Acute appendicitis - new diagnostic algorithm using RIPASA score and non-contrast Computed Tomography Scan
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Abstract

Objective: To compare the accuracy of Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and modified Alvarado scores with that of non-contrast computed tomography scan and ultrasound of abdomen and pelvis.

Methods: The observational correlational study was conducted at Manipal Hospital, Bengaluru, India, from April 1, 2014, to April 30, 2016, and comprised patients aged 18-60 years presenting with right lower quadrant pain to the emergency department. Modified Alvarado, RIPASA scores and ultrasound of abdomen and pelvis with optional non-contrast computed tomography scan reports were collected. Subjects underwent laparoscopic appendectomy, followed by histopathological analysis of specimen. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of diagnostic modalities in question were computed using SPSS 15.

Results: Of the 206 patients, 126(61%) were males and 80(39%) were females. Overall mean mean age was 27.81±9.23 years. The diagnostic accuracy was 92.72% for RIPASA score and 59.22% for the modified Alvarado score. Ultrasound showed a high sensitivity of 94.65% but specificity of only 5.26%. Of the total, 25 patients underwent non-contrast computed tomography scan, and among them, 10(40%) were reported as cases of acute appendicitis. Diagnostic accuracy of non-contrast computed tomography scan was 100%.

Conclusion: Non-contrast computed tomography scan and RIPASA score were the most accurate diagnostic modalities.

Keywords: Appendicitis, RIPASA, Diagnosis, Algorithm. (JPMA 69: S-12; 2019)

Introduction

In an acute surgical setting, appendicitis is a ubiquitous diagnosis for abdominal pain. Western literature reports that during the last century, the incidence of appendicitis was 100 per 100,000 person-years. Yet, the challenge remains to make an accurate pre-operative diagnosis, in the setting of myriad differential diagnosis of right iliac fossa pain.

The morbidity of a negative appendectomy needs to be weighed against those of potentially fatal complications of misdiagnosis, like perforation and sepsis. The morbidity of appendiceal perforation ranges from 17% to 40%, with a higher risk in the elderly and children. A diagnosis of acute appendicitis is thus of paramount importance for making a choice in treatment, requiring a combination of diagnostic modalities, namely, thorough clinical history, physical examination, biochemical and radiological investigations.

Scoring systems were developed to aid in making an accurate diagnosis, using symptoms, signs and diagnostic tests. The modified Alvarado scoring system was designed as a risk stratification system by narrowing down treatment options based on probability of appendicitis. It is rapidly calculated, does not require imaging and has good validity as a scoring system. On the other hand, it was found to be inaccurate in women, children and elderly populations. A more extensive scoring system, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score, was then developed, with a higher sensitivity, specificity and diagnostic accuracy.
Further, RIPASA was found to be a more suitable scoring system in south-east Asian populations.\textsuperscript{5} Ultrasonography (USG) of abdomen and pelvis is the most widely used, economical radiological investigation in the diagnosis of right iliac fossa pain. It has the disadvantages of low sensitivity and specificity, high operator dependency and is, thus, unreliable. Comparatively, computed tomography (CT) scan of abdomen and pelvis is more accurate and reliable due to ease in interpretation and low operator dependency.\textsuperscript{6} Further, expense and discomfort to the patient is reduced with the use of non-contrast CT over contrast-enhanced CT of abdomen and pelvis.

The current study was planned to analyse the comparative value of Alvarado scoring system and non-contrast CT of abdomen and pelvis over RIPASA scoring system in diagnosing acute appendicitis.

**Patients and Methods**

The observational correlational study was conducted at Manipal Hospital, Bengaluru, India, from April 1, 2014, to April 30, 2016, and comprised consecutive patients aged 18-60 years presenting with right lower quadrant pain to the emergency department (ED) where there were provisionally diagnosed with acute appendicitis and subsequently underwent laparoscopic appendectomy. Those excluded were patients who were pregnant, who presented with a mass in right iliac fossa, those with a previously diagnosed urological and gynaecological condition, those with a history of trauma prior to the development of right iliac fossa pain, and those who had undergone prior radiological examination following the development of pain.

