

# Combined Use of High Resolution Ultrasonography and Ripasa Score in Acute Appendicitis with the Aim to Reduce Negative Appendicectomy Rate

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## ABSTRACT

**Introduction:** Acute appendicitis has an unpredictable course which varies from complete resolution to perforation within a small time period. It is the most common cause of surgical acute abdomen presenting to emergency department where it is challenging for the surgeon to take a call for conservative or surgical management. Unnecessary surgery, failed conservative management leading to further complications, post surgical complications necessitate accurate diagnosis and prognosis which require combination of imaging and clinical measures. This study aims to compare specificity, sensitivity, positive and negative predictive value of RIPASA and HRUSG in diagnosis of appendicitis that requires surgical intervention

**Materials and methods:** This is a prospective cross-sectional study with purposive sampling technique conducted among 150 patients suspected of acute appendicitis, referred for USG abdomen and underwent surgery for the same, in Father Muller Hospital. Clinical RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) score and HRUSG (high resolution ultrasonography) findings were noted and correlated with the histopathological findings.

**Results:** Out of 150 patients, 62% were justified with surgery while 38% underwent unnecessary surgery that could have been prevented using criteria of RIPASA  $\geq 11$ , Luminal diameter of  $\geq 7.9$  and degree of periappendiceal inflammation as per this study. Combination of HRUSG and RIPASA score has reduced the NAR (negative appendicectomy rate) from 39% on clinical alone and 7.4% on USG alone to 3.1%.

**Conclusion:** The addition of HRUSG to clinical assessment of acute appendicitis increases the sensitivity and specificity, reduces the false positive rate (NAR), assists surgical decision making in doubtful cases to prevent complications and morbidity. HRUSG is also needed to rule out complications like mass formation/abscess/perforation where outcome of surgery is poor.

**Key words:** Acute appendicitis, negative appendicectomy, RIPASA score, Ultrasonological criteria.

## INTRODUCTION

Acute appendicitis is defined as the transmural inflammation of appendix. It has an incidence of about 1 in 400 or 0.25% in South India.<sup>1</sup> Acute appendicitis along with its unpredictable course, can mimic or be mimicked by many acute abdominal illnesses. It is thus necessary to make an accurate diagnosis to prevent unnecessary surgery. Likewise timely surgery is very important as delay in decision can lead to highly morbid complications. NAR is defined as the rate of surgically removed appendix that are pathologically normal.<sup>2</sup> Overall, NAR of approximately 20%-30% is commonly reported which warrants a better clinical method and imaging correlation.<sup>2</sup> RIPASA score is a new clinical diagnostic scoring system developed for diagnosis of acute appendicitis with significantly higher sensitivity, specificity and diagnostic accuracy particularly in an Asian population compared to Alvarado and modified Alvarado method.<sup>3,4,5</sup> Of the various commonly used diagnostic aids for appendicitis, no single test can reduce the rate of negative appendicectomy to zero.

This study aims to compare specificity, sensitivity, positive and negative predictive value of RIPASA and HRUSG in diagnosis of appendicitis that requires surgical intervention. It also evaluates the combined role of HRUSG and RIPASA score in management of acute appendicitis to reduce the NAR.

## MATERIAL AND METHODS

This is a prospective cross-sectional study done at Father Muller Hospital with purposive sampling technique conducted among 150 patients suspected of acute appendicitis, referred for USG abdomen and underwent surgery for the same from June 2017 to December 2017. Written and informed consent was obtained from all patients prior to inclusion in the study. Inclusion criteria being all patients who had presented to emergency and surgery OPD with complaints of right iliac fossa pain. Exclusion criteria included those patients who were managed conservatively and did not undergo surgery,

those who presented with history of trauma and those with non visualisation of appendix on HRUSG.

The algorithm of RIPASA, HRUSG and HPE was made to decrease the NAR. It was focused on RIPASA score<sup>6</sup> and its interpretation, imaging findings and diagnosis, histopathological final diagnosis being the gold standard (TABLE 1). RIPASA score was calculated from demographic details, clinical symptoms, examination signs and investigations and divided into four categories of score <5, 5-7, 7.5-11 and >12.

