

The Study To Evaluate The Efficacy Of Alvarado Score And RIPASA Score In Diagnosis Of Acute Appendicitis And Correlation With Intra Operative And Pathological Findings.

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ABSTRACT

Background: Diagnostic scores are useful and easy methods which help in reaching surgical decision. These scores make use of clinical, analytical and radiological findings to produce a rationalized model of clinical decision making. The objectives are to analyse clinico-pathological condition of acute appendicitis and to confirm diagnosis by histo-pathological examination and by Alvarado score and RIPASA score. **Methods:** A prospective study of 100 patients who were suspected enough to warrant surgery for acute appendicitis admitted in St. Stephens Hospital under various surgical units was conducted for a period of 2 years. Base line investigations (full blood count, urine routine examination, USG abdomen and peripheral smear for shift to left) are done. USG is an optional study. Then a specially designed Performa is filled for each patient. These Performa have general information about the patient plus all the variables based on Alvarado and RIPASA score. **Results:** The sensitivity of RIPASA Score in our study (cut off value of 7.5) is 95.6% while the specificity is 50%. The positive predictive value is 94.5% and negative predictive value is 55.6%. Accuracy of the scoring system is 91%. The sensitivity of Alvarado score (cut off value of 7) in our study is 63.3% while the specificity is 100%. The positive predictive value is 100% and negative predictive value is 23.3%. Accuracy of the scoring system is 67%. RIPASA score is highly sensitive score for Acute appendicitis at a cut off value of 7.5 in contrast to ALVARADO score which is both sensitive as well as specific at cut off value of 6. Area under ROC curve for ALVARADO score is slightly higher than RIPASA 0.926 vs 0.914 hence we can conclude that ALVARADO score at cut off value of 6 is better than RIPASA but results are not statistically significant. **Conclusion:** The application of these scoring systems improves diagnostic accuracy and thus consequently reduces complication rates.

Keywords: Alvarado score, Appendicitis, Histo-pathology, RIPASA score.

INTRODUCTION

Acute surgical abdomen is an important problem faced by surgeons. The wide range of cause and varied patient presentation pose a formidable diagnostic and therapeutic challenge. As with all new developments however, enthusiasm for the new and modern techniques has sometimes overwhelmed good clinical judgment.^[1]

Acute appendicitis is one of the most common surgical emergencies. The lifetime rate of appendectomy is 12% for men and 25% for women, with approximately 7% of all people undergoing appendectomy for acute appendicitis

during life time.^[1,2] The diagnosis of acute appendicitis is based purely on clinical history and examination combined with laboratory investigations such as elevated WBC. Despite being a common problem, acute appendicitis remains a difficult diagnosis to establish particularly among the young, elderly and females of reproductive age group where a host of other genito-urinary and gynaecological inflammatory conditions are present with signs and symptoms that are similar to those of acute appendicitis.^[3,4]

The surgical principle about acute appendicitis "when in doubt, take it out", is not correct in view of the number of major and minor complications following appendectomy. Despite more than 100 years of experience, accurate diagnosis still evades the surgeon. Owing to its myriad presentations, acute appendicitis is a common but difficult diagnostic problem. The accuracy of the clinical examination

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has been reported to range from 71% to 97% and varies greatly depending on the experience of the examiner.^[5-7]

A delay in performing an appendectomy in order to improve its diagnostic accuracy increases the risk of appendicular perforation and sepsis which in turn increases morbidity and mortality, the opposite is also true, where with reduced diagnostic accuracy the negative or unnecessary appendectomies rate is increased and this is generally reported to be approximately 20-40%.^[8-11]

Perforation may occur in upto 35 % of cases. So traditionally surgeons have accepted that higher rate of negative appendectomies in order to decrease the incidence of perforation. This approach has been increasingly questioned in today's era of cost effective health care. The goal of surgical treatment is removal of inflamed appendix before perforation with minimal number of negative appendectomies.^[12,13]