Approval was obtained from the institutional ethics review committee, and informed consent was taken from the subjects or guardians.

The subjects were scored using RIPASA and were categorised into high or low probability groups, with a cut-off score of 7.5. They were also scored using modified Alvarado scoring system in ED. USG of abdomen and pelvis was performed on all patients, followed by non-contrast CT of abdomen and pelvis for those with an inconclusive USG. Radiological investigations were performed and reported by one of the five certified radiologists, as 'normal', 'acute appendicitis', 'inconclusive' or 'others', based on which patients were excluded from the study, if categorized as 'normal', 'inconclusive' or 'others'. Those who met the inclusion criteria were subjected to laparoscopic appendectomy. Following laparoscopic appendectomy, all specimens underwent histopathological examination which was performed by a senior pathologist, the report of which was considered the final diagnosis.

Data was recorded, tabulated and compared using Chi square test or Fisher's exact test, as necessary with SPSS 15. The level of significance was set at 5%.

**Results**

Of the 206 patients, 126(61\%) were males and 80(39\%) were females. Overall mean mean age was 27.81±9.23 years. Overall, 180(87.4\%) scored equal to or more than 7.5 on RIPASA. According to the modified Alvarado system, only 109(52.9\%) subjects were categorised as having a high probability of acute appendicitis, with a cut-off score of 7. On USG abdomen and pelvis, 195(94.7\%) were diagnosed as acute appendicitis. Of the total, 25 patients underwent non-contrast CT scan, and 10(40\%) of them were reported as cases of acute appendicitis.

### Table 1: Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.0</td>
</tr>
<tr>
<td>Female</td>
<td>0.5</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>&lt; 39.9 years</td>
<td>1.0</td>
</tr>
<tr>
<td>&gt; 40 years</td>
<td>0.5</td>
</tr>
<tr>
<td>RIF Pain</td>
<td>0.5</td>
</tr>
<tr>
<td>Migration of RLQ Pain</td>
<td>0.5</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1.0</td>
</tr>
<tr>
<td>Nausea and Vomiting</td>
<td>1.0</td>
</tr>
<tr>
<td>Duration of Symptoms &lt; 48 hours</td>
<td>1.0</td>
</tr>
<tr>
<td>Duration of Symptoms &gt; 48 hours</td>
<td>0.5</td>
</tr>
<tr>
<td>Signs</td>
<td></td>
</tr>
<tr>
<td>RIF Tenderness</td>
<td>1.0</td>
</tr>
<tr>
<td>RIF Guarding</td>
<td>2.0</td>
</tr>
<tr>
<td>Rebound Tenderness</td>
<td>1.0</td>
</tr>
<tr>
<td>Rovsing’s Sign</td>
<td>2.0</td>
</tr>
<tr>
<td>Fever</td>
<td>1.0</td>
</tr>
<tr>
<td>Investigations</td>
<td></td>
</tr>
<tr>
<td>Raised WBC</td>
<td>1.0</td>
</tr>
<tr>
<td>Negative Urinalysis</td>
<td>1.0</td>
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<tr>
<td>Additional Scores</td>
<td></td>
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<tr>
<td>Foreign NRIC</td>
<td>1.0</td>
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</tbody>
</table>

RIF-Right Iliac Fossa; RLQ-Right Lower Quadrant; WBC-White blood cell; NRIC-National Registration Identity Card
On further analysis, RIPASA score classified 116 (92.1%) males as having high probability of acute appendicitis compared to 64 (80%) females, whereas this gender difference in probability of acute appendicitis was not appreciated in the modified Alvarado scoring system (67 [53.2%] males and 42 [52.5%] females).

The diagnosis of 187 (90.8%) patients was confirmed as acute appendicitis by way of histopathological examination, of whom 116 (92.1%) were males and 71 (88.8%) were females.

