Assessment of the RIPASA Score in the Diagnosis of Acute Appendicitis in Khartoum State Hospitals, Sudan

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Abstract: Appendectomy is a common cause of emergency hospitalization, and appendectomy is one of the most common emergency procedures performed in modern medicine. Although it is a common problem, acute appendicitis remains a complex condition to diagnose, especially in the young, the elderly, and women of childbearing age. The aim was to evaluate the accuracy of the RIPASA score for patients with right iliac fossa pain (RIF) and suspected appendicitis. This study is an observational, analytic, and prospective cohort study conducted for one year. All patients suspected of having acute appendicitis and who underwent appendectomy were included in this study. All resected appendages were sent for histological examination. RIPASA scores were calculated for all patients. The study results in the 105 patients studied, 60 (57.1%) were predominantly male. The M/F ratio is 1.3/1. Most of the 98 patients (93.3%) were 40 years old. Most patients had symptoms within 48 hours 79 (75.2%). The most common symptom was anorexia (83.8%). All patients had RIF tenderness (100%). 95 (90.5%) patients had a score >7.5. On gross examination, three patients (2.9%) had a non-inflammatory appendix, 83 patients (79.0%) had a simple inflammatory appendix, the perforated appendix was found in 9 patients (8.6%), appendix mass was found in 6 patients (5,7%), and only four patients (3.8%) had an appendiceal abscess. The appendix was histologically inflamed in 69 patients (65.7%). The sensitivity of the RIPASA scoring system in our study was 69.5%, and the specificity was 70%. The diagnostic accuracy was calculated and was 69.5%. Our study's positive and negative predictive values (PPV, NPV) were 95.7% and 19.4%, respectively. Research conclusion RIPASA value of 7.5 is beneficial and easy to use. Therefore, surgeons can use it as a diagnostic guide for acute appendicitis to reduce the rate of misdiagnosis.
Keywords: Acute appendicitis; appendectomy; histopathology; RIPASA score.

INTRODUCTION

Appendicitis is one of the most common surgical emergencies in modern medicine, with an annual incidence of about 100 per 100,000 population. The lifetime risk of developing appendicitis is 8.6% for men and 6.7% for women, with incidence peaking during the second and third decades (Addiss et al., 1990). Although a common problem, acute appendicitis remains a difficult diagnosis to make. The negative appendectomy rate is about 20% to 40% (Chong et al., 2010). Diagnostic accuracy can be improved by using ultrasound or computed tomography, but these may delay diagnosis and surgical performance (Rodrigues, Rao, and Khan, 2006). The high prevalence of acute appendicitis in the West and relatively rare in Africa suggests a protective effect of a high-fiber diet (Burkitt, 1971; Cuschieri, 2015).

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Appendicitis is caused by obstruction of the lumen, most commonly from lymphatic hyperplasia, secondary to various inflammatory and infectious conditions, feces, parasites, foreign bodies, and tumors (Bower, Bell, and Ternberg, 1981; Rodrigues, Rao and Khan, 2006; Mike et al., 2015).

Over the past three decades, several clinical scores have been developed to help clinicians evaluate patients with abdominal pain and suspected appendicitis (Ohmann, Yang, and Franke, 1995; Nwokoma, 2012; Singh et al., 2018) Alvarado and the modified Alvarado Scoring System have been introduced since 1986 to aid in clinical decision making. The reported sensitivity and specificity for the Alvarado and changed Alvarado scores range from 53% to 88% and 75% to 80%, respectively (Alvarado, 1986; Kalan et al., 1994).

A new scoring system has been developed at Raja Isteri Pengiran Anak Saleha Hospital (RIPAS), Brunei Darussalem. This system was later named the RIPASA scoring system for diagnosing acute appendicitis, which consisted of 15 parameters. The obtained sensitivity and specificity were 88% and 67%, respectively, with a diagnostic accuracy of 81% (Chong et al., 2010).

This study aimed to evaluate the diagnostic accuracy of the RIPASA score in the diagnosis of acute appendicitis.

