Original Research Article

Comparison of Alvarado and RIPASA scoring systems in diagnosis of acute appendicitis and correlation with intraoperative and histopathological findings

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ABSTRACT

Background: Despite extraordinary advances in modern radiology and laboratory investigations an accurate diagnosis of acute appendicitis cannot be made in atypical cases. No single diagnostic aid can dramatically reduce the rate of negative appendicectomy.

Methods: To reduce the rate of negative appendicectomies, application of RIPASA and Alvarado scoring done in every clinically diagnosed cases of appendicitis in a prospective study from January 2015 to January 2016 was done. 100 patients with right lower quadrant abdominal pain fulfilling the inclusion and exclusion criterion underwent appendicectomy in Mahatma Gandhi Hospital, Dr. S.N. Medical college, Jodhpur, Rajasthan, India.

Results: The results of both scoring system were reported and were correlated with intraoperative and histopathological findings. Chi-square test was applied to calculate the p-value for the association between the variables of studied. The mean age was 24.86 years (10-80 years) and there were 61 males and 39 females in the study. Histopathological examination confirmed appendicitis in 95 patients with 5 negative appendicectomies. Negative appendicectomy rate for RIPASA and Alvarado score was 2.17% and 1.54% respectively. Accuracy for RIPASA and Alvarado score was 93% and 68% respectively.

Conclusions: RIPASA score is a more valuable tool for diagnosing acute appendicitis with 93% accuracy, sensitivity 94.74% and specificity 60%; inspite of sophisticated investigations like CT, thus reducing the cost of treatment and minimize negative appendicectomy rate.

Keywords: Accuracy, Acute appendicitis, Alvarado score, Negative appendicectomy rate, RIPASA score

INTRODUCTION

Appendix is a worm like diverticulum arising from posteromedial wall of caecum about 2 cm below ileo-caecal orifice. The length of appendix varies from 2 to 20 cm with an average of 9 cm. It is longer in children than in adults. It has variable positions in relation to neighbouring viscera like retrocaecal (65%), pelvic (30%), paracolic, preileal or postileal.[1] Appendicectomy is the most commonly performed operation (10% of all emergency abdominal operations) and appendicitis is notorious to simulate other acute abdominal conditions, thus it is important differential diagnosis in patients with right iliac fossa pain. Acute appendicitis is one of the most common surgical emergencies with a lifetime prevalence of approximately 1 in 7. Its incidence is 1.5-

1.9/1000 population. Imaging techniques such as ultrasound and CT offer to improve clinical outcome by increasing the accuracy of diagnosis. Stephens demonstrated that when comparing the ultrasound to the Alvarado score for the diagnosis of acute appendicitis, neither one is significantly advantageous.[2] However, the false positive rate is reduced to zero when both the studies are positive and ultrasound improved diagnostic accuracy when the alvarado score was negative or equivocal. Ultrasound has the great advantage of being radiation free, however it is operator dependant. It may be difficult in patients with a retrocaecal appendix and has limited sensitivity. In comparison, CT can overcome these limitations and greater sensitivity in the diagnosis of acute appendicitis, with reported accuracies of 93-98% but it is expensive and not available at all centers particularly in countries, like India.[3,4]

Table 1: Alvarado score for acute appendicitis (mantrels).

Criteria	Score
Symptoms	
Migratory RIF pain	1
Anorexia	1
Nausea and vomiting	1
Signs	
Tenderness in RIF	2
Rebound tenderness	1
Elevated temperature >37.5°C	1
Laboratory	
Leucocyte count>10x10x^9/l	2
Shift to left (neutrophilia)	1
Total	10

There has been a need of some scoring system that can overcome these problems, with good sensitivity and specificity and acceptable negative appendectomies on exploration. One of the common scoring system is Alvarado system to diagnose acute appendicitis which was based on three symptoms, three signs and two laboratory findings and he suggested operation for patients having a score of 7 or above out of 10 (Table 1).[5] Kalan assessed Alvarado score as to its accuracy in the preoperative diagnosis of acute appendicitis and stated that the presence of high score was found to be an easy and satisfactory aid to early diagnosis of acute appendicitis in children and men. However, the false positive rate for appendicitis in women was unacceptably high.[6]

Another scoring system RIPASA score has been derived for diagnosis of acute appendicitis which is more suitable for Middle East and Asian population and suggested operation for patients having a score of 7.5 or above out of 15 (Table 2).[7]

The patient was taken up for surgery once the diagnosis was established and emergency appendectomy was done.