USG was negative for acute appendicitis in more number of females, 6 (7.5%) than males, 5 (4%), thus making non-contrast CT scan ideal for further evaluation in these patients. Of the 25 patients who underwent non-contrast CT scan, 13 (52%) were female and 12 (48%) were male. Non-contrast CT scan diagnosed acute appendicitis in 6 (46.2%) females and 4 (33.3%) males.

At the optimal cut-off threshold of 7.5 for the RIPASA score, the calculated sensitivity and specificity were 94.1% and 78.9% respectively. At the optimal cut-off threshold of 7.0 for the modified Alvarado score, the calculated sensitivity and specificity were 56.7% and 84.2% respectively.

PPV and NPV for RIPASA score were 97.78 and 57.69 respectively, compared with 97.25 and 16.49 for the modified Alvarado score. NPV was significantly higher for RIPASA score compared to modified Alvarado score (p<0.001).

The diagnostic accuracy was 92.72% for RIPASA score and 59.22% for the modified Alvarado score, showing a difference of 33.5%, which amounts to a total of 70 patients who were correctly diagnosed by RIPASA over modified Alvarado score (Table 2). The calculated sensitivity and specificity for USG, as a diagnostic test for acute appendicitis, were 94.7% and 5.3% respectively. The calculated sensitivity and specificity for non-contrast CT was 100%.

### Discussion

Acute appendicitis is a common surgical diagnosis but is associated with multiple differential diagnoses to consider. Efforts to avoid unnecessary appendectomy have resulted in numerous scoring systems, but leave much to be desired in terms of an accurate diagnosis. Overuse of imaging to diagnose acute appendicitis has contributed to increasing healthcare costs and concerns of unnecessary exposure to radiation.

In this study, the diagnosis of acute appendicitis was made 1.6 times more in men than women, according to histopathological confirmation. This is in keeping with the trend of male preponderance of the disease.

According to our results, modified Alvarado score had a sensitivity, specificity and diagnostic accuracy of 56.68, 84.21, and 59.22 respectively. In a prospective study, the corresponding values were 68.32%, 87.91% and 86.51% respectively in Oriental population.

Comparatively, our values were lower, but not by a wide margin. In another study, Alvarado score had a sensitivity and specificity of 58.9% and 85.7%, respectively. Due to low sensitivity rates of modified Alvarado score across various studies conducted in Asian populations, this scoring system is not an ideal screening test.

RIPASA score was recently developed to suit Asian population and was found to be superior in all respects to Alvarado scoring system in both retrospective (sensitivity 88% and specificity 67%) and prospective studies (sensitivity 98% and specificity 81%). The RIPASA system uses 14-point criterion plus one foreign NRIC (national registration identity card - to account for high probability of acute appendicitis found in foreign nationals of Brunei presenting with right iliac fossa pain) criterion specific for Asian population. Of the total, 94.1% of those with histologically confirmed acute appendicitis were categorised as having high probability of acute appendicitis, using RIPASA score (cut-off >7.5) compared to 56.7% by modified Alvarado scoring system (cut-off >7.0).
Among those classified into the low probability group, 78.9% and 84.2% did not have appendicitis, according to RIPASA and Alvarado respectively. Thus these patients were correctly diagnosed to have right iliac fossa pain due to causes other than acute appendicitis, avoiding the negative appendectomy that follows.

In our study, diagnostic accuracy was 92.72% for RIPASA and 59.22% for Alvarado. There was a significant difference of 33.5% between diagnostic accuracies of RIPASA and modified Alvarado scores ($p<0.0001$). Chong et al. found a statistically significant difference in diagnostic accuracy of 5.32% between the two scores. Thus, in our setting, RIPASA can be considered a scoring system that is not only administered with ease, but is also more consistent than modified Alvarado in diagnosing acute appendicitis.