MATERIALS AND METHODS

This is an observational, analytical, prospective, cohort, and hospital-based study. Over one year, the research was carried out at Khartoum state hospitals (Khartoum, Omdurman, Ibrahim Malik, Khartoum North, and Bashair teaching hospitals) over one year (Sept. 2015 – Sept. 2016). All patients who presented with RIF pain and suspected acute appendicitis and had undergone appendicectomy were included in the study. Excluded from the study, all patients with the comorbid disease (e.g., diabetes mellitus, immune-compromised patients, patients on steroid, malignancy, and patients on radiotherapy), Patients will undergo emergency laparotomy and appendicectomy performed as part of the procedure, and those experienced elective appendicectomies. Consent was obtained from patients, ethical clearance from the Sudan medical specialization board, and approval of hospital administrations.

Table 1. RIPASA Scoring System (Chong et al., 2010).

Scoring element	Score	Scoring element	Score
Male	1.0	Duration of symptoms > 48 hrs.	0.5
Female	0.5	RIF tenderness	1.0
Age < 39 yrs.	1.0	RIF guarding*	2.0
Age > 39 yrs.	0.5	Rebound tenderness	1.0
RIF pain	0.5	Rovsing's sign*	2.0
Migration to RIF	0.5	Fever	1.0
Anorexia	1.0	Raised TWBCs	1.0
Nausea & vomiting	1.0	Negative urinalysis**	1.0
Duration of symptoms < 48 hrs.	1.0	Foreign NRIC***	1.0

(Minimum total score2 and Maximum total score16)

*Extra weightage by agreement of a panel of a general surgeon. **Negative urinalysis: absence of blood, neutrophil, and bacteria, ***Additional parameter.
RIF: Right iliac fossa; TWBCs: total white blood cells; NRIC: national registration identity card.

The data was collected using constructed questionnaire over six months by the author and doctors who worked in hospitals mentioned previously. The data collected included all the components of RIPASA score, which were the patients' demographics (age and gender), the presenting symptoms (RIF pain, the migration of pain to the RIF, nausea and vomiting, anorexia and the duration of symptoms), clinical signs (RIF tenderness, guarding, rebound tenderness, Rovsing's sign and fever) and laboratory investigations (elevated white cell count and negative urinalysis) (Table 1).

All resected appendices were sent for histological examination. RIPASA scores are derived for all patients. Data analysis was done by using a computer application used Chi-Square test. P-value was considered significant if less than 0.05.

RESULTS AND DISCUSSION

A total number of 105 patients were included in the study. Male predominance was 60 (57.1%), while females were 45 (42.9%). With the male to female ratio of 1.3:1. Most of the patients 98 (93.3%) were <40 years while 7 (6.7%) were > 40 years.

Clinical pictures

Most of the patients presented within 48 hours from the onset of the symptoms (79 patients, 75.2%). The typical sign is anorexia found in 88 patients (83.8%). And the most common finding is RIF tenderness which is located in all patients (100%). See table 2.

Table 2. Clinical Picture

Presentation	Number of the Patients	Percentage of the Patients
Presented within 48 hours	79	75.2 %
Presented after 48 hours	26	24.8 %
RIF pain	36	34.3 %
Pain shift to RIF	69	65.7 %
Nausea and vomiting	80	76.2 %
Aneroxia	88	83.8 %
RIF tenderness	105	100 %
Rebound tenderness	99	94.4 %
Guarding	71	67.6 %
Fever	48	45.7 %
Rovesing's sign	26	24.8 %

Investigation

Most patients had TWBCs count 7000 to 11000 (43 patients, 41%). And most patients had negative urine analysis (95 patients, 90.5%). See table 3 and 4.

Table 3. White Blood Cell Counts.

