

# To Evaluate The Diagnostic Accuracy of Acute Appendicitis Using Combination of Modified RIPASA Scoring System and Ultrasonography: A Prospective Analytical Study

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## Abstract

**Background:** Acute appendicitis is one of the most common cause of acute abdomen for which a prompt diagnosis and treatment is required to decrease morbidity and mortality. Routine history and clinical examination both remain the most effective and practical diagnostic modalities.

**Material and Methods:** A prospective study conducted during the period of October 2017 up to October 2019 on symptomatic patients presented with complaints of right iliac fossa pain. Clinical history with clinical examination, and radiological record of patient had been taken according to the proforma attached. Diagnosis was confirmed by postoperative histopathological examination reports. We compared combined modified RIPASA score and Ultrasound with Histopathological reports.

**Result:** Sensitivity, specificity and diagnostic accuracy of modified RIPASA score was 89.5%, 60% and 88% respectively. Sensitivity, specificity and diagnostic accuracy of USG was 70.5%, 60% and 70% respectively. On combining modified RIPASA score with USG, Sensitivity, specificity and diagnostic accuracy were 97.8%, 60% and 95% respectively. It is noted that by adding USG with modified RIPASA score sensitivity and diagnostic accuracy is increased and negative appendectomy is reduced to 5%.

**Conclusion:** On adding USG with modified RIPASA score there is increase in sensitivity and diagnostic

accuracy. So modified RIPASA score with USG can be used in patient with RIF pain for making diagnosis of acute appendicitis.

**Keywords:** Right iliac fossa pain; Acute appendicitis; Modified RIPASA score; USG.

## Introduction

Acute appendicitis is a common cause of abdominal pain for which a prompt diagnosis and treatment leads to a tremendous decrease in morbidity and mortality of the patient. History taking and general physical examination both remain the most effective and practical diagnostic modalities.<sup>1</sup> Acute appendicitis is associated with raised total leucocyte count (TLC) which is raised in other inflammatory conditions also and making its role only supportive in the diagnosis of acute appendicitis.<sup>2</sup>

Ultrasonography (USG) is an operator-dependent modality and often misses or over-diagnoses the condition.<sup>3</sup> Contrast-enhanced computed tomography (CECT) scan is the investigation of choice with high sensitivity and specificity for diagnosis but is expensive and not available at all centers particularly in developing countries like India.<sup>4,5,6</sup> Recent reports suggest that the indiscriminate use of CT scans may lead to detection of low-grade appendicitis that would otherwise have resolved spontaneously.<sup>7,8,9</sup>

For a long time, there has been a need of some scoring system with good sensitivity and specificity that can diagnose acute appendicitis and

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decrease the burden of negative appendectomy on exploration, so that morbidity and mortality rates could be reduced among patients. One of the most common and widely used scoring systems is Alvarado (MANTRELS) system which is based on clinical and laboratory evidence of acute appendicitis.<sup>10</sup> It includes pain, migration to right iliac fossa (RIF) anorexia, nausea and vomiting, tenderness, rebound tenderness, fever, leukocytosis and shift of white blood cells (WBC) to the left.<sup>10,11</sup> The reported sensitivity and specificity for the Alvarado and the modified Alvarado scores range from 53%–88% and 75%–80%, respectively.<sup>12,13</sup> However, these scoring systems were developed in western countries, and several studies have reported very low sensitivity and specificity when these scores are applied to a population with a completely different ethnic origin and diet.<sup>14,15</sup>

In 2010 a new scoring system was developed at Department of Surgery, Raja Isteri Pengiran Anak Saleha (RIPAS) Hospital, Brunei Darussalam and named after hospitals name, with calculated sensitivity and specificity of 88.46% (95% confidence interval 83.94%–92.08%) and 66.67% (95% Confidence interval 52.08%–79.24%), respectively.<sup>16</sup>

Hence, this study is designed to evaluate the use of modified RIPASA score along with ultrasonography to diagnose acute appendicitis in preoperative period. The accuracy of the scoring system will be evaluated by operative findings and a postoperative histopathological examination (HPE).

## Methodology

For the study, we had followed 100 patients who presented with complaints of right iliac fossa pain with history and clinical examination, and radiological record of patient had been taken according to the proforma attached. A note was taken of intraoperative finding in every case.