Diagnosis of Acute appendicitis remains challenging despite improvement in history taking, clinical examination, the new computer aided decision support system, clinical diagnostic sourcing and new imaging technique.^[14]

Diagnostic scores are useful and easy methods which help in reaching surgical decision. These scores make use of clinical, analytical and radiological findings to produce a rationalized model of clinical decision making. Presently several such scoring systems have been proposed to aid in diagnosis of acute appendicitis. The description of Alvarado Score system has greatly improved ability to diagnose.^[15]

The use of an objective scoring system such as the Alvarado System can reduce the negative appendectomy rate to 0-5 %.^[5,6]

Another score RIPASA comprising of 15 parameters is a new scoring system designed by Raja Isteri Pengiran Anak Saleha Hospital, Bandar Seri Begawan, Brunei Darussalam which is supposed to be more promising for Asian population.^[9]

Although, a systemic Review of several published scoring systems concludes that they are potentially useful in confirming the diagnosis of acute appendicitis, but not in ruling it out. Therefore, they should not be solely relied upon but used as an adjunct to traditional history, examination and laboratory testing.^[16] This research was undertaken to study various parameters yielding the diagnosis of acute appendicitis by comparing two scores of acute appendicitis, RIPASA and ALVARADO and to find out which scoring method is better.^[3]

In our hospital acute appendicitis is one of the most common acute abdominal emergencies warranting surgery in patient presenting with atypical clinical findings. These scoring system play a definite role in diagnosis of acute appendicitis because these are easy to perform. Till now in our hospital no study to

compare Alvarado and RIPASA score had been done hence this research work was undertaken.^[11]

The objectives are to analyse clinico-pathological condition of acute appendicitis and to confirm diagnosis by histo-pathological examination and to decrease the negative appendectomy rate.

MATERIALS AND METHODS

A prospective study of 100 patients who were suspected enough to warrant surgery for acute appendicitis admitted in St. Stephens Hospital under various surgical units was conducted for a period of 2 years.

Inclusion criteria: All patients admitted with age more than 13 years and irrespective of sex presenting with right iliac fossa pain suspected to be of acute appendicitis and undergone appendectomy.

Exclusion criteria

1. Patients presenting with any form of non- right iliac fossa pain such as right upper quadrant pain etc.
2. Patients who had undergone other emergency laparotomy where appendectomy was also performed as a part of procedure
3. Patients with appendicular lump
4. Patients undergoing elective appendectomies after appendicular lump.
5. Pregnant females.

Diagnostic Criteria for Acute appendicitis

- History of right lower quadrant pain or periumbilical pain migrating to right lower quadrant with nausea and/ or vomiting
- Fever of more than 38 °C.
- Right lower quadrant guarding and tenderness on physical examination.

Base line investigations (full blood count, urine routine examination, USG abdomen and peripheral smear for shift to left) are done. USG is an optional study. Then a specially designed Performa is filled for each patient. These Performa have general information about the patient plus all the variables based on Alvarado and RIPASA score. Both the RIPASA and Alvarado scores were derived, but decisions for appendectomy were based on clinical judgement. Diagnosis of acute appendicitis is confirmed by operative findings and histopathological assessment of the appendectomy specimen. The Appendix specimen is sent for histopathology report and the report is noted. Histopathological diagnosis is considered as final. Both Ripasa and Alvarado scores were compared to Histopathological report.

Alvarado score:^[5] Seven criteria (8 points) were chosen for inclusion in the diagnostic score, weighted to represent joint probability of disease.

These criteria were grouped as

1. Migration of pain
 2. Anorexia
 3. Nausea and vomiting
 4. Tenderness right iliac fossa
 5. Raised Temperature ($> 37.3^{\circ}C$)
 6. Leucocytosis
 7. Shift of left in leucocyte count (Neutrophil $> 75\%$)
- Right lumbar quadrant pain and a left shift were found to be the most prevalent, thus receiving 2 points each, while each of the remaining criteria was attributed 1 point. This initial study included both adults and children, with an age range of 4 to 80 years (mean 25.3). An Alvarado Score of ≥ 7 was considered high risk for appendicitis. Though not explicitly stated in the study, this threshold value had a sensitivity of 81% and a specificity of 74%.