Transabdominal ultrasound was performed using high frequency linear probe of 9MHz (Philips IU22 USG machine). Appendix was visualised using controlled bowel compression method and findings recorded under criteria<sup>7</sup> of luminal diameter (serosa – serosa in axial), periappendiceal inflammation (echogenic fat or bowel wall edema), presence of free fluid, appendicolith and lymphadenopathy (short axis >5mm).

All the post surgical appendicectomy specimens were sent for histopathological examination. Histopathological reports

were categorised as normal (reactive lymphoid hyperplasia), resolving, acute and suppurative appendicitis.

## STATISTICAL ANALYSIS

Data was analyzed by descriptive statistics using Statistical Package for Social Sciences (SPSS) 16.0 version. Chi-square test ( $\chi^2$ ), Fischer exact test were applied to determine the most accurate imaging factor for diagnosis with estimation of sensitivity, specificity and positive and negative predictive values. The assumed significance level was  $P < 0.05$ . Percentage frequency distribution was also used. ROC curve was applied to assess the cut off value of appendix luminal diameter and RIPASA score to acquire least NAR. McNemar test was used for paired data to establish differences in accuracies among various modalities.

## RESULTS

Out of 150 patients referred for HRUSG in view of acute appendicitis with their RIPASA score (maximum of 15), 38% (15% were normal and 23% were resolving appendicitis

| RIPASA SCORE   |                                 | SCORE | RIPASA SCORING                 | INTERPRETATION          |                |
|--|---------------------------------|-------|--------------------------------|-------------------------|----------------|
| PATIENT DEMOGRAPHICS   | FEMALE                          | 0.5   | < 5                            | UNLIKELY                |                |
|  | MALE                            | 1     |                                |                         |                |
|  | AGE < 39.9 YEARS                | 1     |                                |                         |                |
|  | AGE > 40 YEARS                  | 0.5   |                                |                         |                |
| SYMPTOMS   | RIF PAIN                        | 0.5   | > = 11                         | DIAGNOSTIC              |                |
|  | PAIN MIGRATION TO RIF           | 0.5   |                                |                         |                |
|  | ANOREXIA                        | 1     | B                              | HISTOPATHOLOGY CRITERIA | INTERPRETATION |
|  | NAUSEA AND VOMITING             | 1     |                                |                         |                |
|  | DURATION OF SYMPTOMS < 48 HOURS | 1     |                                |                         |                |
|  | DURATION OF SYMPTOMS > 48 HOURS | 0.5   |                                |                         |                |
|  | REACTIVE LYMPHOID HYPERPLASIA   |       |                                |                         |                |
| SIGNS  | TENDERNESS                      | 1     | RESOLVIONG APPENDIX            | CONSERVATIVE MANAGEMENT |                |
|  | GUARDING                        | 2     |                                |                         |                |
|  | REBOUND TENDERNESS              | 1     |                                |                         |                |
|  | ROVSING’S SIGN                  | 2     | ACUTE APPENDICITIS             | SURGERY                 |                |
|  | FEVER > 37 DEGREES CELSIUS      | 1     |                                |                         |                |
| INVESTIGATIONS   | LEUCOCYTOSIS                    | 1     | ACUTE SUPPURATIVE APPENDICITIS | SURGERY                 |                |
|  | NEGATIVE URINE ANALYSIS         | 1     |                                |                         |                |
| A  |                                 | C     |                                |                         |                |
| Table-1: (a) – RIPASA score (b) – Its interpretation and (c) – Histopathological categories and interpretation |                                 |       |                                |                         |                |

**Table-1:** (a) – RIPASA score (b) – Its interpretation and (c) – Histopathological categories and interpretation

| Comparing parameter          | P Value | Significance |
|------------------------------|---------|--------------|
| Ripasa score                 | 0.000   | High         |
| Luminal diameter             | 0.000   | High         |
| Periappendiceal inflammation | 0.000   | High         |
| Free fluid                   | 0.024   | Yes          |
| Appendicolith                | 0.055   | No           |
| Complications on imaging     | 0.010   | Yes          |