White blood cell count	Number of the Patients	Percentage of the Patients
< 7000	24	22.8 %
7000 to 11000	43	41 %
>11000	38	36.2 %
Total	105	100 %

Table 4. Urine Analysis

Urine Analysis	Number of the Patients	Percentage of the Patients
Negative	95	90.5 %
Positive	10	9.5%
Total	105	100 %

RIPASA score for the patients:

All patients were diagnosed based on clinical symptoms, signs, and investigations as acute appendicitis, and the RIPASA scoring system was applied to all patients. The cut-off point for diagnosis of acute appendicitis is 7.5 according to the RIPASA score. Most patients 95 (90.5%) had score > 7.5 and 10 (9.5%) patients had score < 7.5. (Table 5). The sensitivity of the RIPASA score in this study was 69.5%, specificity was 70%, PPV was 95.7, and NPV was 19.4%.

Table 5. RIPASA Scoring and Histologically Proved Acute Appendicitis.

Total Score	Histopathology		Total
	Inflamed	Non-inflamed	
>7.5	66(95.7%)	29(80.6%)	95(90.5%)
<7.5	03(04.30%)	07(19.4%)	10(09.50%)
Total	69(65.7%)	36(34.3%)	105(100%)

The p-value from the Chi-square test on data above is 0.012, which means there was a significant correlation between RIPASA scoring and diagnosis of acute appendicitis proved by histology. So, the higher score, increases the possibility of acute appendicitis.

There were three patients (2.9%) who had negative appendicectomy, 83 patients (79.0%) had an inflamed appendix, a perforated appendix was found in nine patients (8.6%), appendicular mass in sex patients (5.7%), and only four patients (3.8%) had an appendicular abscess (Table 6).

Histopathology

The appendix was histologically inflamed in 69 patients (65.7%) and non-inflamed in 36 patients (34.3%).

Table 6. RIPASA Score and Intraoperative Finding.

Intraoperative finding	Total score		Total
	>7.5	*<7.5*	
Negative appendicectomy	01(01.1%)	02(20.0%)	03(02.9%)
Simple inflamed appendix	76(80.0%)	07(70.0%)	83(79.0%)
Perforated appendix	09(09.50%)	00(00.0%)	09(08.6%)
Appendicular mass	06(06.30%)	00(00.0%)	06(05.7%)
Appendicular abscess	03(03.1%)	01(10.0%)	04(03.8%)
Total	95(90.5%)	10(9.50%)	105(100%)

The p-value from the Chi-square test on data above is 0.007, which means there is a significant correlation between the RIPASA scoring system and intraoperative findings. And this means the higher score increases the possibility of intraoperative conclusions and reduces the negative appendicectomy rate.

Outcome

Most patients underwent uneventful post-operative period (97 patients, 92.3%). Only eight patients (7.6%) developed complications in wound infection (Table 7).

Table 7. Intraoperative Findings and Outcome in Patients who Underwent Appendicectomy

Intraoperative finding	Outcome		Total
	Uneventful	**Wound infection**	
Negative appendicectomy	03(03.1%)	00(00.0%)	03(02.9%)
Simple inflamed appendix	78(80.4%)	05(62.5%)	83(79.0%)
Perforated appendix	09(09.3%)	00(00.0%)	09(08.9%)
Appendicular mass	06(06.9%)	00(00.0%)	06(05.7%)
Appendicular abscess	01(01.0%)	03(37.5%)	04(03.8%)
Total	97(92.4%)	08(07.6%)	105(100%)

The p-value from the Chi-square test on data above is 0.012, which means the accurate diagnosis reduces the rate of complications.

Despite being a not unusual place problem, acute appendicitis stays a challenging analysis to establish, in particular some of the young, the elderly, and ladies of reproductive age, wherein some different genitourinary and gynecological inflammatory situations can gift with signs and symptoms which can be much like the ones of acute appendicitis. A postponement in acting an appendicectomy to enhance its diagnostic accuracy will increase the threat of appendicular perforation and sepsis, which will increase morbidity and mortality. The contrary is likewise true, wherewith decreased diagnostic accuracy, the bad or pointless appendicectomy rate is increased, and that is normally suggested to be about 20%–40% (Chong et al., 2010; Noor. S et al., 2020)