The diagnosis was confirmed by postoperative histopathological examination reports. We compared combined modified RIPASA score and Ultrasound with Histopathological reports and accuracy of modified RIPASA score with ultrasonography was evaluated in the diagnosis of acute appendicitis. Statistical analysis was done by the SPSS.

*Type and Duration of Study:* The study was a prospective analysis of symptomatic patients presented with pain abdomen in the right iliac fossa. All cases treated since October 2017 up to October

2019 and qualifying the criteria were included in the study.

*Sample size and study population:* 100 cases were included in the study, with a minimum follow up of 3 months.

*Data collection tools and techniques:* Data were collected on clinical, radiological, and histopathological and follow up the examination according to the proforma attached. Findings were tabulated and analysed.

### Inclusion criteria

1. Age of patient 10–60 years of either sex.
2. All Patients of suspected acute appendicitis.

### Exclusion criteria

1. Patients of blunt trauma abdomen with right iliac fossa pain.
2. Patients with a history of appendectomy.
3. Patient with an appendicular lump.
4. Patient with perforated appendicitis.
5. Patient with a definite alternate radiological diagnosis.

## Results

In the present study, 100 patients were taken ranging from 10–60 years of age in which age group of 20–30 years have the maximum number of patients (48%) followed by 10–20 years age group (25%) and age group of 40–60 years had only 15% of total patients. (Table 1).

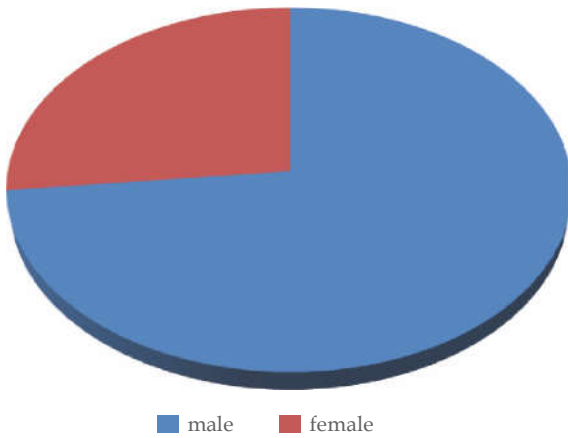
**Table 1:** Age Distribution.

Age Groups	Number of patients	Percentage (%)
10 – 20 yrs	25	25
21 – 30 yrs	48	48
31 – 40 yrs	12	12
41 – 50 yrs	11	11
50–60 yrs	4	4
Total	100	100

From the above comparison it can be concluded that present study was well correlated with above mentioned studies. In present study 85% of patients were of less than 40 years of age and 15% of patients were of more than 40 years of age (Table 2 and Table 3) which also agrees with the study conducted by Chong et al.<sup>16</sup>

**Table 2:** Comparison of mean age in acute appendicitis.

Study	Present study	Osama et al. <sup>17</sup>	Dey et al. <sup>18</sup>	Chong et al. <sup>16</sup>
Mean age (yr)	28.8±11.32	25±12.5	25.8	26.0±13.5



**Fig. 1:** Sex Distribution.

**Table 3:** comparison of age group in acute appendicitis.

Study	Less than 40 years of age	More than 40 years of age
Present study	85%	15%
Chong et al. <sup>16</sup>	84.3%	15.7%

Present study was compared with above mentioned studies and was found well correlated. It was concluded that incidence of acute appendicitis is more common in male than female (Table 4).

**Table 4:** Comparison of Sex distribution in different studies.

Gender	Present study	Chong et al. <sup>16</sup>	Osama et al. <sup>17</sup>	Dey al. <sup>18</sup>
Male	63%	57.69%	73%	53.5%
Female	37%	42.31%	27%	46.5%

In the present study, 63 out of 100 patients (63%) were male and rest 37 patients (37%) were female. (Fig. 1).

Incidence of right iliac fossa pain, migration of pain, nausea and vomiting, anorexia, right iliac fossa tenderness, guarding, rebound tenderness, Rovsing's sign, fever, leucocytosis and negative Urine analysis shown in Table 5.

