Original Research Article

DOI: http://dx.doi.org/10.18203/2349-2902.isj20164470

To evaluate the diagnostic accuracy of alvarado score, C-reactive protein, ultrasonography and computed tomography in acute appendicitis and to correlate them with operative and histological findings

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Received: 09 October 2016 Revised: 02 November 2016 Accepted: 09 November 2016

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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 by the combined use of diagnostic modalities in a prospective study from July 2011 to December 2012 was done. 100 patients with right lower quadrant abdominal pain fulfilling the inclusion and exclusion criterion underwent appendicectomy in Mahatma Gandhi Medical College and Hospital, Jaipur, India.

Results: The results of the diagnostic aids were reported in combination using the "or" rule 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 26 ± 11.25 years (10-59 years) and there were 70 males and 30 females in the study. Histopathological examination confirmed appendicitis in 90 patients with 10 negative appendicectomies. A negative appendicectomy rate of 5.71% in men and 20% in women was observed.

Conclusions: Alvarado score in combination with ultrasonography is a valuable tool for diagnosing acute appendicitis inspite of sophisticated investigations like CT, thus reducing the cost of treatment and preventing negative appendicectomy rate.

Keywords: Acute appendicitis, Mantrels, Negative appendicectomy rate

INTRODUCTION

Appendicectomy is the most commonly performed operation (10% of all emergency abdominal operations) and appendicitis is notorious to simulate other acute abdominal 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. Alvardo proposed his scoring 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). 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 appendicitisin in children and men. However, the false positive rate for appendicitis in women was unacceptably high.²

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>10x10x9/1	2
Shift to left (neutrophilia)	1
Total	10

C-reactive protein (CRP) is an acute phase reactant, which rises rapidly in response to tissue injury and inflammation and can be measured in serum 6-12 hours after the onset of inflammatory process. Study suggested sensitivity and specificity of serum CRP in the diagnosis of acute appendicitis to be 93.65 and 86.6% respectively.

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.³ 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%.

Unfortunately numerous studies over years cannot agree on accuracy of clinician's suspicion compared to alvarado scoring system, CRP and modern radiologic imaging (ultrasound and CT). When imaging is necessary, there is a debate about the appropriate imaging to perform.

Thus present study tries to analyse the utility and diagnostic accuracy of alvarado score, CRP, USG and CT scan.the primary outcome measure of the study was the diagnosis of acute appendicitis by histopathology and wheather the different diagnostic modalities were able to detect the same accuracy.

Because disease was less common than now: with less tools for diagnosis, less life expectancy and general unawareness of the fact that malignancy may occur in younger age group. There has been a decline from previous year in deaths as well as in new cases.⁵

Aim of the present study was to explore the disease on clinical presentation, histopathological typing and grading, 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 July 2011 and December 2012 on hundred patients who underwent appendicectomy in Mahatma Gandhi Medical College, Jaipur, Rajasthan, India.

Inclusion criteria

- Patients of all age groups and genders were included in this study, with complaints of right lower abdominal pain, where acute appendicitis was suspected, purely on a clinical basis
- Well informed patients, willing to comply with the study protocol.

Exclusion criteria

- Appendicular lump
- Patients for interval appendicectomy
- Appendicitis managed conservatively
- History of previous abdominal surgery
- Generalised peritonitis
- Pregnancy

Hundred patients who fulfilled the eligibility criteria were subjected to routine haematological investigations, CRP, USG, and scored on the basis of alvarado scoring system. Non enhanced CT abdomen (NECT) was done in 45 cases. All patients were underwent appendicectomy with prior consent and specimen was sent for histopathological examination.

The result of alvarado score, CRP, USG and nect were reported independently and in combination by using the "or" rule. The result were correlated with surgical and histopathological findings and subjected to statistical analysis.

Over all 70 patients of colorectal malignancies were included in this study. The detailed records were obtained from mrd section. The patients were also contacted by post or by telephone as and when necessary for their follow-up. All the data were analysed using the necessary statistical calculations, the result were then presented.

RESULTS

Present study comprised of 70 males and 30 females patients and their age range was between 10-59 years. Prevalence of appendicitis was highest (39%) in the age of 21-30 years followed by 10-20 years. In majority of the patient (89%) were experienced pain in RIF and rest (11%) of the patient presented with pain around the umbilicus. Migration of pain (MOP) was observed in 60% cases. Nausea and vomiting (n/v) was a prominent symptom, presented in 95% of cases. Anorexia (anrx) was experienced by 83% patients. 32% of patients also complained of fever (fvr). Murphy's triad of symptom i.e. pain abdomen, vomiting and fever was seen in 95% cases.