The confirmation of the diagnosis was done by histopathology. The minimum criterion for acute appendicitis was the presence of neutrophils in mucosa, submucosa and lamina properia.[8]

Table 2: RIPASA score for acute appendicitis.

Parameter		Score
Sex:	Male	1.0
	Female	0.5
Age:	<39.9 years	1.0
	>40.0 years	0.5
RIF pain		0.5
Migration of RLQ pain		0.5
Anorexia		1.0
Nausea and vomiting		1.0
Duration of symptoms:	<48 hours	1.0
	>48 hours	0.5
RIF tenderness		1.0
RIF guarding		2.0
Rebound tenderness		1.0
Rovsing's sign		2.0
Fever		1.0
Raised WBC		1.0
Negative urinalysis		1.0
Foreign NRIC		1.0

Aim of the present study was to explore the disease on clinical presentation and to compare both scoring systems in diagnosis of acute appendicitis and correlating both the scoring systems with the intraoperative and histopathological findings to determine the nature of surgical procedure and other therapeutic options and to know the outcome of disease.

METHODS

This was a prospective study done between January 2015 and January 2016 on hundred patients who underwent appendicectomy in Mahatma Gandhi Hospital, Dr. S.N. Medical College Jodhpur, Rajasthan, India.

Inclusion criteria

All patients presenting with RIF pain and clinically diagnosed as acute appendicitis.

Exclusion criteria

- Patients presenting with non-RIF pain and those who have been admitted by other specialties for other complains but who subsequently developed RIF pain.
- Patient with generalized peritonitis.

Hundred patients who fulfilled the eligibility criteria were subjected to routine haematological investigations, USG, and scored on the basis of Alvarado and RIPASA scoring

system. All patients were underwent appendicectomy with prior consent and specimen was sent for histopathological examination.

The result of Alvarado and RIPASA score were reported independently. The result were correlated with intraoperative and histopathological findings and subjected to statistical analysis. All the data were analysed using the necessary statistical calculations, the result were then presented.

RESULTS

Present study comprised of 100 patients, 91 patients were <40 years of age and 9 patients ≥40 years, the mean age was 24.87 years ranging from 10-80 years and the median age was 20.5 years. Prevalence of appendicitis was highest 82% in 10-30 years age group and only 18% were placed in more than 30 years age group. Out of 100 patients, 61 were male and 39 were females.

Table 3: Symptoms frequency distribution.

Symptoms	Frequency	Percentage
Right iliac fossa pain	100	100
Anorexia	93	93
Nausea and vomiting	88	88
Migration of pain to RIF	67	67
Fever	41	41
Duration of symptoms <48 hours	47	47

According Table 3 right iliac fossa pain was present in all the 100 patients in the study group. Anorexia was present in 93 patients. Nausea and vomiting was present in 88 patients. Pain migration was present in 67 patients. Patients presenting with duration of symptoms less than 48 hours were 47 and fever was present in 41 patients.

Table 4: Signs distribution frequency.

Signs	Frequency	Percentage
Tenderness in RIF	100	100
Rebound tenderness	94	94
Rovsing sign	29	29
RIF Guarding	5	5

According Table 4 tenderness was present in 100 patients in study group. Rebound tenderness was present in 94 patients, Rovsing sign was present in 29 patients and guarding was present in 5 patients.

Out of 100 patients, 53 patients had raised total leucocyte count (>10000), shift of the WBC to the left was seen in 20 patients and urine routine microscopy was normal in 96 patients.

Table 5: Alvarado score group frequency distribution.

Alvarado score	Frequency	Percentage
≥7	65	65
<7	35	35

As per Table 5, Alvarado score, when applied to all the patients in the study group had 65 patients in the ≥7 group and 35 patients in <7 group.

Table 6: RIPASA score group frequency distribution.

RIPASA score	Frequency	Percentage
≥7.5	92	92
<7.5	8	8

As per Table 6, RIPASA score, when applied to all the patients in the study group had 92 patients in the ≥7.5 group and 8 patients in <7.5 group.

