

ORIGINAL ARTICLE

EVALUATION OF MODIFIED ALVARADO, RIPASA AND LINTULA SCORING SYSTEM AS DIAGNOSTIC TOOLS FOR ACUTE APPENDICITIS

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Background: Commonest surgical emergency presenting to emergency departments with abdominal pain is acute appendicitis. Thus, to enable quick and accurate diagnosis of the condition various scoring systems have been developed. Among these, Alvarado and its modified version (Modified Alvarado) are the commonest. Whereas Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score showed promising results in Asian population. Similarly, Lintula score, which was initially developed for paediatric population, has now been validated for elderly too. This study is aimed to compare these in our regional population. **Method:** Project included consecutive 125 clinically suspected acute appendicitis patients. All were scored using Modified Alvarado, RIPASA and Lintula systems. Final diagnosis was based on histopathologic evaluation of excised specimen. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy were computed for all these systems by using SPSS statistical software and ROC curves were plotted. **Results:** With cut-off of 7, Modified Alvarado was 62% specific, 83% sensitive and 65% accurate. While PPV and NPV were 94% and 33%, respectively. Whereas RIPASA yielded better results, i.e., sensitivity of 98.4%, specificity of 87%, PPV of 97%, NPV of 77% and diagnostic accuracy of 92%. Whereas Lintula showed sensitivity of 71%, specificity of 87%, PPV of 96%, NPV of 40 and accuracy of 73%. **Conclusion:** RIPASA demonstrated higher sensitivity, PPV, NPV and diagnostic accuracy than Modified Alvarado and Lintula scores. Hence this study approves use of RIPASA score in the region. However further research on the subject is required to back this inference.

Keywords: Acute appendicitis; Modified Alvarado score; RIPASA score; Lintula score

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INTRODUCTION

Most common ailment requiring emergent surgical care around the globe is acute appendicitis. Lifetime prevalence of the condition is about 14%.¹ The documented incidence of the disease is 1.5–1.9/1000.² It is the most common surgical condition presenting with abdominal pain, though symptoms are atypical in 50% cases making early diagnosis a challenging task.³ Hence delay in diagnosis and subsequent provision of definitive therapy results in complications as higher rates of perforation (34%–75%),^{4–6} wound infection (0%–11%),^{7–9} pelvic abscess (1–5%),^{7–9} and intra-abdominal adhesions.

At present, the gold standard for diagnosis is histopathological evaluation of the appendectomy specimen but a cost effective, repeatable and rapidly applicable method is required for early preop diagnosis and effective management of the condition.^{10,11} Thus various clinical scoring systems were developed.

These systems were developed to bring down the rates of negative appendectomies to about 5–10%. Among these Alvarado scoring, developed in 1986 has been the most popular one (Table-1). Later it was altered to yield Modified Alvarado Score by omitting the last parameter of the pioneer score (i.e., left shift of neutrophils) (Table-2). Though no significant difference in terms of reduction in negative appendectomies has been demonstrated after modification.^{11,12}

The Department of Surgery, Raja Isteri Pengiran Anak Saleha Hospital, Brunei Darussalam established another scoring system called the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score in 2018 (Table-3).¹³ RIPASA score is composed of 14 parameters, and has demonstrated higher sensitivity, specificity and diagnostic accuracy than the Alvarado scoring system, particularly in Asians. Similarly, Lintula *et al* developed another system to diagnose the condition in children¹⁴ and another study validated

this score for use in adult patients¹⁵. Based on this background, this study is modelled to compare the efficacy of all the three mentioned scoring systems by applying all of them at the same patients. Since previous work has shown that these systems don't demonstrate similar results in different populations, so this article is intended to demonstrate performance of these systems in our population.

Also, because each histopathological subtype will be individually evaluated, this will give an insight into the effectiveness of each score for these subtypes. Data will be represented in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy and area under the ROC curve.

