

Original Research Article

Accuracy and diagnostic approach of combining multiple modalities for diagnosing appendicitis among non-pregnant female of reproductive age

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ABSTRACT

Background: Appendicitis is notorious in its ability to simulate other conditions and in the frequency, it can be mimicked by other pathologies. The purpose of this study was to evaluate the accuracy of the diagnostic approach incorporating modified Alvarado score system (MASS) and ultrasonography with clinical findings. The aim of the study was to observe and evaluate different modalities of determining appendicitis among the non-pregnant female population of reproductive age

Methods: This prospective descriptive study was conducted at the department of surgery, Rajshahi College and Hospital, Rajshahi, Bangladesh. The study duration was 6 months, from February 2013 to July 2013. The study was conducted with a total of 101 women who were of reproductive age, presenting with right lower quadrant pain, who went through appendectomy during the study period.

Results: The incidence of negative appendectomy was 4.95% in this study. Most of the patients having appendicitis were in second and third decades with a mean age of 24.79±10.11 years. The rate of perforation in our study was 5.94%. The overall post-operative complication rate was 13.86% with minor wound infection being the most common complication. The accuracy, sensitivity, specificity, PPV and NPV of the diagnostic approach in this study were 95.05%, 98.96%, 20.00%, 95.96% and 50.00% respectively. The accuracy, sensitivity and specificity of ultrasound were found to be 29.47%, 25.56% and 100% respectively.

Conclusions: Combined use of clinical diagnosis incorporating modified Alvarado score and ultrasonography led to a significant reduction in the negative appendectomy rate.

Keywords: Appendicitis, Appendix, Ultrasonography, Alvarado score system

INTRODUCTION

One of the most prevalent causes of acute abdomen with surgical urgency in the general surgery department is acute appendicitis. It is a sudden and acute appendicitis inflammation. It can cause abdominal pain, which can

develop fast and increase over time. It is critical to get a diagnosis as soon as possible in order to reduce morbidity and avoid major consequences. Appendicitis has a perforation rate of 17-20%, and the life time risk is 5-20%.¹ 10% of all emergency abdominal operations are for acute appendicitis.² Despite its high incidence rate since its discovery in 1886, the diagnosis process of

appendicitis remains a mystery to most of the medical world.³ Although the common surgical practice for surgeons is to, "when in doubt, take it out", studies has shown that appendicitis has a negative exploration rate of 15-30%.⁴ This high negative exploration rate leads to a financial burden for both the patient and the overall health service. On the other hand, due to the extremely fast advancement nature of appendicitis, observation of patients is not a viable option, since if the underlying cause of the pain is really appendicitis, it can cause various complications with a mortality rate of 1%.⁵ Due to such factors, a high rate of unnecessary surgical intervention is usually accepted. A variety of variables have been hypothesized to impact the occurrence of negative appendectomy. The surgeon's experience is quite important. Female gender, reproductive age, menstrual cycle stage, and sexual history are all factors that lead to misdiagnosis. Because of the likelihood of gynecological reasons, women of reproductive age have more confusing presentations of lower abdomen discomfort. Menstrual pain might confuse the diagnosis even further. For women with appendicitis, the most common misdiagnoses include pelvic inflammatory disease, gastroenteritis, abdominal pain of unknown origin, urinary tract infection, ruptured or twisted or infarcted ovarian cyst. These diagnoses often imitate the clinical symptoms of acute appendicitis and vice versa as well.⁶ In spite of advancement in accessible laboratory tests and imaging modalities like high resolution ultrasound imaging, CT scan, scintigraphy, MRI and laparoscopy; the diagnosis of appendicitis rests upon the clinical assessment. Various procedures, including Lidverg, Fenyo, Christian, Ohman, and Alvarado scoring systems, have been devised and tried by different researchers over the last two decades to achieve an early diagnosis of this highly enigmatic condition, hence avoiding negative appendectomy. The Alvarado scoring system, established by A. Alvarado in 1986, is one of the scoring systems. It is simply based on history, clinical examination, and a few laboratory tests and is relatively simple to administer.⁷ The Alvarado system was later modified by O' Bengezi and Al-Fallouji, to take into account additional findings, making the system more practical, easy and reliable.⁸ The modified Alvarado scoring system (MASS) has been reported to be a cheap and quick diagnostic tool in patients with acute appendicitis without increasing the morbidity and mortality.⁸ However, differences in sensitivity and specificity have been observed if the score was applied to various populations and clinical settings.⁹ Pain in the right iliac fossa (RIF) is investigated differently in males and women. Women are frequently subjected to an ultrasound examination of the pelvis and abdomen, usually to rule out gynecological or pelvic disease. Men, on the other hand, are far more typically examined by recurrent clinical examination. Given the significant disparity in the differential diagnosis of pain in the RIF between men and women, it is maintained that it should be seen as two distinct clinical disorders. Most surgeons prefer to get an ultrasound report to confirm their