**Table-2:** Illustrating p values on comparing each parameter with histopathology (gold standard)

| DIAGNOSTIC MODALITY | Sn(%) | Sp (%) | PPV (%) | NPV (%) | ACCURACY (%) | P VALUE | NAR(%) |
|---------------------|-------|--------|---------|---------|--------------|---------|--------|
| RIPASA              | 64.95 | 85.12  | 87.38   | 60.69   | 69.77        | 0.001   | 39.31  |
| HRUSG               | 94.74 | 100    | 100     | 92.58   | 96.84        | 0.000   | 7.42   |
| COMBINED            | 98.54 | 90.12  | 92.17   | 96.86   | 91.55        | 0.000   | 3.14   |

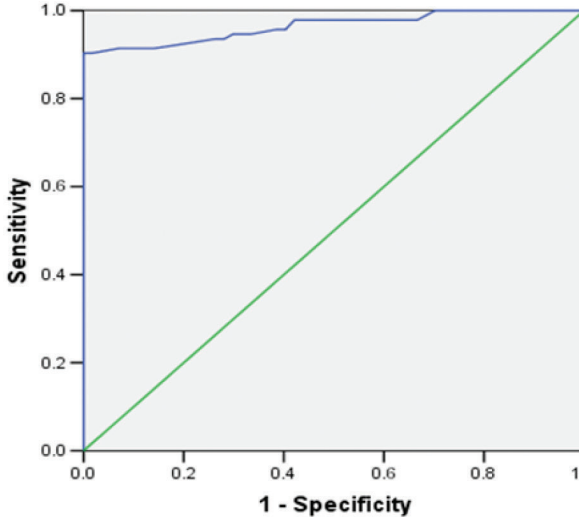
**A**

| MODALITIES                      | HPE ACUTE APPENDICITIS | HPE NORMAL | TOTAL |
|---------------------------------|------------------------|------------|-------|
| RIPASA $\geq 11$ + positive USG | 87                     | 15         | 102   |
| Negative USG + RIPSASA $< 11$   | 6                      | 42         | 48    |
| TOTAL                           | 93                     | 57         | 150   |

**B**

Sn – sensitivity; Sp - specificity; PPV – positive predictive value; NPV – negative predictive value

**TABLE-3:** (a)- Assessment of accuracy of each modality for final diagnosis with supporting raw data (b) as mentioned

| <b>A</b>                               |       |        | <b>B</b>  |  |
|--|-------|--------|---|--|
| POSITIVE IF $\geq$<br>LUMINAL DIAMETER | Sn    | 1 - Sp | ROC Curve   |  |
| 6.1000                                 | 0.978 | 0.456  |  <p>Diagonal segments are produced by ties.</p> |  |
| 6.2500                                 | 0.978 | 0.421  |   |  |
| 6.9000                                 | 0.935 | 0.263  |   |  |
| 7.0500                                 | 0.914 | 0.140  |   |  |
| 7.2000                                 | 0.914 | 0.105  |   |  |
| 7.4000                                 | 0.914 | 0.070  |   |  |
| 7.7000                                 | 0.903 | 0.018  |   |  |
| 7.9500                                 | 0.903 | 0.000  |   |  |
| 8.1000                                 | 0.720 | 0.000  |   |  |
| 8.5500                                 | 0.624 | 0.000  |   |  |
| 9.2500                                 | 0.452 | 0.000  |   |  |

Sn – sensitivity; Sp - specificity

**Table-4:** ROC curve analysis (a), (b) demonstrating 7.9mm as ideal cut off for luminal diameter.

on histopathology) underwent unnecessary surgery and the rest had a timely surgery. Clinical RIPASA cut off in our study was found to be 4.0 with 100% specificity and  $\geq 9.0$  to detect maximum number of positive cases. However HRUSG in such cases helps to rule out complications where surgery adds to deterioration or exclude other associated conditions like Crohn's disease.<sup>8</sup> Histopathologically, reactive and resolving appendix need not be removed surgically<sup>9</sup> and could have been managed conservatively. The most accurate imaging factor for diagnosis

is luminal diameter, which in this study was  $\geq 7.9$ mm. Highest specificity (100%) was seen with periappendiceal inflammation. In clinical ambiguity, luminal diameter of  $\leq 6$ mm with NPV of 96% to exclude acute appendicitis was also proved (TABLE 2). Increase in mean RIPASA scores showed correlation to histopathological severity. The NAR of RIPASA in our study was 39.3% which was lowered to only 3.1% with addition of HRUSG in algorithm and it also increased the specificity, sensitivity and diagnostic accuracy (TABLE 3). HRUSG not only diagnoses acute

appendicitis by itself (when luminal diameter of appendix is  $\geq 7.9\text{mm}$ ) but also helps in exclusion in clinically doubtful cases by demonstrating normal appendix.