MATERIAL AND METHODS

This was a prospective observational study conducted at all the three surgical units of Ayub Teaching Hospital, Abbottabad. All the consenting patients clinically suspected as case of acute appendicitis presenting to the hospital from 01st February to 26th April 2018 were included in the research. While we excluded pregnant patients, and those who presented with right iliac fossa mass. Similarly, a very few patients that were conservatively managed and couldn't be followed up after discharge from the hospital because of inability to communicate and did not presented for follow-up, were not added in the final data.

These patients were admitted in one of the three surgical wards and were attended by surgeons trained to use the three scoring systems to diagnose acute appendicitis. The two investigations, required to complete the three scoring systems, i.e., Complete Blood Count and Urine RE were performed free of cost by the hospital laboratory, alongside other baseline investigations routinely done for every patient admitted at ATH. Concurrently printed proformas containing spaces for personal details and clinical data were provided, that were filled by research assistants trained to use the three scoring systems. The parameter of National Registration Identity Card was excluded from RIPASA scoring system during the study as it is only applicable in Singapore and none of the subjects included in this research were from Singapore.

Final management decision was left to the discretion of the surgeon on duty, i.e. whether to operate or conservatively manage the patient. For the cases that underwent appendectomy the diagnosis was refuted or confirmed by histopathological analysis of the appendectomy specimen. While those discharged from the

hospital after conservative management were contacted after a week to enquire about the outcome. Among these, those in which symptoms were resolved by mere use of analgesics were judged to have not had the disease. Thus, each patient was simultaneously scored by the three scores that enabled impartial comparison between the three, in our population. While correlation of results with histological findings depicted potency of each score, for various histopathological types.

Data from completed questionnaires was entered into the computer, using SPSS-16.0. Results calculated by computing the data, were presented by 2×2 tables and sensitivity, specificity, PPV, NPV and diagnostic accuracy were calculated. For comparative analysis, these parameters were placed side by side in a table and ROC curves were plotted.

RESULTS

All the cases of acute appendicitis that presented to Ayub Teaching Hospital, Abbottabad were followed, over a period of two and a half months. A few that met the exclusion criteria and those that refused to continue their treatment at the facility were not included in our study. Sample consisted of 125 consecutive cases, 79 among them were males and 46 were female. Mean age of sample was 23.62 years. These cases were assessed using Modified Alvarado, RIPASA and Lintula scoring systems, yielding mean scores of 6.75, 9.4 and 20.64 respectively. Among the three scoring systems RIPASA proved to be most sensitive and specific (94% and 87% respectively). Histopathology showed 56% of cases had acutely inflamed appendix, 12% had gangrenous specimen and 13.6% were found to have perforated appendix at the time of surgical removal. Approximately 18.4% (23 patients) underwent negative appendectomy.

With use of cut-off point set at 7, sensitivity of MAS was 63%, whereas the same criteria yielded very high specificity and positive predictive values of 83% and 94% respectively. On the contrary, negative predictive value and diagnostic accuracy were low, that of 33% and 65%, respectively. Table-6 depicts ability of RIPASA score to accurately point out the cases. With the cut-off score set at 7.5, RIPASA was found very specific and sensitive, yielding values of 94% and 87% for the two parameters, respectively. Similarly, noted diagnostic accuracy, positive predictive value and negative predictive value were relatively high, constituting 97%, 77% and 92%, respectively. Lintula method was found to be as specific as RIPASA but lags behind

RIPASA in terms of sensitivity. While it demonstrated very high PPV of 96%, the NPV and diagnostic accuracy were calculated to be as low as 40% and 73%, respectively. Following is the tabulated summary of the findings.

Thus, comparative analysis of the results illustrates that RIPASA is the most sensitive score in our population, while its specificity is equal to that of Lintula, i.e., 87%. Not only this, but RIPASA also yielded higher PPV, NPV and diagnostic accuracy. The Receiver Operator Curve (ROC) plotted below demonstrates Area Under Curve (AUC) of 0.782 (78.2%), 0.783 (78.3%) and 0.785 (78.5%) for MAS, RIPASA and Lintula scores, respectively. As per histological subtypes, acutely inflamed is more accurately diagnosed by both MAS and RIPASA score. While Lintula diagnoses the condition best when vermiform appendix has already perforated, as illustrated by figure-2.