preliminary diagnosis of acute appendicitis, particularly in females of reproductive age, where pelvic disease closely mimics appendicular pain and must be ruled in or out before surgery is performed. Use of ultrasonography may greatly reduce the risk of negative appendectomy while increasing the rate of perforation. However, USG is not a substitute for clinical diagnosis, but it is a valuable adjuvant in the diagnosis of acute appendicitis. This study was focused to diagnosis of acute appendicitis by clinical assessment primarily and correlating with intra operative finding, histopathological diagnosis, preoperative modified Alvarado score and ultrasonogram findings.

Objective

General objective

General objective was to study the incidence of negative appendectomy in non-pregnant female patient of reproductive age group.

Specific objectives

Specific objectives were to determine the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MASS in diagnosing acute appendicitis in non-pregnant women of reproductive age group and to study the role of ultrasound and evaluate the sensitivity and specificity of ultrasonography in the diagnosis of acute appendicitis.

METHODS

This prospective descriptive study was conducted at the department of surgery, Rajshahi collage and hospital, Rajshahi, Bangladesh. The study duration was 6 months, from February 2013 to July 2013. The study was conducted with a total of 101 women who were of reproductive age, presenting with right lower quadrant pain, who went through appendectomy during the study period. Abdominal and pelvic ultrasonography (USG) was done for all patients. Patients with modified Alvarado score ≥ 7 underwent immediate appendectomy even if USG was negative for appendicitis and patients with score < 7 underwent appendectomy if USG was positive for appendicitis. Patients with score 5-6 and USG negative were subjected to appendectomy if clinically deteriorated with conservative management. A semi structured questionnaire containing all necessary variables was prepared for each participant. Prior to data collection both verbal and written informed consent was taken from the respondents and the researcher himself interviewed respondents through conversation.

Inclusion criteria

All non-pregnant female patients of age ranging from 12 to 49 years with right lower quadrant pain, who clinically appeared to have acute appendicitis. Patients who had given consent to participate in the study and all female

cases of suspected appendicitis ready to take surgical treatment were included in the study.

Exclusion criteria

Mentally ill, male patients, patients who have previously undergone appendectomy, exclude those affected with other chronic diseases etc. were excluded from study.

Collected information is compiled, analyzed and edited using the software SPSS (version 24.0) (IBM) Chicago, Illinois. Ethical approval was obtained from the ethical review committee of Rajshahi collage and hospital, Rajshahi, Bangladesh.

RESULTS

Among the 101 participants, 5 cases had no histological evidence of acute appendicitis. Overall incidence of negative appendectomy was 4.95%. Overall, most of the cases were within 12-20 years' age range (48.52%), with maximum incidence of negative appendectomy also being from the same age group (3.96%). The present study had a total adverse outcome of 10.89%, with 4.95% cases of negative appendectomy incidence, and 5.94% cases of perforation. The present study showed that pain in RIF was present in all the cases. 35.64% of the patients had a history of typical pain migration. Anorexia was present in 91.09% of cases. 82.18% patients had nausea and 66.34% experienced one or more episodes of vomiting. Above table shows that 73.27% patients had macroscopically non suppurative inflammation. In 12.87% cases appendices were found to be gangrenous. Appendicular perforation was present in 5.94% cases. Above table shows no post-operative complication in negative appendectomy group. All cases of post-operative complications were found in appendicitis group. The overall rate of complications was 13.86%. Most common complication was minor wound infection, present in 6.93% of cases. Pelvic abscess was found in 1.98% cases. Above table shows that MAAS had high sensitivity (93.75%) but low specificity (20.00%) with an overall accuracy of 90.09%. Above table shows that ultrasonography had low sensitivity (25.56%) but high specificity (100%) with an accuracy of 29.47%. The MAAS had an overall accuracy of 90.09%, much higher than USG findings. Sensitivity was also higher in MAAS. But clinical findings coupled with USG findings gave an accuracy of 95.05%, and sensitivity of 98.96%.

Table 1: Negative appendectomy rate of study (n=101).

