Diagnostic Accuracy of the RIPASA Score in Suspected Acute Appendicitis in Adults: A Cross-sectional Study Comparing it with Histopathological Findings from Bagalkot, India

C SHOBHA[1], G SUSHRUTHA[2], BHIMANAGOUDA V GOUDAR[3]

ABSTRACT

Introduction: Acute appendicitis remains the most commonly occurring surgical emergency, with a prevalence rate of approximately 8% among individuals aged 10-30 years. The Raja Isteri Pengiran Anak Saleha for Appendicitis (RIPASA) scoring system appears to be an accurate, simple, and rapid parameter for predicting Acute Appendicitis (AA).

Aim: To determine the validity and diagnostic efficiency of the RIPASA scoring system for acute appendicitis and compare it with histopathology.

Materials and Methods: A cross-sectional study was conducted on patients admitted to Nijalingappa Medical College in Bagalkot, Karnataka, India, from January 2020 to June 2021. The study included patients of both genders above 18 years of age, presenting with right iliac fossa pain. Detailed history was obtained, and a thorough clinical examination was performed. Appropriate investigations were conducted, and the RIPASA score was calculated. Qualitative data were represented as frequency and percentage. Sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV), and diagnostic accuracy were calculated to assess the validity of the tool. An ROC curve was plotted to determine the area under the curve.

Results: A total of 90 patients had RIPASA scores of ≥7.5, and the majority of them (75.6%) were under the age of 40 years, with a mean age of 39.9 years. The male-to-female ratio was 48.9:51.1, approximately 0.95. The sensitivity, specificity, and diagnostic accuracy of the RIPASA scoring system were 82%, 100%, and 82%, respectively.

Conclusion: The RIPASA scoring system demonstrates good applicability and efficiency in diagnosing acute appendicitis. It is easily accessible and non-invasive, thereby reducing the cost of radiological investigations and unnecessary economic burden.

INTRODUCTION

Acute appendicitis remains the most commonly occurring surgical emergency, with a prevalence rate of approximately 8% among individuals aged 10 to 30 years [1]. According to a study conducted by Singh A et al., the prevalence of acute appendicitis is also approximately 8% in the Indian population [2]. The overall prevalence of acute appendicitis was reported as 44.272% (95% CI: 38.366, 50.180; I2=93.9%) [3]. Subgroup analysis revealed that the prevalence of acute appendicitis in Ethiopia was 36.81% in Amhara, 53.20% in Tigra, 41.30% in Addis Ababa, and 46.54% in Oromia [3].

Leonardo da Vinci depicted the appendix in his anatomical drawings, making him the first person to do so [4]. The appendix develops as an outpouching from the caecal bud during the descent of the colon around the sixth week of gestation [4,5]. It can have various positions, including retrocaecal, retrocolic, pelvic, subcaecal, pre-ileal, and post-ileal, with retrocaecal, retrocolic, and pelvic being the most common [6,7].

The classic Alvarado total score is 10 and includes the left shift of neutrophil maturation (score 1). However, in 1994, Kalan excluded this left shift and created a modified score known as MAS (Modified Alvarado scoring), which is a simple aid for the diagnosis of acute appendicitis [8]. In 2010, a novel scoring system called RIPASA was developed specifically for the diagnosis of acute appendicitis in the Asian population [9]. Anwer M et al., formulated this scoring system to provide an efficient, simple, and reliable diagnostic tool with high accuracy. They also found that ultrasonography is ineffective in ruling out negative appendicitis [10].

Chong CF et al., described a set of 15 parameters, and a score of 7.5 or higher is considered as the cut-off value for diagnosing acute appendicitis that requires surgery [11]. This scoring system also reduces the rate of unnecessary appendicectomies. The RIPASA system was found to be the most suitable score for pregnant patients [12].