Table-1: Alvarado score

Parameters	Score allotted
Migratory right iliac fossa pain	1.0
Anorexia	1.0
Nausea/vomiting	1.0
Tender right iliac fossa	2.0
Rebound tenderness	1.0
Fever	1.0
Leucocytosis	2.0
Left shift of neutrophils	1.0
Total Score	10.0

Table-2: Modified Alvarado Score

Parameters	Score allotted
Migratory right iliac fossa pain	1.0
Anorexia	1.0
Nausea/vomiting	1.0
Tender right iliac fossa	2.0
Rebound tenderness	1.0
Fever	1.0
Leucocytosis	2.0
Total Score	9.0

Table-3: RIPASA Score

Parameters	Score allotted
Male	1.0
Female	0.5
Age<39.9	1.0
Age>40.0	0.5
Right iliac fossa pain	0.5
Migration of pain to RIF	0.5
Anorexia	1.0
Nausea and vomiting	1.0
Symptoms duration<48hrs	1.0
Symptoms duration>48hrs	0.5
Tender right iliac fossa	1.0
Guarding	2.0
Rebound tenderness	1.0
Rovsing's sign	2.0
Fever	1.0
Elevated WBC count	1.0
Negative urine analysis	1.0
Total score	16.5

Table-4: Lintula Score

Parameters	Score allotted
Male	2.0
Severe pain	2.0
Migration of pain	4.0
Vomiting	2.0
RLQ pain	4.0
Fever (>37.5)	3.0
Guarding	4.0
High pitched, tingling or absent bowel sounds	4.0
Rebound tenderness	7.0
Total score	32.0

Table 5: Results for Modified Alvarado at diagnostic cut-off point score of 7

	Histopathology Result			Total
	Inflamed	Normal	Total	
MAS	Positive	63	4	67
	Negative	39	19	58
	Total	102	23	125

Sensitivity: 62%, Specificity: 83%, PPV: 94%, NPV:33%, D. Accuracy: 65%

Table-6: Results for RIPASA at diagnostic cut-off score of 7.5

	Histopathology Result			Total
	Inflamed	Normal	Total	
RIPASA	Positive	96	3	99
	Negative	6	20	26
	Total	102	23	125

Sensitivity: 94%, Specificity: 87%, PPV: 97%, NPV: 77%, D.Accuracy: 92%

Table-7: Results for Lintula score at diagnostic cut-off point of 21

	Histopathology Result			Total
	Inflamed	Normal	Total	
Lintula	Positive	72	3	75
	Negative	30	20	50
	Total	102	23	125

Sensitivity: 71%, Specificity: 87%, PPV: 96%, NPV: 40%, D.Accuracy: 73%

Table-8: Comparative analysis of the scores

Variable	Modified Alvarado score ≥ 7	RIPASA ≥7.5	Lintula≥21
Sensitivity	62%	94%	71%
Specificity	83%	87%	87%
PPV	94%	97%	96%
NPV	33%	77%	40%
Diagnostic Accuracy	65%	92%	73%