**Table 5:** Incidence of Signs and symptoms.

Signs and Symptoms	Number of patients
<b>Right iliac fossa pain</b>	
No/Yes	0/100
<b>Migration of pain to Right Iliac fossa</b>	
No/ Yes	69/31
<b>Nausea and vomiting</b>	
No/ Yes	30/70
<b>Anorexia</b>	
No/ Yes	72/24
<b>Right iliac fossa tenderness</b>	
No/ Yes	6/94

<b>Guarding</b>	
No/ Yes	76/24
<b>Rebound tenderness</b>	
No/ Yes	32/68
<b>Rovsing's sign</b>	
No/ Yes	47/53
<b>Fever</b>	
No/ Yes	44/56
<b>Leucocytosis</b>	
No/ Yes	33/67
<b>Negative Urine analysis</b>	
No/ Yes	55/45

In the present study symptom like right iliac fossa pain was present in all cases of acute appendicitis (100%). Other symptoms such as migration of pain to the right iliac fossa was present in 31 out of 100 patients of acute appendicitis, anorexia in 24 cases (24%), nausea and vomiting in 70 cases (70%), fever in 56 cases (56%). Only symptom that came out to be statistically significant was nausea, vomiting and anorexia.

**Table 6:** Duration of symptoms.

Duration of symptoms	Number of patients
<48 hrs	44
>48 hrs	56
Total	100

56 % of all patients in this study presented with duration of more than 48 hours while rest 44% patients presented within 48 hours of symptoms (Table 6). In the present study all 100 patients are divided in two groups on the basis of duration of symptom, one group presented within 48 hours of the onset of symptom and other group presented after 48 hours of onset of symptoms. It had a role in calculating score as patient presented within 48 hours had been given 1 point and patients presented after 48 hours had been given 0.5 point. 44 out of 100 patients (44%) were presented within 48 hours of onset of symptoms while 56 of 100 patients presented beyond 48 hours of onset. More patients presented delayed may be due to the reason that our centre is a tertiary care centre and patients came here after visiting local practitioner and nursing homes.

In our study 87 patients (87%) were having score  $\geq 7.5$  and 13 patients (13%) were having score  $< 7.5$ . Out of 87 patients who were having score  $\geq 7.5$ , 85 patients were found to be positive on histopathological examination and 2 patients were negative on HPE (Table 7). Out of 13 patients who were having score  $< 7.5$ , 10 patients were positive on histopathology and 3 patients were negative on histopathology. Modified RIPASA score was having

sensitivity, specificity, PPV, NPV and accuracy of 89.5%, 60%, 97.7%, 23.07% and 88% respectively.

**Table 7:** Correlation of Modified RIPASA Score with Histopathology Findings.

Modified RIPASA Score	Histopathology Findings			
	Positive	%	Negative	%
≥7.5	True Positive 85	89.5	False Positive 2	40
<7.5	False negative 10	10.5	True Negative 3	60
Total	95	100	5	100

89.5% patients who were positive on histopathology had modified RIPASA SCORE ≥7.5 and 10.5% who were positive for acute appendicitis on histopathology had modified RIPASA score <7.5 (Table 9). 40% of patients with negative histopathology had modified RIPASA score ≥ 7.5. 60% of Patients with histopathology negative had score < 7.5. It shows significant correlation between modified RIPASA score and HPE of acute appendicitis.

**Table 8:** Diagnostic Accuracy of Modified RIPASA Score.

Study	Percentage (%)
Sensitivity	89.5
Specificity	60
PPV	97.7
NPV	23.07
Accuracy	88

According to our study Modified RIPASA score has sensitivity, specificity, PPV, NPV and accuracy of 89.5%, 60%, 97.7%, 23.07% and 88% respectively (Table 8).

**Table 9:** Comparison of RIPASA Score in different study.

Study	Present study Threshold score 7.5	Chong et al. <sup>16</sup> Threshold score 7.5	Osama et al. <sup>17</sup> Threshold score 7.0
Sensitivity	89.5%	88.46%	100%
Specificity	60%	66.67%	97%
Accuracy	88%	80.5%	98%

**Table 10:** Ultra sound abdomen is done in all patients included in this study and 72% of patients were positive on ultrasound.

USG	Number of patients
Positive	72
Negative	28
Total	100

In present study ultrasound is performed in all 100 patients, out of which, Ultrasonography was suggestive of acute appendicitis in 72 (72%) of total patients (Table 10). On comparing with histopathology sensitivity, specificity and accuracy of Ultrasonography was found to be 70.5%, 60% and 70.0% respectively.