Table 7: Qualitative analysis of both the scoring systems.

Alvarado score	RIPASA score		Total
	≥7.5	<7.5	
Alvarado score ≥7	65	0	65
Alvarado score <7	27	8	35
Total	92	8	100

On analyzing the cross Table 7 by fisher's exact test, there is definitive agreement that both the scoring systems are positively correlating with each other with respect to diagnosis of the disease (p-value 0.0001).

Table 8: Comparison of Alvarado and RIPASA scoring system with intraoperative findings.

Operative findings	No. of patients	Mean±SD Alvarado score	Mean±SD RIPASA score
Inflamed appendix	83	7.16±1.58	9.29±1.64
Inflamed appendix with meckel's diverticulum	4	8.25±0.95	9.62±0.75
Gangrenous appendix	7	8.57±1.51	12.21±2.05
Perforated appendix	5	8±1.58	11±2.03
Mucocele appendix	1	9±0	10.5±0

As per Table 8 on the basis of intra operative findings all study group has been further divided into 5 groups namely inflamed appendix, inflamed appendix with Meckel's diverticulum, gangrenous appendix, perforated appendix and mucocele appendix.

All 100 clinically diagnosed cases of acute appendicitis in the study were histopathologically examined, 95 were acute appendicitis and 5 were absolutely normal.

Table 9: Comparison of Alvarado score diagnosis with histopathological diagnosis.

Alvarado score	Histopathological diagnosis		Total
	Appendicitis	No appendicitis	
Alvarado score ≥7	64	1	65
Alvarado score <7	31	4	35
Total	95	5	100

Fischer's exact test has been applied over Table 9 and Alvarado scoring system diagnosis correlates well with the histopathological diagnosis. P-value was <0.0495. Sensitivity of the scoring system in the study is 67.37%, specificity comes out to be 80%. The positive and negative predictive values are 98.46% and 11.43% respectively. Accuracy of the scoring system is 68%.

Table 10: Comparison of RIPASA scoring diagnosis with histopathological diagnosis.

RIPASA score	Histopathological diagnosis		Total
	Appendicitis	No appendicitis	
RIPASA score≥7.5	90	2	92
RIPASA score <7.5	5	3	08
Total	95	5	100

Fischer's exact test has been applied Table 10 and RIPASA scoring system diagnosis correlates well with the histopathological diagnosis (p-value was <0.0032). Sensitivity of the scoring system in the study was 94.74%, specificity comes out to be 60%. The positive and negative predictive values are 97.83% and 37.50% respectively. Accuracy of the scoring system was 93%.

Histopathological diagnosis of appendicitis group has been further divided into 3 groups in the study according to increase in severity, namely healed appendix, healing appendicitis and acute appendicitis.

Table 11: Pattern of Alvarado score with decrease in histopathological severity.

Histopathological finding	Frequency	Mean±SD of Alvarado in each category
Acute appendicitis	58	8.01±1.36
Healing appendicitis	12	7.16±1.02
Healed appendix	25	6.36±1.55
Normal appendix	5	5.4±1.14

As per Table 11 there has been increase in mean Alvarado score with increase in histopathological severity.

The mean score for normal appendix, healed appendix, healing appendicitis and acute appendicitis was 5.4, 6.36, 7.16 and 8.01 respectively.

Table 12: Pattern of RIPASA score with decrease in histopathological severity.

Histopathological finding	Frequency	Mean±SD of RIPASA in each category
Acute appendicitis	58	10.29±1.79
Healing appendicitis	12	9.25±1.07
Healed appendix	25	8.62±1.41
Normal appendix	5	7.5±1.45

As per Table 12 there has been increase in mean RIPASA score with increase in histopathological severity. The mean score for normal appendix, healed appendix, healing appendicitis and acute appendicitis was 7.5, 8.62, 9.25 and 10.29 respectively.

Table 13: Distribution of Alvarado score with length of appendix.

Alvarado score	Length			Total
	<6cm	6-9cm	>9cm	
Alvarado score ≥7	4	36	25	65
Alvarado score <7	7	23	5	35
Total	11	59	30	100

On applying chi square test over Table 13, there has been correlation between increase in length of appendix with increase in Alvarado score (P-value 0.0122).