RIPASA (Raja Isteri Penigiran Anak Saleha) Score –

What is probably the newest member to the group of appendicitis scores is the RIPASA (Raja Isteri Penigiran Anak Saleha) score, named after its hospital of origin in Brunei. Clinical data from 312 patients who had undergone an emergency appendectomy was retrospectively collected and used to generate 15 parameters by Chong et al.^[13]

The 15 parameters and the scores generated by Chong et al were^[13]

1. Age (less than 40 years is 1 point; greater than 40 years is 0.5 point)
2. Gender (male is 1 point; female is 0.5 point)
3. Right iliac fossa (RIF) pain (0.5 point)
4. Migration of pain to RIF (0.5 point),
5. Nausea and vomiting (1 point),
6. Anorexia (1 point),
7. Duration of symptoms (less than 48 hours is 1 point; more than 48 hours is 0.5 point),
8. RIF tenderness (1 point),
9. Guarding (2 points),
10. Rebound tenderness (1 point),
11. Rovsing's sign (2 points),
12. Fever (1 point),
13. Raised white cell count (1 point),
14. Negative urinalysis (1 point)
15. Foreign national registration identity card (1 point).

We have given 1 pt to all our patients in RIPASA score as all patients were local residents.

According to the RIPASA score the cut-off threshold score is 7.5.

Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0. Continuous variables are presented as mean \pm SD, and categorical variables are presented as absolute numbers and percentage. The comparison of normally distributed continuous variables between the groups was performed using Student's t test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate. A receiver operating

characteristics (ROC) analysis was calculated to determine optimal cut-off value for ALVARADO score and RIPASA score. The area under the curve, the sensitivity, specificity, PPV and NPV was also calculated to analyse the diagnostic accuracy of Alvarado and RIPASA were Gold standard HPE diagnosis. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

RESULTS

The study was conducted in Department of Surgery, St Stephens Hospital for a period of 2 years. A total of 100 patients attending surgical emergency were offered to be part of study.

Table 1: Results of histo-pathology examination.

| Histopathology | Number of patients | Percentage |
|------------------------|--------------------|------------|
| Acute Appendicitis | 90 | 90% |
| Non Acute Appendicitis | 10 | 10% |
| Total | 100 | 100% |

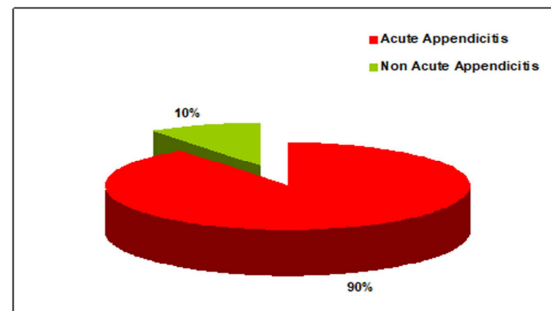


Figure 1: Graphical representation.

Histopathology has been taken as reference gold standard for diagnosis of acute appendicitis in our study. Out of the total 100 patients in our study 90 no of cases (90%) were actually found acute appendicitis on histopathology while rest 10 cases were normal on histopathology [Table 1, Figure 1].