Over the past three decades, several clinical scores have been developed to help clinicians evaluate patients with abdominal pain and suspected appendicitis (Ohmann, Yang, & Franke, 1995; Nwokoma, 2012). Several scoring systems, such as the modified Alvarado and Alvarado scoring systems, have been introduced to aid clinical decision-making in rapidly diagnosing acute appendicitis. The reported sensitivity and specificity for the Alvarado and changed Alvarado scores range from 53% to 88% and 75% to 80%, respectively (Alvarado, 1986; Kalan et al., 1994). However, both of these scoring systems were created in the West. When applied in different settings, such as the Middle East and Asia, the sensitivity and specificity are very low. Khan et al. (2005) used the Alvarado scoring system in an Asian population and achieved sensitivity and specificity of only 59% and 23%, respectively, with a negative appendectomy rate of 15.6. % (Khan and ur Rehman, 2005). Another study by AlHashemy et al., using the modified Alvarado scoring system in a Middle Eastern population, reported similarly low sensitivity of 53.8% and a specificity of 80% (Al-Hashemy and Seleem, 2004; Pasumarthi and Madhu, 2018).

Patients' demography

Male predominance was 60 (57.1%), while females were 45 (42.9%) with a male to female ratio of 1.3:1. Compared to the original study or RIPASA scoring system, the male to female ratio is approximately similar (1.4:1)(Chong et al., 2010). There is a slight male preponderance (3:2) in teenagers and young adults from literature. In adults, the incidence of appendicitis is approximately 1.4 times higher in males (Cuschieri, 2015). And this seems to be similar to our results. Compared with

local data, in the study performed in Khartoum on 280 patients, the male to female ratio was 1:1 (Ahmed, 1987).

Most of the patients 98 (93.3%) were <40 years while seven (6.7%) were > 40 years. Compared to the original study of the development of the RIPASA scoring system, 84.3% of the patients with acute appendicitis were < 40 years of age, while 15.7% were > 40 years of age(Chong *et al.*, 2010). The percentages are not similar, but both confirmed that the diagnosis of acute appendicitis is common under the age of 40 years. Also, from the local data, the peak incidence of the disease was between 10 to 30 years (Ahmed, 1987).

Clinical pictures

Most patients presented within 48 hours from the onset of the symptoms; see table 2. And most patients with positive intraoperative findings presented within 48 hours, see table 8. Similarly, in the original score study, most patients with positive appendicectomy presented within 48 hours (67%), and those who showed after 48 hours compromised 33%. In addition, for those with negative appendicectomy, the majority presented within 48 hours (55%) (Chong et al., 2010; Díaz-Barrientos et al., 2018). In the study done in Khartoum teaching hospital in 280 patients, most patients presented within 48 hours (86%)(Ahmed, 1987).

Table 8. Duration of Symptoms and Intraoperative Findings in Patients with Acute Appendicitis.

Intra Operative Finding	Duration of Symptoms		Total
	<48H	**>48H**	
Negative appendicectomy	01(33.3%)	02(66.7%)	03(02.9%)
Non complicated appendicitis	68(81.9%)	15(18.1%)	83(79.0%)
Complicated appendicitis	10(52.6%)	09(47.7%)	19(18.1%)
Total	79(75.2%)	26(24.8%)	105(100%)

The p-value from the Chi-square test on data above is 0.007, which means it is clinically significant between symptom duration and intraoperative outcome; patients presenting within 48 hours have a higher rate of positive appendectomy, so those with higher RIPASA scores have less possibility of a negative test.

The most common presenting symptom in our study was anorexia 88 (83.8%), followed by nausea and vomiting 80 (76.2%), the shift of pain to RIF 69 (65.7%), and RIF pain 36 (34.3%), see table 2. According to the literature, the diagnostic sequence of central abdominal pain, colic followed by vomiting with pain migrating to the right iliac fossa, was first described by Murphy but may be present in only 50% of patients. A meta-analysis of symptoms and signs associated with the presentation of acute appendicitis did not identify anyone but did suggest that pain migration was related to the diagnosis of acute appendicitis (Humes and Simpson, 2006)

All patients had RIF tenderness, 99 (94.4%) had rebound tenderness, 71 (67.6%) had guarding, 48(45.7%) had fever (temperature >37.5) and Rovsing's sign in 26 patients (24.8%), see table-2. Guarding and Rovsing's sign was considered early indicators of a local inflammatory process, while rebound tenderness is a much later sign when the peritoneum is involved with inflammation. So guarding and Rovsing's sign was given 2 points for each and 1 point for rebound tenderness in the score (Chong *et al.*, 2010).