On imaging, an appendix with anteroposterior diameter of 7mm and above (7.9mm being ideal) under compression is the most indicative finding for acute appendicitis with high sensitivity and specificity (TABLE 4).

## DISCUSSION

The routine protocol for evaluation of acute appendicitis should begin with RIPASA scoring, assessment of HRUSG findings, combination of clinic radiologic scoring to decide for the management by surgery or non surgical methods. This leads to the best outcome for the patient.

Clinical examination with RIPASA score  $\geq 12$ , when used alone, was able to diagnose acute appendicitis with 100% accuracy, confirmed by HPE but the rate of complications was high in this group.

In cases with RIPASA score 7-11.5, was the situation where HRUSG criteria when used as an adjunct for diagnosis of appendicitis could accurately diagnose 96.5% of cases that required timely surgery. These two modalities together had a high specificity (90%) and sensitivity (98.5%) and a high positive predictive value (92%).

A cross sectional diameter  $>7\text{mm}$ , was a reliable indicator for acute appendicitis according to our algorithm with a NAR of 3.1% and without increasing the rate of complications.

In a study by SacharSudhir et al<sup>10</sup>, the main USG features for diagnosing acute appendicitis were an incompressible appendix with a transverse outer diameter of  $>7\text{mm}$ . According to the study by Hasan Erdem et al<sup>11</sup>, 7mm luminal diameter of appendix with non compressibility and periappendiceal inflammation was the most accurate feature for diagnosis. They also concluded that RIPASA and USG in combination were able to diagnose 88% of the cases showing high diagnostic accuracy. In our study, similar results were obtained with the luminal diameter cut off value for acute appendicitis being 7mm and the diagnostic accuracy of clinicoradiological scoring being 91.5%.

Kessler et al<sup>12</sup>, in their study of evaluation US, Doppler US and Laboratory Findings in appendicitis concluded that the most accurate periappendiceal finding of appendicitis was the presence of inflammatory fat changes, with an NPV of 91% and a PPV of 76%. Our study proved similar results with high specificity of 100%.

A study by Mardan et al<sup>13</sup> assessing the role of USG in the management of acute appendicitis showed that the addition of ultrasonography in clinical assessment for acute appendicitis decreases the sensitivity but significantly increases the specificity of the protocol thereby reducing the false positive rate translating into decreased NAR. In the study by Subedi et al<sup>14</sup> who analyzed the NAR by combining RIPASA and HRUSG scoring system came out to be 1.2%. In our study, similar scoring system resulted in NAR of 3.1%. In the study by Chong et al<sup>15</sup>, the presence of appendicolith is a surgical indication irrespective of luminal diameter, however in our study presence of appendicolith was not as statistically significant as that of luminal diameter as a prerequisite criteria for surgery (TABLE 2).

In the study by Flum et al<sup>16</sup>, the HRUSG alone showed a NPV of 91% and a PPV of 76% in diagnosis of acute appendicitis. In our study, using HRUSG alone, the NPV was 92.5% and PPV of 100% in evaluation of acute appendicitis, thereby emphasizing the role of imaging.

### limitations

All suspected cases on HRUSG might not show appendix due to poor acoustic window or non co-operability of patient. HRUSG is an adjunct to clinical and laboratory findings in making decisions regarding surgical or medical management of the patient. Thus positive HRUSG only must not be a prerequisite for surgery due to false negative results.

### strengths of the study

This study has assessed the specificity, sensitivity, predictive values and accuracy of HRUSG and RIPASA score individually and in combination for diagnosis of acute appendicitis.

This study has used RIPASA scoring system rather than Alvarado or modified Alvarado score as RIPASA has higher diagnostic accuracy for acute appendicitis especially in Asian population.

## CONCLUSION

Combination of HRUSG and clinical RIPASA score in the management of acute appendicitis has a major role in reducing NAR to minimum, reducing complications and better patient outcome.