Table 2: Alvarado Score groups frequency distribution.

| AS | Number of patients | Percentage |
|----------|--------------------|------------|
| ≥ 7 | 57 | 57% |
| < 7 | 43 | 43% |
| Total | 100 | 100% |

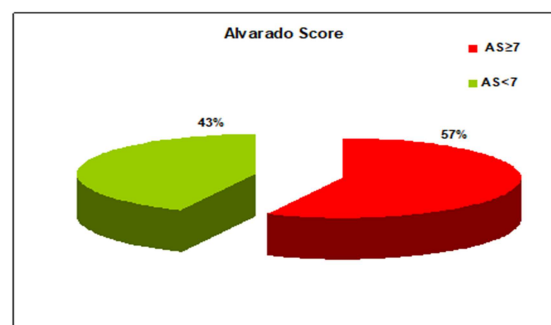


Figure 2: Graphical representation.

Alvarado score was ≥ 7 in 57% and < 7 in 43%. So according to AS, there were 57 patients in highly probability of acute appendicitis category while rest 43 were in low/mild probability Table 2, Figure 2].

Table 3: Comparison of Alvarado Score (AS) with Gold standard (Histopathology).

| | Acute Appendicitis (Histopathologically) | Non Appendicitis (Histopathologically) | Total |
|-------------|--|--|---------|
| AS ≥ 7 | 57 (63.3%) | 0 (0%) | <0.001* |
| AS < 7 | 33 (36.7%) | 10 (100%) | |
| Total | 90 (100%) | 10 (100%) | |

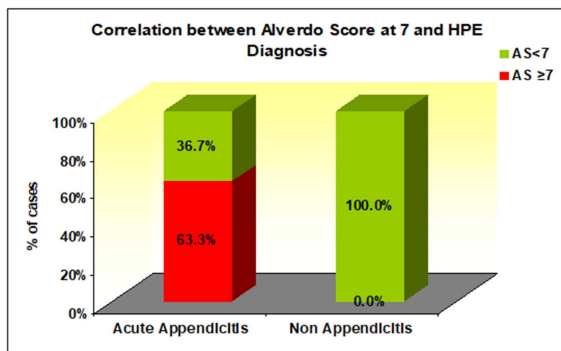


Figure 3: Graphical representation.

The sensitivity of AS in our study is 63.3% while the specificity is 100. The positive predictive value is 100% and negative predictive value is 23.3%. Accuracy of the scoring system is 67% [Table 3, Figure 3].

Table 4: RIPASA Score groups frequency distribution.

| RIPASA Score | Number of patients | Percentage |
|--------------|--------------------|------------|
| ≥ 7.5 | 91 | 91% |
| < 7.5 | 9 | 9% |
| Total | 100 | 100% |

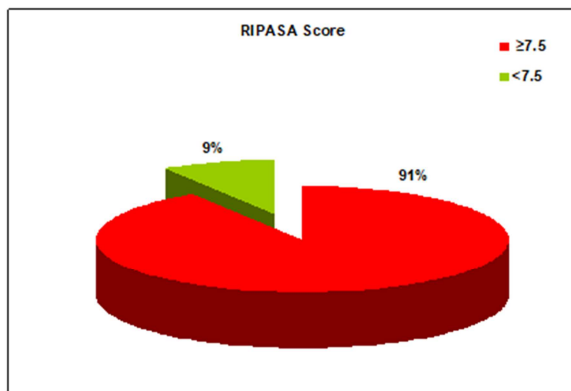


Figure 4: Graphical representation.

RIPASA Score was ≥ 7.5 in 91 no (91%) and < 7 in 9 no (9%). So according to RRIPASA Score there

were 91% patients in highly probability of acute appendicitis category while rest 9% were in low/mild probability [Table 4, Figure 4].

