivan Higuera-Cetina C, Chavarro-Gomez JC, Fernanda Aristizabal M, Solarte-Martinez B. Management of acute appendicitis in emergency departments during pandemic times: who are the most affected, children or adults? *J Surg Trauma* 2021; 9(4): 1-3.
13. Lamture YR, Gajbhiye VP. The role of rebound tenderness in acute appendicitis and appendicular perforation. *Int Surg J* 2017; 4(2): 725-727.
14. Petroianu A. Diagnosis of acute appendicitis. *Int J Surg* 2012; 10(3): 115-119.
15. Iftikhar M, Shah S, Shah I, Shah JA, Faisal M. Outcomes of conservative management of acute appendicitis during COVID-19 Pandemic. *Pain* 2021; 51(30): 48-43.
16. Kularatna M, Lauti M, Haran C, MacFater W, Sheikh L, Huang Y, et al. Clinical prediction rules for appendicitis in adults: which is best? *World J Surg* 2017; 41(7): 1769-1781.
17. Podda M, Pisanu A, Sartelli M, Coccolini F, Damaskos D, Augustin G, et al. Diagnosis of acute appendicitis based on clinical scores: is it a myth or reality? *Acta Biomed* 2021; 92(4): e2021231.
18. Teng TZJ, Thong XR, Lau KY, Balasubramaniam S, Shelat VG. Acute appendicitis-advances and controversies. *World J Gastrointest Surg* 2021; 13(11): 1293-1314.
19. Wagner M, Tubre DJ, Asensio JA. Evolution and current trends in the management of acute appendicitis. *Surg Clin* 2018; 98(5): 1005-1023.
20. Ahmad A, Tariq M, Javaid Y, Rasheed A, Rehman S, Ahmad R. Validity of modified Alvarado scoring system (mass) in the diagnosis of acute appendicitis. *Pak Armed Forces Med J* 2017; 67(5): 813-818.
21. Bundy DG, Byerley JS, Liles EA, Perrin EM, Katznelson J, Rice, HE. Does this child have appendicitis? *J Am Med Assoc* 2007; 298(4): 438-451.

.....