**Table 11:** Correlation of Ultrasonography with Histopathology Findings.

USG	Histopathology Findings			
	Positive	%	Negative	%
Positive	True positive 70	73.7	False positive 2	40
Negative	False negative 25	26.3	True Negative 3	60
Total	95	100	5	100

In our study, among histopathologically positive patients, 73.7% were true positive on ultrasound and 26.3% were false negative on ultrasound. Among 5 patients who were negative on histopathological examination, 40% were false positive on ultrasound and 60% were true negative ultrasound (Table 11).

**Table 12:** Diagnostic accuracy of Ultrasonography with Histopathology Findings.

Study	Percentage (%)
Sensitivity	70.5
Specificity	60
PPV	97.1
NPV	9.6
Accuracy	70.0

In our study, ultrasound has sensitivity, specificity, PPV, NPV and accuracy of 70.5%, 60%, 97.1%, 9.6% and 70% respectively (Table 12).

**Table 13:** Comparison of USG in different studies.

Study	Present study	Wade et al. <sup>21</sup>	John et al. <sup>22</sup>
Sensitivity	70.5%	74 %	78%
Specificity	60%	58 %	73%
Accuracy	70%	76 %	76%

Present study is correlated with study conducted by John et al.<sup>22</sup> and Wade et al.<sup>21</sup> which are consistent with the study (Table 13).

**Table 14:** Histopathology.

Histopathology	Number of patients
Positive	95
Negative	5
Total	100

Histopathology is the gold standard for diagnosis in our study and 95 out of 100 (95%) patients were found to be positive on histopathological examination (Table 14).

In the present study modified RIPASA SCORE is calculated and ultrasound was done in all the 100 patients before taking up for appendectomy. After surgery specimen was sent for histopathology and HPE report were correlated with Modified RIPASA score and ultrasound finding.

It was found that 95 out of 100 patients were positive for acute appendicitis on HPE and only 5(5%) patient was negative on HPE. So Negative

appendectomy rate in our study was found to be 5% which was comparable to the study conducted by Nautiyal et al.<sup>23</sup> and Osama Khalil et al.<sup>17</sup> (Table 15).

**Table 15:** Comparison of negative appendectomy in different studies.

Study	Present study	Nautiyal et al. <sup>23</sup>	Osamaetal. <sup>17</sup>
Negative Appendectomy	5%	8.11%	3%

On combining Modified RIPASA score and ultrasound, 97.8% were found true positive and 2.1% patient was false negative in all 95 who were positive on HPE. In 5 patients who were negative on HPE, 60 % were true negative on modified RIPASA+USG and 40% patients were false positive on modified RIPASA+USG (Table 16). In our study it was found that on combining Modified RIPASA score with USG had statistically significant correlation with HPE of acute appendicitis.

**Table 16:** Correlation of Combined (Modified RIPASA Ultrasonography) with Histopathology Findings.

Combined (Modified RIPASA + USG)	Histopathology Findings			
	Positive	%	Negative	%
Positive	True Positive 93	97.8%	False Positive 2	40
Negative	False negative 2	2.1%	True Negative 3	60
Total	95	100%	5	100

In our study Modified RIPASA with USG has sensitivity, specificity, PPV, NPV and accuracy of 97.8%, 60%, 97.8%, 60% and 95% respectively (Table 17).

In the present study, we try to demonstrate to increase the diagnostic accuracy in acute appendicitis by combining modified RIPASA score and USG while maintaining timely and accurate diagnosis and treatment of acute appendicitis.

**Table 17:** Diagnostic Accuracy of Combined (Modified RIPASA + USG ) with Histopathology Findings.

Sensitivity	97.8%
Specificity	60%
PPV	97.8%
NPV	60%
Accuracy	95%

From above data comparison we conclude that on combining USG with modified RIPASA score diagnostic accuracy and sensitivity of acute appendicitis was increased while specificity remains same. We believe that patients with modified RIPASA score < 7.5 should be either followed up or further investigation for alternate

diagnosis should be considered (Table 18). Patients with score  $\geq 7.5$  were highly suspicious of having acute appendicitis and surgical decision depends on experience of surgeon.