Table 14: Distribution of RIPASA score with length of appendix.

RIPASA score	Length			Total
	<6cm	6-9cm	>9cm	
RIPASA score≥7.5	8	56	28	92
RIPASA score <7.5	3	3	2	08
Total	11	59	30	100

On applying chi square test over Table 14, there has been correlation between increases in length of appendix with increase in RIPASA score (P-value 0.042).

According Table 15, out of all the symptoms only anorexia came out to be statistically significant (p-value 0.038).

According Table 16, out of all the signs only rebound tenderness came out to be statistically significant (p-value 0.027).

According Table 17, out of all 100 patients, male and female patients were 61 and 39 respectively. Negative appendectomy percentage was 1.64 and 10.26 in male and female respectively.

Table 15: Statistical significance analysis of symptoms.

Symptoms		Histopathological		Statistical significance (p value)
		Appendicitis	No appendicitis	
RIF pain	Present	95	5	1.00
	Absent	0	0	
Anorexia	Present	90	3	0.038
	Absent	5	2	
Nausea and vomiting	Present	83	5	1.00
	Absent	12	0	
Fever	Present	40	1	0.645
	Absent	55	4	
Pain migration to the RIF	Present	63	4	1.00
	Absent	32	1	
Symptoms duration	<48 hours	46	1	0.366
	>48 hours	49	4	

Table 16: Statistical significance analysis of signs.

Signs		Histopathological		Statistical significance (p value)
		Appendicitis	No Appendicitis	
RIF tenderness	Present	95	5	1.00
	Absent	0	0	
Rebound tenderness	Present	91	3	0.027
	Absent	4	2	
RIF Guarding	Present	5	0	1.00
	Absent	90	5	
Rovsing sign	Present	29	0	0.317
	Absent	66	5	

DISCUSSION

Acute appendicitis is one of the most common surgical emergencies encountered in the world particularly in age group less than 30 years.[9] In United States, rate of negative appendicectomy is approximately 15% out of total appendicectomies done each year. Surgeon's good clinical assessment is considered to be the most important requisite in the diagnosis of appendicitis. Several other conditions can mimic this clinical condition.[10] 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.[3,4]

There has been a need of scoring system that can overcome these problems with acceptable sensitivity, specificity and negative appendectomy rate. One of the most commonly used is the Alvarado scoring system which incorporates symptoms, signs and laboratory investigations to reach the diagnosis.[5] Another scoring system, RIPASA score has been developed, claimed to have better outcomes in Asian settings.[7]

Table 17: Incidence of negative appendectomy in male and female patients.

Sex	No. of patients	Negative appendectomy	
		No. of patients	Percentage
Male	61	1	1.64
Female	39	4	10.26
Total	100	5	5.00

This study was an attempt to compare both the scoring systems in the diagnosis of acute appendicitis and to see whether there is correlation between the scores with intraoperative and histopathological findings.

Present study included clinically suspected 100 cases, with 91% patients in <40 years age group and 9% patients in ≥40 years. Mean age of the patients was 24.86 years. There were 61 males and 39 females in the study. All the patients clinically suspected to be acute appendicitis were scored according to both the scoring systems and were taken up for surgery. Intraoperative parameters such as length of appendix, position of appendix, presence of free fluid, type of free fluid, presence of gangrene, presence of fecolith and base of appendix were assessed. Histopathology was the gold standard for confirmation of the diagnosis. The histopathologically inflamed appendix was classified under three groups namely, acute appendicitis, healing appendicitis, healed appendix. Histopathologically 95 patients were in appendicitis group and 5 patients were in no appendicitis group.

Table 18: Comparison of Alvarado with RIPASA scoring in the diagnosis of acute appendicitis.