The RIPASA test demonstrated higher sensitivity than the Alvarado test, while the Alvarado test showed greater specificity. RIPASA also exhibited a larger Area Under the ROC Curve (AUC) compared to Alvarado. The diagnostic odds ratio was higher for RIPASA than for Alvarado [13]. Other scoring systems for acute appendicitis include Izbicki, Ohman, Tzanaki, Lintula, Eskelinen, Fenyo-Lindberg, Pediatric Appendicitis Score, and Appendicitis Inflammatory Response scoring systems [14,15]. Tzanakis's score is more sensitive and specific than the scores of Alvarado, RIPASA, Eskelinen, and Ohmann in diagnosing Acute Appendicitis (AA). Based on the AUC, Tzanakis's score outperformed Ohmann's and Alvarado's scores in diagnosing AA. Tzanakis's scoring system is useful for screening purposes. The Ohman score is a simple test that can aid in diagnosing AA, while the Eskelinen score is helpful in ruling out AA. Erdem et al., found that the sensitivity and specificity of the Ohmann and Eskelinen scores were 96% and 42%, and 100% and 44%, respectively. Ohmann and Eskelinen's scores demonstrated sufficient specificity. However, the Eskelinen score has the disadvantage of involving decimal calculations, which may make it less practical. It may also require additional diagnostic methods such as laboratory testing or ultrasonography [16].

The aim of the study is to determine the validity and diagnostic efficiency of the RIPASA scoring system for acute appendicitis and compare it with histopathology, which is an innovative aspect of this study.

MATERIALS AND METHODS

A cross-sectional study was conducted at Shri Hangal Kumareshwara Hospital and Nijalingappa Medical College, Bagalkot, Karnataka, India, from January 2020 to June 2021. Ethical committee clearance was obtained from the institution (IEC approval number: SNMC/IECHSR/2019-20/A-18/1.2), and informed consent was obtained from the participants.

Inclusion criteria: Patients of both genders, aged 18 to 60 years, presenting with right iliac fossa pain were included in the study.

Exclusion criteria: Patients with a right iliac fossa mass, pregnant women, and those with a previous history of urolithiasis or pelvic inflammatory disease were excluded.

Sample size calculation: According to the study conducted by Singh A et al., the diagnostic accuracy of the RIPASA scoring system was reported as 90.5% [2]. Therefore, with a 95% confidence level and 80% power of the study, the sample size was determined to be 90.

Procedure

Data were collected from patients admitted with pain in the appendicular area and meeting the inclusion criteria. Detailed history was obtained, and a thorough clinical examination was conducted. Appropriate investigations were performed, and the RIPASA score was calculated [Table/Fig-1] [9]. Appendicectomy was performed based solely on clinical judgment, taking into consideration the RIPASA score. The resected appendix was subjected to histopathological examination.

RIPASA scoring system	Score	n	Percent
Gender			
Female	0.5	46	51.1
Male	1	44	48.9
Age (years)			
Age ≤39.9	1	68	75.6
Age >39.9	0.5	22	24.4
Symptoms			
Right iliac fossa pain	0.5	90	100
Pain migrating to RIF	0.5	15	16.7
Anorexia	1	70	87.9
Nausea and vomiting	1	85	94.4
Duration of symptoms <48 hours	1	39	43.3
Duration of symptoms >48 hours	0.5	51	56.7
Signs			
RIF tenderness	1	90	100
Guarding	2	33	36.7
Rebound tenderness	1	9	10
Rovsing's sign	2	11	12.2
Fever >37ºC	1	70	77.8
Investigations			
Raised WBC	1	49	54.4
Negative urinalysis	1	90	100
Additional scores			
Foreign NRIC	1	0	0

[Table/Fig-1]: †RIPASA scoring parameters of the present study (N=90).
(NRIC: National registration identity card)

STATISTICAL ANALYSIS

Categorical data were represented using frequency and percentage. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated to test the validity of the tool. An ROC curve was plotted to assess the area under the curve. A p-value of <0.05 was considered significant. IBM SPSS Version 28.0 for windows was used for statistical analysis.