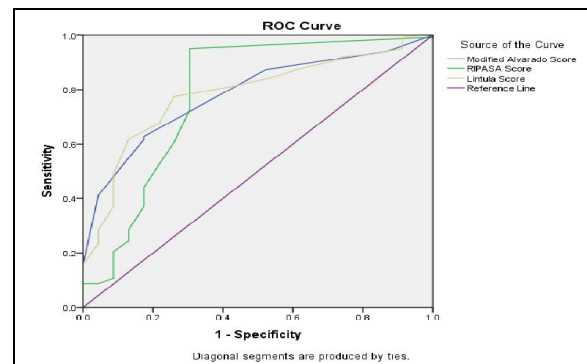


Figure-1: ROC curve for MAS, RIPASA and Lintula scores

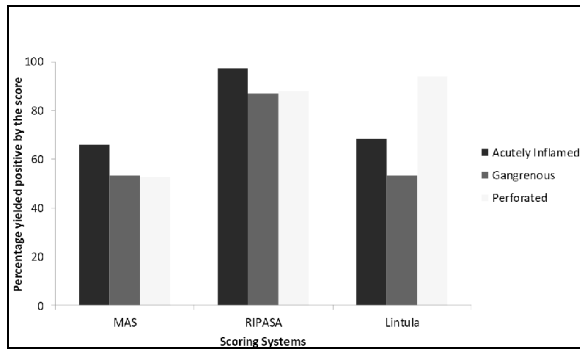


Figure-2: Results yielded by each score for different histological subtypes

DISCUSSION

Diagnosing acute appendicitis has proven to be a challenge for surgeons over the time.¹⁶ This results in delay in provision of definitive treatment which can result in grave outcomes like appendicular mass and perforation etc. Also, the prevalent rate of negative appendectomies (20–30%) has been considered unacceptable.^{17,18} Thus investigations such as ultrasonography and computed tomography (CT) were introduced for diagnosing the condition, but they were not applicable tools for general use because of their high costs. Hence various scoring systems that depend on clinical evaluation and cheap investigations, are generally applied to make the diagnosis cheap and quick. Among these, most popular is Alvarado and Modified Alvarado system that proved to be most useful in Western population. Whereas RIPASA that was later developed in Asia, was found to be a better tool in this region. Another system was developed by Lintula *et al* in Turkey for paediatric population that was later validated for adult population.

In this study cut-off value for modified Alvarado score was set as 7, yielding sensitivity, specificity, PPV, NPV and diagnostic accuracy of 62%, 83%, 94%, 33% and 65%, respectively. While Chong *et al* provided values of 68.3%, 87.9%, 86.3%, 71.4% and 86.5%, respectively for the same.¹⁴ Similarly Chong *et al* findings for diagnostic accuracy, sensitivity, specificity, PPV and NPV were of 91.8%, 98.0%, 81.3%, 85.3% and 97.4%, respectively, using the RIPASA score. These are identical to our results of 94%, 87%, 97%, 77% and 92%. Results of other researches as Rathod *et al*³ and Shuaib *et al*¹⁷ are also identical to these findings. Lintula showed sensitivity of 71%, specificity of 87%, PPV of 96%, NPV of 40 and accuracy of 73%, while previously noted values were 60.8%, 60%, 79.5%, 37.5% and 60.6% respectively.¹⁵

Comparative analysis of the three scoring systems, depicted by Table-8 clearly reveals that RIPASA is the most sensitive among the three.

Whereas, both RIPASA and Lintula scoring systems are equally specific for the condition. Values of all other variables, i.e., PPV, NPV and diagnostic accuracy were also highest for RIPASA. These results are in accordance with the inference of previous researches on the topic.¹⁸ But if these values are compared with previously carried out research on the subject, all these systems are less sensitive and specific than Appendicitis Inflammatory Response (AIR) score and CT scan. In 2004, a research regarding use of radiological investigations for appendicitis showed that CT is 94% sensitive and 95% specific.¹⁹ A decade later, AIR score showed promising sensitivity and specificity, that of 97% and 77% for a value of greater than four, as cut-off to consider the results positive. While the recorded values were 12% and 100%, respectively with cut-off score of greater than 8.

Study limitations

One of the recent scoring systems, AIR score was not included in the study. Furthermore, CT scan that has yielded great results in the past was not used for the diagnosis of the condition throughout the study, albeit it has been used in Western world for diagnosis of the condition.

CONCLUSION

RIPASA score is better than the other two implemented during the study. It is an easily applicable system comprising of 14 parameters, depending upon clinical evaluation and affordable investigation. It has better sensitivity, PPV, NPV and diagnostic accuracy than Modified Alvarado and Lintula scores in our region. Hence this study approves that RIPASA should be used in this region for the diagnosis of acute appendicitis. However further research on the subject is required to back this inference.