Statistical analysis	Alvarado	RIPASA
Sensitivity	67.37%	94.74%
Specificity	80%	60%
Positive predictive value	98.46%	97.83%
Negative predictive value	11.43%	37.5%
Accuracy	68%	93%
Negative appendectomy rate	1.54%	2.17%

Symptoms such as migration of pain to the RIF was present in 67 cases out of 100 cases (67%) of acute appendicitis (p value 1.000), anorexia in 93cases (93%) (p-value 0.038), nausea and vomiting in 88 cases (88%) (p-value 1.000), fever in 41 cases (41%) (p-value 0.645). RIF pain was present in all the cases of acute appendicitis (100%). Only symptoms that came out to be statistically significant was anorexia. In a study by Korner H et al nausea and vomiting, and pain migration to the RIF were the two symptoms that were statistically significant.[11] Present study did not agreed with the study by Korner H et al as it did not find nausea and vomiting and pain migration as statistically significant.

Signs such as RIF tenderness was present in all the 100 cases of acute appendicitis, rebound tenderness in 94 patients (p-value 0.0279), guarding in 5 patients (p-value 1.000), Rovsing sign in 29 patients (p-value 0.317). Out of all the clinical signs, rebound tenderness was found statistically significant; this finding has been found consistent with the study by Wagner JM.[10]

Alvarado score when applied in all the clinically suspected patients, has 65 cases (65%) with score ≥7 and 35 Cases (35%) with score less than 7. When analyzed with respect to histopathology the sensitivity of the scoring system in the present study came out to be 67.37%, specificity was 80%, positive and negative predictive values were 98.46% and 11.43% respectively. Accuracy was 68%. Negative appendectomy rate was

1.54%. Dev et al study reported the sensitivity and specificity of Alvarado score to be 94.2% and 70% respectively, positive and negative predictive values of Alvarado score were 86.9% and 69.80%. Negative appendectomy rate in that study was 13%.[12] The sensitivity in the present study was 67.37% which is around 26% less than quoted study, specificity being 10% higher in present study which is nearly comparable with the quoted study. It can be concluded from studies by Jawaid et al, Dey S et al, Baiday N et al, Chan MY et al, Khan et al that sensitivity, specificity, positive predictive value and negative predictive value of Alvarado scoring system range from 59% to 89%, 23% to 70%, 77% to 98% and 69.8% to 98% respectively.[12-16]

RIPASA score when applied in all patients suspected to be acute appendicitis, 92 patients were in ≥7.5 score group (92%) and 8 were in <7.5 score group (8%). When analyzed with respect to histopathology the sensitivity of the scoring system in the present study came out to be 94.74%, specificity of 60%, positive and negative predictive values were 97.83% and 37.5% respectively. Negative appendectomy rate was 2.17% and accuracy was 93%. Chong CF et al study based on retrospective and ROC analysis quoted that the expected sensitivity and specificity of the RIPASA scoring system were 88% and 67% respectively, and diagnostic accuracy being 81%. The positive and negative predictive values were expected to be 93% and 53% respectively.[7]

On comparing both the scoring systems in the present study, RIPASA score has been found more sensitive (94.74%) as compared to Alvarado (67.37%), Alvarado score was more specific (80%) as compared to RIPASA score (60%). Positive predictive value of Alvarado score came out to be 98.46% as compared to 97.83% in RIPASA score. Negative predictive value of RIPASA scoring system was 37.5% as compared to 11.43% in Alvarado system. Accuracy of Alvarado system was 68% as compared to 93% in RIPASA system. Negative appendectomy rate by application of Alvarado system was 1.54% as compared to 2.17% by RIPASA system. In a prospective study by Chong CF et al, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the RIPASA score were 98%, 81.3%, 85.3%, 97.4% and 91.8% respectively when compared to Alvarado score with sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of 68.3%, 87.9%, 86.3%, 71.4% and 86.5% respectively.[17] The authors of the RIPASA scoring system have claimed in this comparative prospective study that RIPASA score is better than Alvarado score in Asian settings.[17] There is paucity of published studies, by other authors, comparing these scoring systems.

Receptor operative curve analysis was done in the present study to look for the cut off score for both the scoring systems, with good sensitivity and specificity. Alvarado score cut off was found to be >7 while original cut off was ≥7.[5] The sensitivity and specificity at score >7 was

found to be 52.63% and 100% respectively, when compared with sensitivity and specificity of 67.37% and 80% respectively at cut off ≥7 in the present study.

RIPASA score cut off came out to be >7, which was inconsistent with the original cut off ≥7.5.[7] The sensitivity and specificity were found to be 94.74% and 60% respectively at cut off >7, which were same at cut off ≥7.5 as in the present study. The cut off value needs to be evaluated in further studies with increased sample size and in different geographic conditions.