RESULTS

The age distribution showed a similar pattern in both sexes, with a peak incidence in the third decade and a mean age of 39.9 ± 6.8 years [Table/Fig-2].

Age in years	Male	Female	Total
10-20	7	8	15
21-30	8	4	12
31-40	18	23	41
41-50	10	8	18
>50	1	3	4
Total	44	46	90

[Table/Fig-2]: Age-wise and gender-wise distribution of subjects.

The negative appendicectomy rate in the present study was 3%. Although these three cases exhibited symptoms and some gross features of appendicitis, microscopic examination could not confirm the diagnosis. Among the 87 (97%) cases that showed a positive result for appendicitis, 46 (51.1%) were diagnosed as acute appendicitis [Table/Fig-3].

HPE reports for appendectomy	No. of cases	Percent
Acute appendicitis	46	51.1
Chronic	4	4.4
Subacute	28	31.1
Recurrent	9	10.0
Na	3	3.3
Total	90	100.0

[Table/Fig-3]: Histopathology (HPE: Histopathological examination).

Histopathological findings of the resected appendix revealed areas of hyperemia, congestion, and inflammation with an average increase in diameter of up to 1 cm. Some cases showed pockets of abscess in the mesoappendix and periappendiceal areas in recurrent cases. In chronic cases, few showed gangrenous necrosis.

The sensitivity and specificity of the scoring system were 82% and 100%, respectively, and the PPV and NPV were 100% and 16%, respectively [Table/Fig-4,5].

Validity of RIPASA compared to HPE	
Sensitivity	82%
Specificity	100%
PPV	100%
NPV	16%
Diagnostic accuracy	82%
AUC	0.908

[Table/Fig-4]: Validity of RIPASA scoring system.

DISCUSSION

Acute appendicitis is a significant surgical emergency worldwide and is often misdiagnosed among all abdominal emergencies. Prompt intervention is required for acute appendicitis [2]. The most characteristic and common symptom is pain that ranges from the umbilical area to the right iliac fossa. Additional symptoms may include fever, abdominal pain, guarding, and anorexia [17]. Approximately 50% of acute appendicitis cases present with imprecise and uncommon symptoms, which hinders accurate diagnosis, even in the modern era [18]. According to a study by Singh TB et al.,
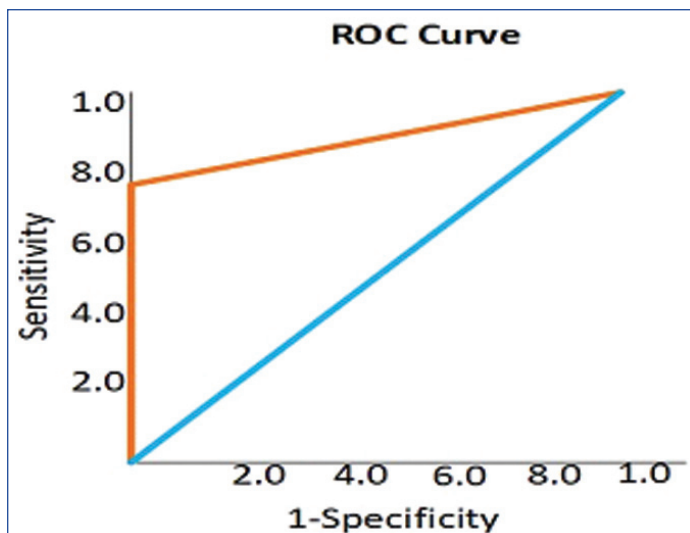
[Table/Fig-5]: Receiver operating characteristic curve for RIPASA score.

appendicitis affects both sexes with a male preponderance and most commonly occurs in the second and third decades of life [19]. Mumtaz H et al., found a sensitivity of 88% and specificity of 67% for the RIPASA score compared to the Alvarado score, which had a specificity of 23% and sensitivity of 59% in the Asian population [20]. Many studies have compared the RIPASA score to the Alvarado score [8,9,13,16,19,21,22]. However, this study did not compare the RIPASA score to the Alvarado score; instead, the authors assessed the diagnostic accuracy of the RIPASA score and compared it to histopathology.