With a difference of only few easily available parameters between Alvarado and RIPASA, it would seem worthwhile to employ the latter as an initial screening modality in an algorithm, especially in an Asian population. Imaging of the appendix provides a definitive diagnosis in most cases of right lower quadrant pain, and CT scan of abdomen and pelvis is gold standard among the investigation modalities. On the contrary, subjecting all patients with right iliac fossa pain to contrast CT scan might result in excessive exposure to radiation, thus increasing the risk of iatrogenic cancer in a predominantly young population. In this study, all 25 patients who underwent non-contrast CT abdomen and pelvis were correctly diagnosed with acute appendicitis, making it the most accurate diagnostic modality, with sensitivity, specificity and diagnostic accuracy of 100%. In a retrospective cohort study on 297 patients, sensitivity, specificity and accuracy of multi-slice CT abdomen and pelvis for diagnosing acute appendicitis were 98.9%, 96.4% and 98.0% respectively. Wen Liu et al. further compared CT abdomen and pelvis over RIPASA scoring system and found the difference in diagnostic accuracy to be significant $11\%$, compared to 7% in the current study. This difference could be explained by the fact that a diagnosis of acute appendicitis on CT involves consideration of more specific parameters like signs of peri-appendicular inflammation, which can more efficiently differentiate it from other diagnoses like right ureteric calculus.

It has been shown that 12 negative appendectomies can be avoided for each cancer death due to radiation from contrast CT abdomen and pelvis.$^{11}$ Further, the precise diagnosis offered by CT can shorten the length of stay and avoid misdiagnosis leading to unnecessary litigation claims, making it worth the additional cost. The current study found that non-contrast CT abdomen and pelvis outperformed RIPASA and Alvarado, with the additional benefit of avoiding the renal complications of contrast administration.

On further analysis, we found that RIPASA score incorrectly classified 4 patients, each with a score of 8, resulting in negative appendectomies. An ideal screening test can be created by modification of the cut-off score of RIPASA to 8.5.

On the other hand, 11 patients with RIPASA scores between 6 and 5 were proven to have acute appendicitis by histology. Modification of RIPASA cut-off score to 5 would make RIPASA 100% specific for the diagnosis of acute appendicitis. In other words, ruling in patients with a score of greater or equal to 8.5 and ruling out patient with scores less than 5 would put RIPASA on par with non-contrast CT abdomen and pelvis as an ideal diagnostic tool.

Some studies have documented a high diagnostic accuracy achieved by following an algorithm to decide the requirement for a pre-operative non-contrast CT abdomen and pelvis.$^{12,13}$ RIPASA score and non-contrast CT abdomen and pelvis were found to be ideal diagnostic modalities in our study. On this basis, a diagnostic algorithm was constructed by stratifying RIPASA scores into 3 categories instead of the two current strata of high and low probability of acute appendicitis. By classifying RIPASA scores into three strata, all patients with scores greater or equal to 8.5 fall in the TP category, making them candidates for appendectomy without further evaluation. For patients with RIPASA scores between 8 and 5, addition of non-contrast CT scan abdomen and pelvis in the workup rules out other differential diagnoses. All patients in this study with a score of less than 5 were correctly classified as not having a diagnosis of acute appendicitis. These patients can be observed and re-assessed at a later time (Figure).

With a high sensitivity and specificity, reaching 100% when the inclusion and exclusion cut-off thresholds are changed to 8.5 and 5 respectively, the RIPASA scoring system could function as an initial ‘stepping stone’ to more complicated modalities of diagnosis. In the era of
increasing medico-legal claims for misdiagnosis and delay in treatment, there is a need for accurate imaging, partly for legal documentation purposes. Making a diagnosis of acute appendicitis based purely on the RIPASA score might be inadequate, under these circumstances.

**Conclusion**

Non-contrast CT scan abdomen and pelvis proved to be superior to the others in terms of accuracy of diagnosis. A diagnostic algorithm incorporating at least two or more modalities might be appropriate for a large hospital setting where infrastructure and availability of equipment is not a limiting factor for speedy diagnosis.

**Conflict of Interest:** None.

**Source of Funding:** None.

**Disclaimer:** None.

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**References**