HRUSG has a diagnostic role as well as prognostic role in following up patients on conservative management to assess progression or resolution of disease. It also excludes other conditions as well as appendicitis itself by visualising a normal appearing appendix. It establishes the severity of the disease as well as existing complications like abscess or perforation or mass formation that hinder immediate surgical intervention and call for higher investigation.

## REFERENCES

1. Lohar H, Asger Calcuttawala M, Nirhale D, Athavale V, Malhotra M, Priyadarshi N. Epidemiological aspects of appendicitis in a rural setup. *Med J Dr DY Patil Vidyapeeth*. 2014;7(6):753-7.
2. Nautiyal H, Ahmad S, Keshwani NK, Awasthi DN. Combined use of modified Alvarado score and USG in decreasing negative appendectomy rate. *Indian J Surg*. 2010;72(1):46-52.
3. Chong CF, Adi MI, Thien A, et al. Development of the RIPASA score: a new appendicitis scoring system for the diagnosis of acute appendicitis. *Singapore Med J* 2010; 51(1):220-25.
4. Nanjundaiah N., Mohammed A., Shanbhag V., Ashfaque K., Priya S.A. A comparative study of RIPASA score and ALVARADO score in the diagnosis of acute appendicitis. *J Clin Diagn Res*. 2014;8(11):NC03-NC05.
5. A. Singla, S. Singla, M. Singh. A comparison between modified Alvarado score and RIPASA score in the diagnosis of acute appendicitis. *Updates Surg*. 2016; 68(2): 351-355
6. Karan M, Mukesh MK, Atul K, Vijay A, Atul J, Akshay



- P. Significance of Ripasa Scoring System in Diagnosis of Acute Appendicitis. 2015;3(1):4–10.
7. Brooke A, Jam A, Nghiem V. Pictorial Essay Sonographic Pitfalls of Acute Appendicitis: Am J Roentgenol. 1994;162(1):55–9.
  8. Batra, p, Kurhade, S, Rana, KVS, Singh, A, Zaveri, A, Pathak, J. Evaluation of Clinical algorithm in acute appendicitis with the aim to reduce the negative appendectomy rate. J Dent Med Sci. 2016;15(6):01–6.
  9. Cobben LP, de Van Otterloo AM, Puylaert JB. Spontaneously resolving appendicitis: frequency and natural history in 60 patients. Radiology. 2000;215(2):349–52.
  10. SacharSudhir, MaheshwariAlok, BalianSubhash, Goyal Sunder, SacharSaurabh, GoyalSnigdha. Comparative study Of ultrasonography (USG) Versus Computed Tomography (CT) In Clinically Suspected Cases Of Acute Appendicitis: Retrospective study Of 100 cases. Journal of Advance Researches in Biological Sciences. 2013;5(2) :191-198.
  11. Erdem H, Çetinkünar S, Daş K, Reyhan E, Değer C, Aziret M et al. Alvarado, Eskelinen, Ohlmann and Raja IsteriPengiranAnakSaleha Appendicitis scores for diagnosis of acute appendicitis. World J Gastroenterol. 2013;19(47):9057–62.
  12. Kessler N, Cyteval C, Gallix B, Lesnik A, Blayac P-M, Pujol J, et al. Appendicitis: Evaluation of Sensitivity, Specificity, and Predictive Values of US, Doppler US, and Laboratory Findings. 2004;230(2):472-8.
  13. Mardan MA, Mufti TS, Khattak IU, Chilkunda N, Alshayeb AA, Mohammad AM, urRehman Z. Role of ultrasound in acute appendicitis. J Ayub Med Coll Abbottabad. 2007;19(3):72-9.
  14. Subedi N, Dangol US, Adhikary MB, Pudasaini S, Baral R. Acute appendicitis: a 2year review of clinical presentation and histopathology. Journal of Pathology of Nepal. 2011; 1(2) :104 -107.
  15. Chong CF, Thien A, Mackie AJA, Tin AS, Tripathi S, Ahmad MA, et al. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. Singapore Med J. 2011;52(5):340–5.
  16. Flum DR, McClure TD, Morris A, Koepsell T. Misdiagnosis of appendicitis and the use of diagnostic imaging. J AmCollSurg 2005; 201(2): 933–939.

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