**Table 18:** Comparison of Modified RIPASA Score, USG and Combined (Modified RIPASA + USG).

Present study	Modified RIPASA score	USG	Combined modified RIPASA score and USG
Sensitivity	89.5%	70.5%	97.8%
Specificity	60%	60.0%	60%
Accuracy	88%	70.0%	95%

## Discussion

Acute appendicitis is one of the most common surgical emergencies encountered in the world particularly in the age group of less than 30 years. Good clinical assessment of surgeon is considered to be the most important factor in the diagnosis of acute appendicitis. Several other conditions can mimic this clinical condition. Only CECT can diagnose the condition with very high sensitivity and specificity but it is not feasible to have this investigation done for each and every patient suspected to be appendicitis, particularly in countries with limited resources like India. From the above comparison, it can be concluded that the present study was well correlated with above-mentioned studies. In the present study, 85% of patients were of less than 40 years of age and 15% of patients were of more than 40 years of age (Table 2 and Table 3) which also agrees with the study conducted by Chong et al.<sup>16</sup>

In a study by Korneret al.<sup>19</sup> nausea and vomiting and pain migration to RIF were the two symptoms that were statistically significant. The present study agreed with a study by Korneret al.<sup>19</sup> with respect to nausea and vomiting being statistically significant but did not find pain migration as statistically significant. The difference is probably due to the poor communication skills in uneducated and illiterate population coming to our hospital. In our study, a sign such as RIF tenderness was present in 94 out of 100 patients (94%). Guarding was present in only 24% of patients. Rebound tenderness was present in 68 out of 100 patients (68%). Rovsing's sign was positive in 53 out of 100 (53 %) patients. Leukocytosis was present in 67 of 100(67%) patients. Urine analysis was negative in 45 of 100 (45%) patients. These findings had been found consistent with the study by Wagner et al.<sup>20</sup>

Modified RIPASA score was having sensitivity, specificity, PPV, NPV and accuracy of 89.5%, 60%, 97.7%, 23.07% and 88% respectively. This

study agreed with the study by Chong et al.<sup>16</sup> had sensitivity, specificity, PPV, NPV and accuracy of 88.46%, 66.67%, 93%, 53% and 80.5% respectively. It was found that 95 out of 100 patients were positive for acute appendicitis on HPE and only 5(5%) patient was negative on HPE. So Negative appendectomy rate in our study was found to be 5% which was comparable to the study conducted by Nautiyalet al.<sup>23</sup> and Osama Khalil et al.<sup>17</sup> In RIPASA score study by Chong et. al.<sup>16</sup> They had taken 15 parameters and the scores generated were age (less than 40 years is 1 point; greater than 40 years is 0.5 point), gender (male is 1 point; female is 0.5 point), right iliac fossa (RIF) pain (0.5 point), migration of pain to RIF (0.5 point), nausea and vomiting (1 point), anorexia (1 point), duration of symptoms (less than 48 hours is 1 point; more than 48 hours (0.5 point), RIF tenderness (1 point), guarding (2 points), rebound tenderness (1 point), Rovsing's sign (2 points), fever (1 point), raised white cell count (1 point), negative urinalysis (1 point) and foreign national registration identity card (1 point). The maximum score was 16 and minimum score was 2. The optimal cut-off threshold score of 7.5.

## Conclusions

Modified RIPASA score is an important tool for the diagnosis of acute appendicitis with sensitivity, specificity, PPV, NPV and accuracy of 89.5%, 60%, 97.7%, 23.07% and 88% respectively.

Original cut off of 7.5. Among 95 patients with score  $\geq 7.5$ , 85 patients were positive on HPE and 2 patients were negative on HPE. Among 5 patients with score  $< 7.5$ , 2 were positive and 3 were negative on HPE.

Ultrasound is a good adjunct for diagnosis of acute appendicitis with sensitivity, specificity and diagnostic accuracy of 70.5%, 60%, and 70.0% respectively in our study.

By adding USG with Modified RIPASA score sensitivity and diagnostic accuracy is increased from 70.5% to 97.8% and Specificity decreased from 66.7% to 60%. Negative appendectomy reduced to 5% by adding USG with Modified RIPASA score in compared with 16.3% in RIPASA score study by Chong et al.<sup>16</sup>

Modified RIPASA score with USG can successfully diagnose acute appendicitis with less negative appendectomy rate and can be used in Asian population for diagnosing acute appendicitis.

There is a paucity of studies that compares

histopathological findings with score and USG findings, needs to be evaluated further by prospective studies.

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