Intraoperative findings such as length of appendix, presence of free fluid, presence of gangrene, presence of fecolith and base of appendix were assessed in all patients of acute appendicitis. Increase in length of appendix was found statistically significant for the groups with Alvarado score ≥7 and RIPASA score ≥7.5 (p-value <0.05). Other findings were statistically not significant when analyzed with both the systems at their respective cut off score. There is lack of published studies which correlate intraoperative findings with scoring systems and further analysis through multicentric prospective studies is needed.

CONCLUSION

RIPASA scoring system is more sensitive 94.74% as compared to Alvarado scoring system (67.37%). Alvarado scoring system is more specific (80%) as compared to RIPASA scoring system (60%). PPV of Alvarado scoring system is 98.46% as compared to 97.83% in RIPASA scoring system. NPV of RIPASA scoring system is 37.5% as compared to 11.43% in Alvarado scoring system. Diagnostic accuracy of RIPASA scoring system is 93% as compared with 68% in Alvarado scoring system. Negative appendectomy rate with Alvarado scoring system is 1.54% as compared to 2.17% with RIPASA scoring system. Intraoperative finding such as increase in length of appendix is consistent with increase in Alvarado score and RIPASA score at >7 and >7.5 respectively and statistically significant. There is paucity of studies that compare intraoperative and histopathological findings with both scoring systems and needs to be evaluated further by prospective studies.

REFERENCES

1. Chaurasia BD. Human anatomy regional and applied; 7th ed. 2016;2:295-298.
2. Stephens PL, Mazzucco JJ. Comparison of ultrasound and Alvarado score for the diagnosis of acute appendicitis. Conn Med. 1999;63:137-40.
3. Ozao-Choy J, Kim U, Vieux U, Menes TS. Incidental findings on computed tomography scans for acute appendicitis: prevalance, costs and outcome. Am Surg. 2011;77:1502-9.
4. Petrosyan M, Estrada J, Chan S, Somers S, Yacoub WN, Kelso RL,et al. CT scan in patients with suspected appendicitis: Clinical implications for the acute care surgeon. Eur Surg Res. 2008;40(2):211-9.
5. Alvarado A. A practical score for early diagnosis of acute appendicitis. Ann Emerg Med. 1986;15:557-64.
6. Kalan M, Talbot D. Evaluation of the modified alvarado score in the diagnosis of acute appendicitis-a prospective study: Ann Coll Surg Engl. 1994;76:418-9.
7. Chong CF, Adi MIW, 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;51:220-5.
8. Andreou P, Blain S, Boulay CEH. A histopathological study of appendix at autopsy and after surgical resection. Histopathology. 1990;17:427-31.
9. Williams GR. Presidential address: A history of appendicitis. Ann Surg. 1983;197:495-506.
10. Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time? A population based analysis. JAMA. 2001;286:1748-53.
11. Korner H, Sondenaa K, Soreide JA, Nystad A, Vatten C. The history is important with suspected appendicitis. Dig Surg. 2000;17(4):364-8.
12. Jawaid A, Asad A, Motiei, Munir A, Bhutto E, Choudry H, et al. Clinical scoring system: a valuable tool for decision making in cases of acute appendicitis. J Pak Med Assoc. 1999;49:254-9.
13. Baidya N, Rodrigues G, Rao A, Khan SA. Evaluation of Alvarado score in acute appendicitis: a prospective study. Internet J Surg. 2007;9:1-3.
14. Chan MY, Teo BS, Ng BL. The Alvarado score and acute appendicitis. Ann Acad Med Singapore. 2001;30:510-2.
15. Khan I, Ur Rehman A. Application of Alvarado scoring in diagnosis of acute appendicitis. J Ayub Med Coll Abbottabad. 2005;17:41-4.
16. Jang SO, Kim BS, Moon DJ. Application of Alvarado score in patients with suspected appendicitis. Korean J Gastroentrol. 2008;52:27-31.
17. Chong CF, Thien A, Mackie AJ, Tin AS, Tripathi S, Ahmad MA, Tan LT, Ang SH, Telisinghe PU. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. Singapore Med J. 2011;52(5):340-5.