Table 5: Comparison of RIPASA Score with Gold standard (Histopathology).

| | Acute Appendicitis (Histopathologically) | Non Appendicitis (Histopathologically) | Total |
|-------------------------|--|--|---------|
| RIPASA Score ≥ 7.5 | 86 (95.6%) | 5 (50%) | <0.001* |
| RIPASA Score < 7.5 | 4 (4.4%) | 5 (50%) | |
| Total | 90 (100%) | 10 (100%) | |

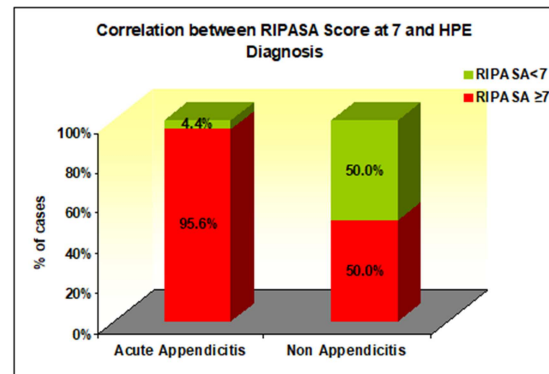


Figure 5: Graphical representation.

The sensitivity of RIPASA Score in our study is 95.6% while the specificity is 50%. The positive predictive value is 94.5% and negative predictive value is 55.6%. Accuracy of the scoring system is 91% [Table 5, Figure 5].

Table 6: Comparison of AS and RIPASA Score.

| | AS | RIPASA Score |
|-------------|-------|--------------|
| Sensitivity | 63.3% | 95.6% |
| Specificity | 100% | 50% |
| PPV | 100% | 94.5% |
| NPV | 23.3% | 55.6% |
| Accuracy | 67% | 91% |

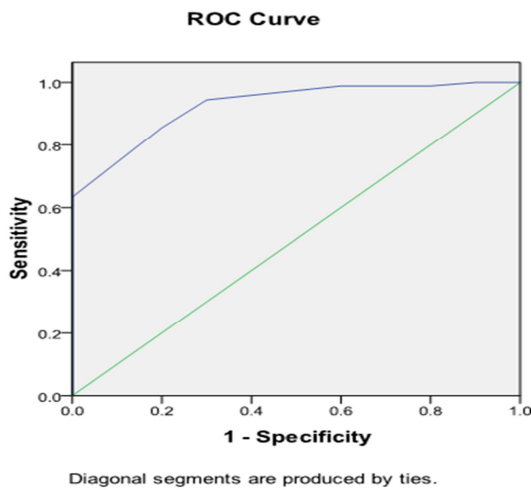


Figure 6: Receiver Operating Curve Analysis of scoring systems.

Area under curve is 0.926 (0.857 – 0.996). From the curve the cut off comes out to be 6 at which there is a good balance between sensitivity and specificity [Table 6, Figure 6].

Table 7: Comparison of Alvarado Score (AS) with Gold standard (Histopathology).

| | Acute Appendicitis (Histopathologically) | Non Appendicitis (Histopathologically) | Total |
|--------|--|--|----------|
| AS ≥ 6 | 77 (85.6%) | 2 (20%) | <0.001 * |
| AS < 6 | 13 (14.4%) | 8 (80%) | |
| Total | 90 (100%) | 10 (100%) | |

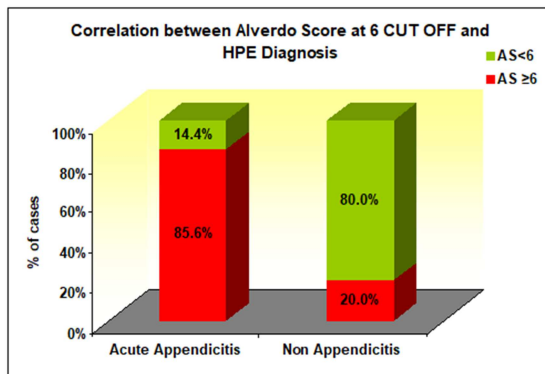


Figure 7: Graphical representation.

Sensitivity = 85.6%, Specificity = 80%, Positive Predictive Value = 97.5%, Negative Predictive Value = 38%, Accuracy = 85%.