Another study by Karami MY et al., showed that the sensitivity and specificity of the RIPASA scoring system were higher than those of the Alvarado system, i.e., 93.18% and 91.67% compared to 78.4% and 100%, respectively [21]. Nanjundaiah N et al., also demonstrated that the sensitivity of the RIPASA scoring system was higher than that of the Alvarado scoring system for the diagnosis of acute appendicitis, i.e., 96.2% and 58.9%, respectively [22]. According to Karapolat B, the RIPASA scoring system can accurately diagnose acute appendicitis, including the pathological stage, without the use of computed tomography [23]. Bhatnagar SP and Chavan S proved that RIPASA is more efficient [24]. Even in the present study, ultrasonography did not play a significant role.

The diagnostic accuracy of RIPASA for acute appendicitis was 93.18% according to a study conducted by Barman MK et al., [25]. In a study by Singh A et al., the RIPASA sensitivity was 95.89% and specificity was 75.92%, with a diagnostic accuracy of 90.5% [2]. The positive predictive value (PPV) was 91.50% and negative predictive value (NPV) was 87.23%. The mean duration of hospital stay was 4.7 days, and the negative appendectomy rate was 12.35% (22 total cases). According to the RIPASA scoring system, the expected rate of negative appendectomy was 8.5%, resulting in a reduction of the negative appendectomy rate by 3.85%. The study concluded that in an Indian scenario where the majority of the population is rural and middle-class, the RIPASA score is an easy, better, safe, and non-invasive diagnostic tool for acute appendicitis, considering availability and affordability, thereby reducing healthcare costs [2]. Due to the same geographic location, the present study was compared with study by Singh A et al., [2]. Apart from the NPV, the authors obtained very good results and reached the same conclusion.

Validating RIPASA by comparing it with histopathological examination, the authors found a sensitivity of 82%, specificity of 100%, PPV of 100%, and NPV of 16%, with a diagnostic accuracy of 82%. A ROC curve was also plotted, showing an area under the curve of 0.908. According to the study conducted by Chong CF et al., the negative appendectomy rate was 6.9% with a p-value of 0.0007. The cut-off threshold score from the

ROC curve was 7.5, with a sensitivity of 88%, specificity of 67%, PPV of 93%, and NPV of 53% [11].

According to the study conducted by Pasumarthi V and Madhu CP, the diagnostic accuracy of the RIPASA score was 73.28%, with a difference of 16.38% compared to the Alvarado scoring system. Both the RIPASA and Alvarado scores had a significant area under the curve (AUC). Out of 116 patients, 17.2% were diagnosed with negative appendicitis and 82.8% were positive for appendicitis. There was a 7% difference between ultrasonography and histopathology, but it was not considered significant [26]. In comparison, the present study showed an AUC of 0.908. After appendicectomy, 87 (97%) cases showed a positive result for appendicitis, with 46 (51.1%) being diagnosed as acute appendicitis. The negative appendicectomy rate in the present study was 3%. The RIPASA scoring system demonstrated an accurate diagnosis of acute appendicitis, including the pathological stage [Table/Fig-6].

Study	Sample size	Location	Year	Histopathology
Shobha C et al., (present study)	90	Bagalkot, Karnataka, India.	January 2020 to June 2021	AA-46, chronic-4, subacute-28, Recurrent-9, negative-3
Singh A et al., [2]	200	Ajmer, Rajasthan, India	Dec 2014 to Jan 2017	Total:200 patients, True positive:140,false positive:13 both categories had RIPASA >7.5. True negative:19, negative appendectomy rate12.35% (22cases),appendicular Perforation:4,wound sepsis: 6 patient.
Karami MY et al., [21]	100	Nemazee Hospital, Shiraz, Iran.	Nov 2014 to Jan 2017	88% were positive for appendicitis on the HPR.
Bhatnagar SP andChavan S [24]	100	Dr. DYPatil Medical College, Pune, Maharashtra, India	2017	Normal appendix-1, Acute appendicitis-77, Suppurative appendicitis-12, Perforated appendix-7, Gangrenous-3
Pasumarthi V and Madhu CP [26]	116	JSS Medical College, Mysore, Karnataka, India.	2017-2018	Confirmed Appendicitis with diagnostic RIPASA score; cases-72,62.1%, mean-9.55, SD-260.