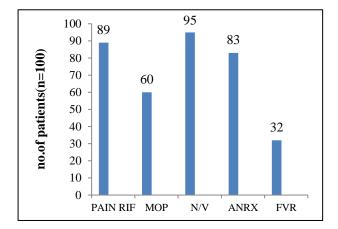


Figure 1: Complaints associated with acute appendicitis.

On examination; tenderness in right lower quadrant was noted in 95% of cases (Figure 2).

TLC revealed leucocytosis in 75% of cases. DLC showed neutrophilia in 63% cases (Figure 3). Appendicitis was confirmed in 90 patients by histopathological examination in the form of acute appendicitis (n=75), gangrenous appendicitis (n=6), sub-acute appendicitis (n=4), acute catarrhal appendicitis (n=2), acute haemorrhagic appendicitis (n=2) and acute appendicitis with carcinoid tumor (n=1). Out of them perforated appendix was found in 6 patients during surgery. The total number of negative appendicectomies were 10 (10%) with a negative appendicectomy rate of 5.71% in

men and 20% in women. 60% of normal appendix were found in women.

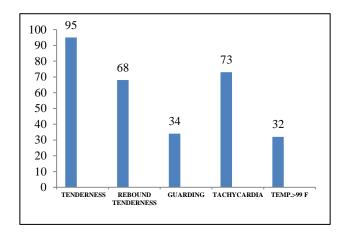


Figure 2: Distribution of clinical sign of acute appendicitis.

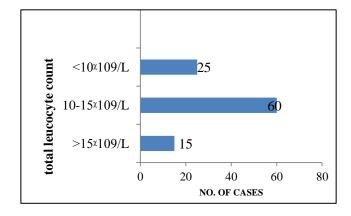


Figure 3: Distribution of TLC.

The sensitivity and specificity of CRP were 88.9% and 60% respectively (Table 3). PPV NPV was 95.2% and 37.5% respectively. The diagnostic accuracy of CRP was 86%. The association between HPE and CRP was statistically significant, indicating that CRP is a nonspecific marker of acute appendicitis.

Patients were divided into three groups on the basis of alvarado score (Table 4). Mean score was 7.4±1.55. In the first group, 6 (6%) patient having the alvarado score 1-4 of which there were only two negative appendicectomies.

Table 2: Negative appendicecyomy rate.

Annondiacatomy	Appendici	tis on h/p report	Negative a	appendicectomy
Appendicectomy	No.	Percentage	No.	Percentage
Male (70)	66	94%	4	5.71%
Female (30)	24	80%	6	20
Total (100)	90	90%	10	10

Table 3: Association b/w CRP and HPE findings.

Diagnostic of toot words of CDD	Histopathological diagnosis			
Diagnostic of test result of CRP	Appendicitis	Normal	Total	lu-s
Positive	73	2	75	p value 0.0004
Negative	17	8	25	0.0004
Total	90	10	100	

Table 4: Association b/w alvarado score and histopathological diagnosis.

Diagnostic test	HP diagnosis	HP diagnosis		
Diagnostic test	Appendicitis	Normal	Total	Danahas
Score ≥7 positive	73	2	75	P-value 0.0021
Score < negative	17	8	25	0.0021
Total	90	10	10	

Table 5: Association b/w USG and HP diagnosis.

Diagnostic test result	HP diagnosis	HP diagnosis		
Diagnostic test result	Appendicitis	Normal	Total	D l
USG diagnostic of appendicitis	86	2	88	P-value <0.0001
USG not diagnostic of appendicitis	4	8	12	<0.0001
Total	90	10	100	

19 cases (19%) were recognized as within 5-6 (equivocal score) with six negative appendicectomies; 75 cases were in the score range of 7-10, suggestive of acute appendicitis, with only two negative appendicectomies. Present study demonstrated a stastically significant association b/w alvarado score and hp diagnosis. The

sensitivity, specificity, PPV, NPV of the scoring system was 80%, 70%, 96% and 28% respectively.

The diagnostic accuracy of the scoring system was 79%. Thus, the decision to operate the patient cannot be made on alvarado score alone.

Table 6: Association b/w NECT and HP diagnosis.

Dia amantia tant manult	HP diagnosis	HP diagnosis		
Diagnostic test result	Appendicitis	Normal	Total	
Positive	32	1	33	p value 0.004
Negative	7	5	12	0.004
Total	39	6	45	

Table 7: Association b/w alvarado score or USG and HP diagnosis.