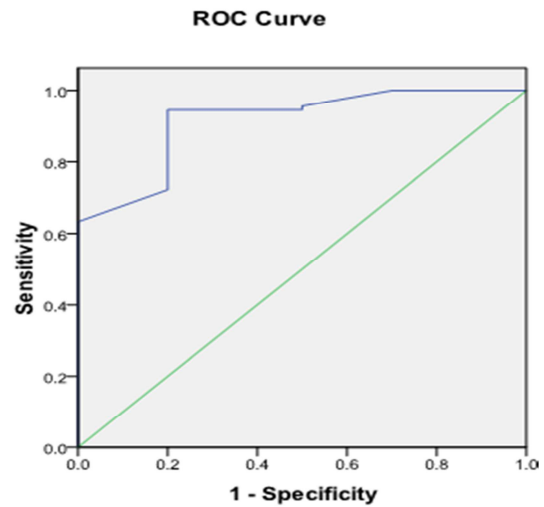


Figure 8: RIPASA Score Receiver Operating Curve analysis.

Area under curve is 0.914 (0.832 – 0.996) From the curve the cut off comes out to be 8 at which there is a good balance between sensitivity and specificity [Figure 8].

Table 7: Comparison of RIPASA with Gold standard (Histopathology).

| | Acute Appendicitis (Histopathologically) | Non Appendicitis (Histopathologically) | Total |
|------------|--|--|---------|
| RIPASA ≥ 8 | 85 (94.4%) | 5 (50%) | 0.001 * |
| RIPASA < 8 | 5 (5.6%) | 5 (50%) | |
| Total | 90 (100%) | 10 (100%) | |

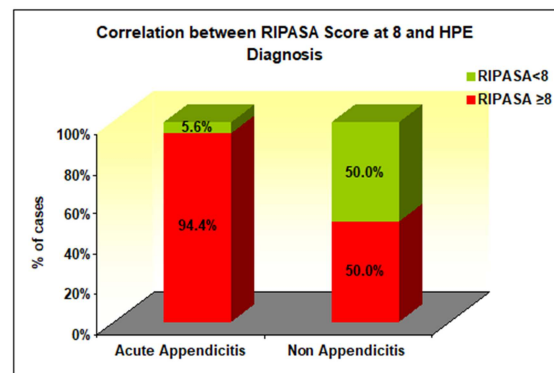


Figure 9: Graphical representation.

Sensitivity = 94.4%, Specificity = 50%, Positive Predictive Value = 94.4%, Negative Predictive Value = 50%, Accuracy = 90%.

DISCUSSION

Acute Appendicitis remains a common abdominal surgery throughout the world. Early and accurate

diagnosis of acute appendicitis is required to reduce the mortality and morbidity associated with delayed diagnosis and its complications. In addition to significant mortality and morbidity, negative appendectomy is also responsible for loss of precious staff hours and financial resources. None of the investigations like USG, CT scan can conclusively diagnose appendicitis. Some of the investigations already discussed are costly, time consuming; require more sophisticated equipment and expertise, while some are not feasible and not readily available. The diagnosis of acute appendicitis continues to be difficult due to variable presentation of disease and the lack of reliable diagnostic test. Even today, a thorough clinical examination with basic investigations like WBC counts remains the cornerstone in the diagnosis of acute appendicitis. With this background many eminent surgeons have been adopting different scoring systems in order to decrease negative appendectomy.^[5,9]

A number of clinical scoring system has been used as a complimentary aid in the diagnosis of acute appendicitis. Initial assessment can be improved by the use of clinical scoring system. Alvarado scoring system is one of the oldest scoring system while RIPASA is the newest scoring system. Both these scoring systems are based on history, physical examinations and few laboratory tests. Both scoring systems are simple, easy to apply and cheap complimentary aid for supporting the diagnosis of acute appendicitis. The present study was undertaken to evaluate the usefulness of Alvarado and RIPASA scoring system in reducing the number of negative appendectomies and to compare both these scoring systems. Our results and observations are discussed and compared with various other studies.^[1,9,12]