[Table/Fig-6]: Comparison of the findings of present study with published studies [2,21,24,26, Present study].

Limitation(s)

Histopathological examinations were conducted by different pathologists, leading to inter-observer differences in the severity of inflammation. There may also have been a delay in the examination process from excision to examination time. The sample size was small, the study duration was short, and the NPV was low at only 16%.

CONCLUSION(S)

The RIPASA scoring system is a simple and accurate tool for diagnosing acute appendicitis. It includes easily available and non-invasive parameters, reducing the need for costly radiological investigations and unnecessary economic burden. The score is effective in reducing negative appendectomies and enabling faster diagnosis of acute appendicitis.

REFERENCES

[1] Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol. 1990;132(5):910-25.
[2] Singh A, Parihar US, Kumawat G, Samota R, Choudhary R. To determine Validation of RIPASA Score indiagnosis of suspected acute appendicitis and histopathological correlation with applicability to Indianpopulation: A single institute study. Indian J Surg. 2018;80(2):113-17.
[3] Obsa MS, Adema BG, Shanka GM, Lake EA, Azeze GA, Fite RO. Prevalence of acute appendicitis among patient admitted for acute abdomen in Ethiopia: Systematic review and meta-analysis. International Journal of Surgery Open. 2020;26:154-60.

[4] Gul SI, Laharwal AR, Wani AA, Rashid A. Comparison of Classical Open Appendectomy, Small Incision Appendectomy, and Laparoscopic Appendectomy in Children with Uncomplicated Acute Appendicitis. International Journal of Contemporary Surgery. 2020;8(1):36-39. DOI: https://doi.org/10.37506/ijocs.v8i1.1296.

[5] Sadler TW, Lang man. Lang man's Medical Embryology. 9th ed. Lippincott Williams and Wilkins publications; 2004.

[6] Susan Stand ring. Gray's Anatomy. 39th ed. London; 2005:Pp. 1189-90.

[7] Luckman R, Davis P. The epidemiology of acute appendicitis in California. Epidemiology. 1991;2(5):323-30.

[8] Bhondave ST, Anchawale A, Dash N. Study of comparison between Alvarado scoring system and RIPASA scoring system in clinical diagnosis of acute appendicitis. Journal of Medical Science and Clinical Research. 2020;08(02). Doi: https://dx.doi.org/10.18535/jmscr/v8i2.69.

[9] Damburacı N, Sevinç B, Güner M, Karahan Ö. Comparison of Raja Isteri Pengiran Anak Saleha Appendicitis and Modified Alvarado scoring systems in the diagnosis of acute appendicitis. ANZ J Surg. 2020;90(4):521-24.

[10] Anwer M, Ahmed S, Rehman MF. Evaluation of RIPASA scoring system for diagnosis of acute appendicitis. The Professional Medical Journal. 2020;27(08):1541-45.

[11] Chong CF, Adi MIW, Thien A, Suyoi A, Mackie AJ, Tin AS, et al. Development of the RIPASA score: a new appendicitis scoring system for the diagnosis of acute appendicitis. Singapore Med J. 2010;51(3):220-25.

[12] Mantoglu B, Gonullu E, Akdeniz Y, Yigit M, Firat N, Akin E, et al. Which appendicitis scoring system is most suitable for pregnant patients? A comparison of nine different systems. World Journal of Emergency Surgery. 2020;15(1):34.

[13] Frountzas M, Stergios K, Kopsini D, Schizas D, Kontzoglou K, Toutouzas K. Alvarado or RIPASA score for diagnosis of acute appendicitis? A meta-analysis of randomized trials. Int J Surg. 2018;56:307-14. Doi: 10.1016/j.ijsu.2018.07.003. Epub 2018 Jul 12.