Diagnostic test result	HP diagnosis			
Diagnostic test result	Appendicitis	Normal	Total	Danalara
Score≥7/USG diagnostic of appendicitis	88	3	91	P value <0.0001
Score<7/USG not diagnostic of appendicitis	2	7	9	<0.0001
Total	90	10	100	

Table 8: Association b/w CRP or USG and HP diagnosis.

Diagnustia tast ussult	HP diagnosis			
Diagnpstic test result	Appendicitis	Normal	Total	
Crp positive/usg diagnostic of appendicitis	87	4	91	P value
CRP negative/USG not diagnostic of appendicitis	3	6	9	<0.0001
Total	90	10	100	

USG had the highest sensitivity (94.4%) and specificity (80%). The PPV and NPV values were 97.7% and 61.5% respectively. The diagnostic accuracy was 93%. There was a ststistically significant correlation between USG and histopathological diagnosis.

NECT was performed in 45 patients only, due to cost factor and lack of time interval between admission and surgery. A limitation of present study was the oral and rectal contrast could not be administered as bowel rest is mandatory in the initial management of acute appendicitis. The present study depicted sensitivity of 82% but a higher specificity of 83% for NECT as compared to USG.

The test of alvarado score, CRP and USG were analysed in all possible combinations using the "or" rule (if any of the individually linked test of the combination was above the reference range, the combination was considered indicative of acute appendicitis). NECT was not included as it was done in 45 cases only. Alvarado score ≥7 in combination with USG had the highest sensitivity of 97.8%, specificity of 70% with a diagnostic accuracy of 95%. The above association was statistically significant.

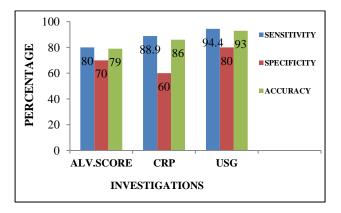


Figure 4: Comparison of results of various tests.

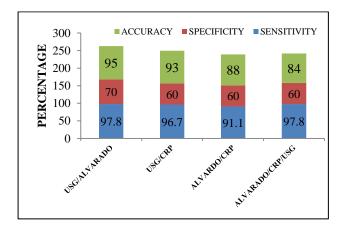


Figure 5: Comparison of results of various tests.

With the use of "or" rule, CRP in combination with USG had a sensitivity of 96.75 and a specificity of 60%.

Diagnostic accuracy of the combination was 93%. This combination yielded inferior results when compared to the combination of alvarado score and USG.

DISCUSSION

Appendicectomy is most frequently performed surgery (10% of all emergency abdominal operations).each year over. In United States, rate of negative appendicectomy is approximately 15% out of total appendicectomies done each year. Considerable effort has done into strategies aimed at decreasing the negative appendicectomy rate. Hoffmans J et al reviewed the different methods of diagnosis of acute appendicitis to improve the accuracy of its diagnosis like laproscopy, barium enema, ultrasonography, and computer assistance, but no one method is of proven superiority.

It has been established by several author that incidence of acute appendicitis is higher in males compared to females. Out of 100 cases in present study, there were 70 male patients and 30 female patients.

In present study 89% cases presented with pain in right lower quadrant (RLQ) and migration of pain was seen in most cases (60%), which aids in the diagnosis of acute appendicitis. These results compared well with Alvi MA et al study where 85.3% patients had pain in RLQ and migration of pain was present in 48.78%.⁵

Anorexia was present in 83% of cases in present study that is simillar to study of Kallan M et al.² Fever was present in 32% of patients which is compared well with Tauro F et al.⁶

RLQ tenderness was present in 95% of patients at the time of presentation in present series where RLQ tenderness was present in 100% of cases. Rebound tenderness was present in 68% of cases were similar to study of Alvi MA et al (65.85%) and Tauro F (65%). 5,6

In most of the studies tlc was raised over $10^x 10^9 / 1$ in 60% of the cases of acute appendicitis. In the present study leucocyte count was elevated in 75 patients, comparable with the relevant literature.

Negative appendicectomy rate was 5.71% in males and 20% in females with overall negative appendicectomy rate of 10%, which is comparable with that of Jawed A et al (7%), Alvi M (10.97%). 6.7

Alvarado scoring system is commonly used scoring system to aid in the diagnosis of acute appendicitis and to bring down negative appendicectomy rate. The score ≥ 7 indicate the high probability of acute appendicitis.

In the present study, the overall sensitivity and specificity of alvarado score was 80% and 70% respectively. The PPV and NPV were 96% and 28% respectively. The original article by Alvarado investigated 305 patients and

reported sensitivity, specificity and PPV of the scoring system to be 80%, 74% and 92% similar to our study, although the NPV of 46% was higher than our study.