The sensitivity of RIPASA Score in our study is 95.6% while the specificity is 50%. The positive predictive value is 94.5% and negative predictive value is 55.6%. Accuracy of the scoring system is 91%. The sensitivity of AS in our study is 63.3% while the specificity is 100. The positive predictive value is 100% and negative predictive value is 23.3%. Accuracy of the scoring system is 67%. Comparison of Sensitivity of Alvarado score (cut off 7) in different studies revealed that sensitivity of Alvarado score varies from 53 % to 95%.

| | |
|--------------------------------------|--------|
| Kalem et al ^[17] | 81.63% |
| Denizbasi A ^[18] | 95.40% |
| Al- Hashemy et al ^[19] | 53.90% |
| Shrivastava UK et al ^[20] | 92.40% |
| Present study (cut off 7) | 63.3% |
| Present study (cut off 6) | 85.6% |

Comparison of RIPASA score (cut off 7.5) in different studies revealed that sensitivity and specificity of RIPASA score ranges between 88 to 98 % and 66 to 81 % respectively.

| | | | |
|--|--------------------------------|------------------------------|-----------|
| | Chong FC et al (Retrospective) | Chong FC et al (prospective) | Our Study |
|--|--------------------------------|------------------------------|-----------|

| | | | |
|---------------------|------------------------|------------------------|-------|
| | study) ^[13] | study) ^[21] | |
| Sensitivity | 88.46% | 98% | 95.6% |
| Specificity | 66.7% | 81.3% | 50% |
| PPV | 93 % | 85.3% | 94.5% |
| NPV | 53% | 97.4% | 55.6% |
| Diagnostic Accuracy | 80.50% | 91.8% | 91% |

Comparison of RIPASA and ALVARADO score by Chong CF et al and our study.^[21]

| | | Chong CF et al ^[21] | Our Study |
|----------------|---------------------|--------------------------------|-----------|
| RIPASA score | Sensitivity | 98% | 95.6% |
| (cut off 7.5) | Specificity | 81.3% | 50% |
| | PPV | 85.3% | 94.5% |
| | NPV | 97.4% | 55.6% |
| | Diagnostic Accuracy | 91.8% | 91% |
| Alvarado Score | Sensitivity | 68.3% | 63.3% |
| (cut off 7) | Specificity | 87.9% | 100% |
| | PPV | 86.3% | 100% |
| | NPV | 71.4% | 23.3% |
| | Diagnostic Accuracy | 86.5% | 67% |

In our study, usefulness of the scoring system was demonstrated beyond doubt by reducing the number of negative appendectomies.

In Our study we found that sensitivity of Alvarado score increases from 63.3 % to 85.6% at a cut off value of ≥ 6 . Similar results were observed in a study by Shrivastva UK et al^[20]. In this study also author found that sensitivity of Alvarado sore increases from 63.3% to 85.6% at a cut off value of ≥ 6 especially in Indian set up. None of the patients in our study with normal appendix had Alvarado score of 7 or more.

Area under ROC curve for ALVARADO score is slightly higher than RIPASA (0.926 vs 0.914) hence we can conclude that ALVARADO score at cut off value of 6 is better than RIPASA but results are not statistically significant.

CONCLUSION

- Both scoring systems are fast, simple, reliable, non-invasive, repeatable and safe diagnostic modality without extra expense and complications.
- The sensitivity of RIPASA Score in our study (cut off value of 7.5) is 95.6% while the specificity is 50%. The positive predictive value is 94.5% and negative predictive value is 55.6%. Accuracy of the scoring system is 91%.
- The sensitivity of Alvarado score (cut off value of 7) in our study is 63.3% while the specificity is 100%. The positive predictive value is 100% and negative predictive value is 23.3%. Accuracy of the scoring system is 67%.
- Higher RIPASA score correlates with higher chances of perforation.