[14] Mundada AV, Lamture Y, Yeola M. Scoring systems in acute appendicitis- a review. Journal of Evolution of Medical and Dental Sciences. 2020;9(51):3881-86.

[15] Saleem ZG, Alkawaz HS. Evaluation of the Ohmann Scoring System in the diagnosis of acute appendicitis in Al-Yarmouk Teaching Hospital. Indian Journal of Forensic Medicine & Toxicology. 2021;15(3):4588-93.

[16] 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. PMID: 32259117; PMCID: PMC7130437.

[17] Shuaib A, Shuaib A, Fakhra Z, Marafi B, Alsharaf K, Behbehani A. Evaluation of modified Alvarado scoring system and RIPASA scoring system as diagnostic tools of acute appendicitis. World Journal of Emergency Medicine. 2017;8(4):276-80.

[18] Stringer MD. Acute appendicitis. Journal of Paediatrics and Child Health [Internet]. 2017;53(11):1071-76. Available from: https://pubmed.ncbi.nlm.nih.gov/29044790/.

[19] Singh TB, Ratan R. Acute appendicitis: epidemiological trends and seasonal variation in subset of South western part of India. International Journal of Scientific Research. 2018;7(9). https://www.worldwidejournals.com/international-journal-of-scientific-research-(IJSR)/article/acute-appendicitis-epidemiological-trends-and-seasonal-variation-in-subset-of-south-western-part-of-india/MTY5NzQ=/?is=1&b1=905&k=227.

[20] Mumtaz H, Sree GS, Vakkalagadda NP, Anne KK, Jabeen S, Mehmood Q, et al. The RIPASA scoring system: A new era in appendicitis diagnosis. Annals of Medicine and Surgery. 2022;80(8):104174.

[21] 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. Annals of Coloproctology. 2017;33(6):227-31.

[22] Nanjundaiah N, Ashfaque M, Shanbhag V, Ashfaque K, Priya SA. A comparative study of RIPASA Score and ALVARADO Score in the diagnosis of acute appendicitis. J Clin Diagn Res. 2014;8(11):NC03-NC05.

[23] Karapolat B. Can RIPASA Scoring System Predict the Pathological Stage of Acute Appendicitis? Emerg Med Int. 2019;2019:8140839.

[24] Bhatnagar SP, Chavan S. Evaluation of RIPASA score in the diagnosis of acute appendicitis. International Surgery Journal. 2017;5(1):193.

[25] Barman MK, Das K, Mukherjee K. Use of RIPASA Score in the diagnosis of acute appendicitis: A pilot study from West Bengal, India. Journal of Medical Science and Clinical Research. 2019;7(7). Doi: https://dx.doi.org/10.18535/jmscr/v7i7.26.

[26] Pasumarthi V, Madhu CP. A comparative study of RIPASA score and ALVARADO score in the diagnosis of acute appendicitis. International Surgery Journal. 2018;5(3):796-801.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of General Surgery, Nijalingappa Medical College and Kumareshwara Hospital, Navnagar, Bagalkot, Karnataka, India.
2. Senior Resident, Department of General Surgery, Nijalingappa Medical College and Kumareshwara Hospital, Navnagar, Bagalkot, Karnataka, India.
3. Professor, Department of General Surgery, Nijalingappa Medical College and Kumareshwara Hospital, Navnagar, Bagalkot, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
C Shobha,
Mch Doctors New Quarters, Government District Hospital, Navnagar, Bagalkot-587103, Karnataka, India.
E-mail: drshobhacnaik@gmail.com

AUTHOR DECLARATION:
• Financial or Other Competing Interests: None
• Was Ethics Committee Approval obtained for this study?   Yes
• Was informed consent obtained from the subjects involved in the study?   Yes
• For any images presented appropriate consent has been obtained from the subjects.   NA