From the study done in Khartoum, all patients presented with pain and tenderness at the appendix site, anorexia in 94%, nausea in 88.5%, and rebound tenderness in 88.5%. The classic presentation of central colicky abdominal pain then shifts to RIF was found in 56% of patients. Pulse, temperature, and total white cell count readings were minimal diagnostic help (Ahmed, 1987).

Investigations

There is clinical significance between TWBCs and histologically proved appendicitis and intraoperative findings. See tables 9 and 10.

Table 9. TWBCs and Histologically Proved Acute Appendicitis in the Study.

TWBCs	Histopathology		Total
	Inflamed	**Non inflamed**	
<7000	10(41.6%)	14(58.3%)	24(22.9%)
7000-11000	29(67.4%)	14(32.6%)	43(41.0%)
>11000	30(78.9%)	08(21.1%)	38(36.1%)
Total	69(65.7%)	36(34.3%)	105(100%)

The p-value from Chi-square test on data above is 0.010 which means there is clinical significance between TWBCs and histologically proved acute appendicitis. TWBCs >11000, associated with higher rate of histologically proved acute appendicitis).

Table 10. TWBCs Results and Intraoperative Findings in Patients with Acute Appendicitis.

Intra Operative Finding	Raised TWBCs			Total
	<7000	**7000-11000**	**>11000**	
Negative appendicectomy	01(33.3%)	02(66.7%)	00(00.0%)	03(02.9%)
non complicated appendicitis	20(24.1%)	36(43.4%)	27(32.5%)	83(79.0%)
complicated appendicitis	03(15.8%)	05(26.3%)	11(57.9%)	19(18.1%)
Total	24(22.8%)	43(41.0%)	38(36.2%)	105(100%)

The p-value from the Chi-square test on data above is 0.193, which means there is a clinically not significant relation between TWBCs and intraoperative findings. TWBCs >11000, associated with a higher rate of positive intraoperative findings.

RIPASA score

The cut-off point for diagnosis of acute appendicitis is 7.5 according to the RIPASA score. Most patients 95 (90.5%) had score > 7.5 and 10 (9.5%) patients had score < 7.5. there was a significant correlation between RIPASA scoring and diagnosis of acute appendicitis proved by histology (P-value 0.012). Of those with a score > 7.5, 66 patients (69.5%) had histologically inflamed appendix while 29 of them (30.5%) had non-inflamed appendices histologically, see table-5.

Intra-operative findings

There was a significant correlation between RIPASA score and intraoperative findings (P-value 0.007). And this means the higher score increases the possibility of positive intraoperative conclusions and reduces the negative appendicectomy rate, see table-6.

Histopathology

All specimens of appendices were investigated by histopathology to confirm the presence of acute appendicitis, see table-5. Compared to the original study of the development of the RIPASA scoring system, a positive diagnosis of acute appendicitis was confirmed on histological analysis of the resected appendix in 261 patients. In

comparison, 51 patients had a normal appendix, indicating a negative appendicectomy rate of 16.3% (Chong et al., 2010). The negative appendicectomy rate is higher in our study (34.3% vs. 16.3%). But in our research, when the score correlated to histological findings, we found a significant correlation, P-value 0.019.

Outcome

Most patients underwent uneventful post-operative period (97 patients, 92.3%). And only eight patients (7.6%) developed complications in the form of wound infection. Five of them had inflamed appendices, and three had an appendicular abscess. There was a significant correlation between intraoperative findings and outcome, P-value <0.001. See table-7.