AUTHORS' CONTRIBUTION

KS, UM, BMY: Proposed the study, analysed data and prepared the first draft. Others contributed to data collection, design and interpretation of the project.

REFERENCES

- Stephens PL, Mazzucco JJ. Comparison of ultrasound and the Alvarado score for the diagnosis of acute appendicitis. *Conn Med* 1999;63(3):137–40.
- Cuschieri A. The small intestine and vermiform appendix; In: Cuschieri A, Giles GR, Mossa AR, editors. *Essential surgical practice*. 3rd ed. London: Butter worth Heinman, 1995; p.1325–8.
- Chong CF, Adi MI, 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):220–5.
- Stone HH, Sanders SL, Martin JD. Perforated appendicitis in children. *Surgery* 1971;69(5):673–9.

5. Graham JM, Pokorny WJ, Harberg FJ. Acute appendicitis in preschool age children. *Am J Surg* 1980;139(2):247–50.
6. Gilbert SR, Emmens RW, Putnam TC. Appendicitis in children. *Surg Gynecol Obstet* 1985;161(3):261–5.
7. Curran TJ, Muenchow SK. The treatment of complicated appendicitis in children using peritoneal drainage. Results from public hospital. *J Pediatr Surg* 1993;28(2):204–8.
8. Pearl RH, Hale DA, Molloy M, Schutt DC, Jaques DP. Pediatric appendectomy. *J Pediatr Surg* 1995;30(2):173–81.
9. Surana R, O'Donnell B, Puri P. Appendicitis diagnosed following active observation does not increase morbidity in children. *Pediatr Surg Int* 1995;10(2-3):76–8.
10. Erdem H, Çetinkünar S, Daş K, Reyhan E, Değer C, Aziret M, *et al.* Alvarado, Eskelinen, Ohmann and Raja Isteri Pengiran Anak Saleha Appendicitis scores for diagnosis of acute appendicitis. *World J Gastroenterol* 2013;19(47):9057–62.
11. Kanumba ES, Mabula JB, Rambau P, Chalya PL. Modified Alvarado Scoring System as a diagnostic tool for acute appendicitis at Bugando Medical Centre, Mwanza, Tanzania. *BMC Surg* 2011;11:4.
12. Kalan M, Talbot D, Cunliffe WJ, Rich AJ. Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis: a prospective study. *Ann R Coll Surg Engl* 1994;76(6):418–9.
13. Chong CF, Adil MI, Thien A, Suyoi A, Mackie AJ, Tin AS, *et al.* Evaluation of the RIPASA score: A new scoring system for the diagnosis of acute appendicitis. *Singapore Med J* 2010;51(3):220–5.
14. Lintula H, Pesonen E, Kokki H, Vanamo K, Eskelinen M. A diagnostic score for children with suspected appendicitis. *Langenbecks Arch Surg* 2005;390(2):164–70.
15. Yoldas O, Karaca T, Tez M. External validation of lintula score in Turkish acute appendicitis patients. *Int J Surg* 2012;10(1):25–7.
16. Gilmore OJ, Browett JP, Griffin PH, Ross IK, Brodribb AJ, Cooke TJ, *et al.* Appendicitis and mimicking conditions. *Lancet* 1975;2(7932):421–4.
17. Antel J, Rivera L, Landenberg B, Halm G, Fatava MA, Brown CV. Computed tomography-based clinical diagnostic pathway for acute appendicitis: prospective validation. *J Am Coll Surg* 2006;203(6):849–56.
18. 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 J Emerg Med* 2017;8(4):276–80.
19. Terasawa T, Blackmore CC, Bent S, Kohlwes RJ. Systematic review: Computed tomography and ultrasonography to detect acute appendicitis in adults and adolescents. *Ann Intern Med* 2004;141(7):537–46.

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