Regarding CRP, the present study depicted a high sensitivity of 88.9%, specificity of 60%, PPV 95.2% and NPV 37.5%. The results were compared well with Sadaf A et al study.⁸

All acute inflammatory processes and certain malignant conditions results in rise of CRP as a non-specific phenomenon, and it can never, on its own, be used as a diagnostic test. But it was observed in this study that the sensitivity improved to 91.1% while the specificity reduced to 60% when alvarado score \geq 7 and raised CRP as combined by the "or" rule.

Ultrasound depicted a high sensitivity of 94.4%, with a specificity of 80% and PPV and NPV of 97.7% and 61.53% respectively in our study. In Rioux M et al study, the sensitivity of 93% matched well with our study although the specificity of 94% was higher than our study.

Ultrasonography is highly operator dependent and is technically difficult to detect inflamed appendix in obese patients by USG. A CT scan can identify appendix in obese patient better than USG.

Although CT is the gold standard imaging tool to diagnose appendicitis still there are good reasons to choose USG like USG is non-invasive, has short acquisition time. Is relatively low cost, does not require iodinised contrast agent or oral preparation, lacks radiation exposure, can be performed on small children even with some degree of motion, is considered safe during pregnancy, has high potential for diagnosis of alternative conditions mimicking acute appendicitis (e.g. ovarian cyst. Ectopic pregnancy, mesenteric lymphadenopathy etc.) and is available in most institutions.

Nect was done in 45 patients. Lack of affordability and short time interval between admission and surgery preclude Nect in the rest. As bowel rest is mandatory in initial management of acute appendicitis, oral contrast could not be administered. Rosen MP et al CT performed in the emergency department increases the physician's level of certainity and reduces the hospital admission rates by 23.8% and leads to more timely surgical intervention.¹⁰

The present study depicted the sensitivity and specificity of NECT was 82% and 83% respectively. These results were in line with Poortman's study on 199 patients in which ct showed a sensitivity of 76% and specificity of 83% for the detection of acute appendicitis. In the study of Balthazar EJ, CT had 98% sensitivity and 83% specificity, and a 93% accuracy. According to Weyant MJ, although the negative appendicectomy rate was

decreased by CT, there was no correlation between CT findings and pathological proven disease. ¹³ the use of CT scan as a diagnostic investigation for acute appendicitis has increased during the last few years. This increased used is attributed to many factors, including the high accuracy, speed of the examination and patient tolerance. Interpretation of the findings is relatively easy and clinicians feel comfortable reviewing the images with the radiologist.

Various test combinations analysed showed that combination of alvarado score and ultrasonography yielded the highest sensitivity (97.8%) and specificity (70%). Nautiyalet H et al also concluded that the combination use of alvarado score and high frequency USG not only reduces negative appendicectomy rate but also reduces morbidity and postoperative complications. ¹¹

CONCLUSION

No single diagnostic aid can dramatically reduce the rate of negative appendicectomy. Alvarado score is an easy, cheap and useful tool in postoperative evaluation of suspected acute appendicitis, but the final discussion to operate cannot be based on alvarado score only. Additional investigations like, CRP, USG, CT are required to arrive at a final diagnosis, especially in female patients and in patients with equivocal score.

CRP being an acute phase reactant is sensitive but not specific in the diagnosis of acute appendicitis. USG is more sensitive, specific and has a higher diagnostic accuracy than alvarado score or CRP. It helps in excluding other causes of RLQ pain which leads to a reduction in the negative appendicectomy rate without adversely affecting the perforation rate.

The combined use of alvarado score and USG had the highest sensitivity and diagnostic accuracy. This combination is a practical approach to suspect cases of acute appendicitis as it combines the benefits of clinical scoring system with imaging. Hence it may help to diagnose patients in early stage of acute appendicitis, thereby decreasing morbidity and post-operative complications.

Nect although highly specific in comparison to USG, cannot be applied in all cases in all developing countries like present study because of affordability and availability concerns. Its use is highlighted in equivocal cases in which alvarado score and USG cannot establish the diagnosis.

Study found that alvarado score in combination with USG is a valuable tool for diagnosing acute appendicitis inspite of sophisticated investigations like CT, thus reducing the cost of treatment and preventing negative appendicectomies, while maintaining a high diagnostic performance.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

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Cite this article as: Pipal DK, Kothari S, Shrivastava H, Soni A, Pipal V. To evaluate the diagnostic accuracy of alvarado score, C-reactive protein, ultrasonography and computed tomography in acute appendicitis and to correlate them with operative and histological findings. Int Surg J 2017;4:361-7.