5. RIPASA score is highly sensitive score for Acute appendicitis at a cut off value of 7.5 in contrast to ALVARADO score which is both sensitive as well as specific at cut off value of 6.
6. Area under ROC curve for ALVARADO score is slightly higher than RIPASA 0.926 vs 0.914 hence we can conclude that ALVARADO score at cut off value of 6 is better than RIPASA but results are not statistically significant.
7. The application of these scoring systems improves diagnostic accuracy and thus consequently reduces complication rates.
21. C F Chong, A Thien, A J Mackie, A S Tin, S Tripathi, M A Ahmad, L T Tan, S H Ang , P U Telisinghe. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. Singapore Med J. 2011; 52(5):340-5.

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REFERENCES

1. Hardin DM. Acute Appendicitis : Review and update. Am Fam Physician. 1999 ; 60: 2027-34.
2. Cuschieri A. The small intestine and vermiform appendix; In: Cuschieri A, G R Giles, R Mossa.(ed). Essential surgical practice. 3rded. London: Butter worth Heinman. 1995;1325-8
3. Hoffmann J Rasmussen. Aids in diagnosis of acute appendicitis. Br S Surg. 1989; 76 :774-9
4. Borushok KF, Jefferey RB, Laing FC, Townsend RR. Sonographic diagnosis of perforation in patients with acute appendicitis. AJR Am J Roentgenol. 1990; 154 : 275-8.
5. Alvarado A. A practical score for early diagnosis of acute appendicitis. Ann emerg. Med. 1986; 15: 557
6. Teicher I. Scoring system to aid in diagnosis of appendicitis. Ann Surg. 1983; 198:753.
7. Liu JL, Wyatt JC, Deeks JJ. Systemic reviews of clinical decision tools for acute abdominal pain. Health technol Assess. 2006;10:1-167.
8. Yale SH, Musana KA. Famous names and medical eponyms. CM and R. 2005; 3(3) : 187-189.
9. Fitz RH: Perforating inflammation of the vermiform appendix: With special reference to its early diagnosis and treatment. Trans Assoc Am Phys. 1886; 1:107-43.
10. McBurney C. Experience with early operative interference in cases of disease of the vermiform appendix. N Y State Med J. 1889; 50:676-84.
11. Skandalakis JE, Gray SW, Ricketts R. The colon and rectum. In Skandalakis JE, Gray SW (eds): Embryology for Surgeons. Baltimore, Williams & Wilkins, 1994; 242-81.
12. Chevre F, Gillet M, Veilleumier H. Agenesis of vermiform appendix. Surg Lap end Percut Tech. 2000; 10 : 110-2
13. Chong CF, Adi MI, Thien A. Development of the RIPASA score: a new appendicitis scoring system for the diagnosis of acute appendicitis. Singapore Med J. 2010; 51:220-5.
14. Standring S. Gray's Anatomy : The Anatomical Basis of clinical practice 40th edition . UK: Churchill Livingstone, 2008
15. Michels NA. The anatomical variations of the arterial Pancreatico-duodenal arcades. J int Coll Sur. 1962;37:13-40
16. Singh I. Textbook of human histology 6th revised edition, Delhi, India: Jaypee Brothers Medical Publishers, 2001; 188.
17. Kalem M, Rich AJ, Talbot DR, Canlitie WJ. Evaluation of modified Alvarado score in diagnosis of acute appendicitis: A Prospective study. Ann R Coll Surg. 1994; 76: 418-9.
18. Denizbasi A, Unlever EE. The role of emergency medicine resident using the Alvarado score in the diagnosis of acute appendicitis compared with general surgery resident. Eur J; Emerg Med. 2003 Dec; 10(4): 296-301.
19. Al- Hashemy AM, Saleem MI. Appraisal of the modified Alvarado score for acute appendicitis in adults. Saudi Med J. 2004; 25 (9): 1229-31.
20. Shrivastava UK, Gupta A, Sharma D. Evaluation of Alvarado score in diagnosis of acute appendicitis. Trop Gastrentrol. 2004, oct; 25 (4): 184-6.