Diagnostic accuracy

The sensitivity of the RIPASA scoring system in our study was 69.5%, and specificity was 70%. The diagnostic accuracy was calculated and was 69.5%. Compared to the original analysis of the development of the RIPASA scoring system, the sensitivity and specificity achieved were 88% and 67%, respectively, with a diagnostic accuracy of 81% (Chong et al., 2010). The sensitivity and diagnostic accuracy appear lower in our study, and this can be justified by the sample size in our study being lower than the original study (105 vs. 312).

Our study's positive and negative predictive values (PPV, NPV) were 95.7% and 19.4%, respectively. In the original research, The PPV and NPV for the new appendicitis score, at 93% and 53%, respectively (Chong *et al.*, 2010).

A study conducted in Pakistan was conducted to determine the usefulness of the RIPASA scoring system in diagnosing acute appendicitis using histopathology as the gold standard. The sensitivity of the RIPASA score was 96.7%, the specificity was 93.0%, and the diagnostic accuracy was 94.8%. PPV was 94.8%, and NPV was 95.54% (Butt et al., 2014). Comparing these results with our study, our study's sensitivity, specificity, and diagnostic accuracy were low. This study can also be justified by the small sample size of our research.

Another study was done by the creators of the RIPASA score, comparing the new score with the ALVARADO score. The study included two hundred patients, and RIPASA and ALVARADO scores were calculated for the patients. Only 192 of the 200 patients met the inclusion and exclusion criteria. At the optimal threshold of 7.5, the sensitivity, specificity, diagnostic accuracy, PPV and NPV for RIPASA scores were 98.0%, 81.3%, 85.3%, 97.4%, 97.4% ,and 91.8% respectively. At the optimal threshold of 7.0, the sensitivity, specificity, diagnostic accuracy, PPV, and NPV of the ALVARADO score were 68.3%, 87.9%, 86.3%, 71.4%, 86, and 3%, respectively. (Chong et al., 2011). The sensitivity of our study is lower than that of the RIPASA score in this study (69.5% vs. 98.0%) and higher than that for ALVARADO (69.5% vs. 68.3%). And the diagnostic accuracy of our study is lower than both (69.5% vs. 85.3% vs. 86.3%). Again, this can be demonstrated by our small sample size.

The study was conducted at Kasturba Hospital and Medical College, Mangalore, Karnataka, India. A total of 206 patients were eligible for the study between December 2011 and December 2012. All 206 patients were scored using the Alvarado and RIPASA scoring systems. At the optimal threshold > 7.5, the sensitivity and specificity of the RIPASA scoring system were 96.2% and 90.5%, respectively. Similarly, at the optimal threshold > 7, the sensitivity and specificity of the Alvarado scoring system were 58.9% and 85.7%, respectively. The positive and negative predictive values of the RIPASA score were 98.9% and 73.1%, respectively. The positive predictive value and negative predictive value of the Alvarado score were 97.3% and 19.1%, respectively (Nanjundaiah et al., 2014). When we compared these results with our

results, we found that the sensitivity and specificity of the study were lower than that of the RIPASA score in this study (sensitivity 69.5% vs. 96). .2%, specificity 70% vs. 90.5%). But the sensitivity of the score in our study was higher than that of ALVARADO in this study (69.5% vs. 58.9%). The limitations of this study are the small sample size due to the short study period and the difficulty of collecting specimens for histological studies.

CONCLUSION

The RIPASA sorting system at a threshold of 7.5 or higher can be used to increase diagnostic accuracy in the diagnosis of acute appendicitis. And can be used by emergency department surgeons to reduce the need for imaging tests (abdominal ultrasound and computed tomography) and negative appendicectomy rates.

CONFLICT OF INTEREST

The authors declare that this study and the work presented are our original work. And we confirm that this study has not been previously submitted for a degree or qualification in any other institution, university, or board. Where we have consulted the public work of others, this is always clearly attributed. Where we have quoted from the work of others, the source is always given. Except for such quotations, this study is entirely our work. I acknowledged all primary sources of help. Where the study is based on work done by ourselves jointly with others, we have made clear exactly what was done by others, and we contributed ourselves. None of this work has been published before submission. And this is to notify no personal, financial or ethical interest.

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