Appendicitis status	N	Percentage (%)
Histopathologically confirmed appendicitis	96	95.05
Negative appendectomy	5	4.95

Table 2: Age distribution of study population, (n=101).

Age range (years)	Histo-pathologically confirmed appendicitis		Negative appendectomy		Total (%)
	N	%	N	%	
12-20	45	44.56	4	3.96	48.52
21-30	28	27.72	0	0.00	27.72
31-40	13	12.87	1	0.99	13.86
≥40	10	9.90	0	0.00	9.90
Mean age±SD	24.79±10.11				

Table 3: Overall adverse outcome, (n=101).

Adverse effect	Frequency	Percentage (%)
Incidence of negative appendectomy	5	4.95
Incidence of perforation	6	5.94
Total adverse outcome	11	10.89

Table 4: Presenting symptoms of the patients, (n=101).

Symptoms	Frequency	Percentage (%)
Pain in RIF	101	100
Typical pain migration	36	35.64
Pain on movement	81	80.20
Pain on cough	77	76.24
Anorexia	92	91.09
Nausea	83	82.18
Vomiting	67	66.34
Diarrhea	4	3.96
Dysuria	7	6.93

Table 5: Pre-operative findings of the appendix, (n=101).

Finding	Frequency	Percentage (%)
No inflammation	5	4.95
Non suppurative inflammation	74	73.27
Gangrenous	13	12.87
Perforated	6	5.94
Peri appendicular suppuration	3	2.97
Total	101	100

Table 6: Post-operative complications within 30 days of surgery, (n=101).

Post-operative complication	Histopathologically confirmed appendicitis		Negative appendicectomy	
	N	%	N	%
Minor wound infection	7	6.93	0	0.00
Paralytic ileus	2	1.98	0	0.00
Chest infection	1	0.99	0	0.00
Wound abscess	2	1.98	0	0.00
Pelvic abscess	2	1.98	0	0.00
Total	14	13.86	0	0.00

Table 7: Sensitivity and specificity of modified Alvarado score (MASS).

Diagnostic approach result	Histopathologically confirmed appendicitis		Total	Sensitivity	Specificity	PPV	NPV	Accuracy
	Yes	No						
Score ≥ 7 positive	90 (TP)	4 (FP)	94	93.75%	20.00%	95.75%	14.29%	90.09%
Score < 7 negative	6 (FN)	1 (TN)	7					
Total	96	5	101					

Table 8: Sensitivity and specificity of USG.

Diagnostic approach result	Histopathologically confirmed appendicitis		Total	Sensitivity	Specificity	PPV	NPV	Accuracy
	Yes	No						
USG positive	23 (TP)	0 (FP)	23	25.56%	100%	100%	6.94%	29.47%
USG negative	67 (FN)	5 (TN)	72					
Total	90	5	95					

*PPV= Positive Predictive Value, NPV= Negative Predictive Value

Table 9: Comparisons of various diagnostic approaches.

Measurement	MASS (%)	USG (%)	Clinical + USG (%)
Accuracy	90.09	29.47	95.05
Sensitivity	93.75	25.56	98.96
Specificity	20.00	100	20.00
Positive predictive value	95.75	100	95.96
Negative predictive value	14.29	6.94	50.00

DISCUSSION

Although surgeons have been confronting acute appendicitis as a clinical entity for over a hundred years, an accurate preoperative diagnosis remains a challenge. It is general practice for normal appendix to be removed if the risk of appendicular perforation needs to be reduced. According to William Ravitch, 'the only way to have 100% diagnostic accuracy in all cases of acute appendicitis is to wait till they all perforate'.¹⁰ The present study focused on two different modalities, the modified Alvarado score (MASS) and ultrasonography (USG), to determine the diagnostic accuracy of both methods, and to observe if using multiple modalities increases the diagnostic accuracy of appendicitis. The

histopathological diagnosis of acute appendicitis was taken as the gold standard. In the present study of 101 appendicectomies, 96 were biopsy positive with a negative appendicectomy rate of 4.95%. The negative cases were primarily due to pelvic inflammatory diseases and ruptured follicular cysts. The conditions of these 5 cases were not properly diagnosed on ultrasound and mimicked acute appendicitis. The negative appendicectomy rate in this study was closer to the findings of few studies, while the negative appendicectomy rate was much higher in few other studies, going as high as 30%.¹¹⁻¹⁶ In the present study the common age group for acute appendicitis was found to be second and third decade, which was similar to some other studies, suggesting that the second and third decades of

life were the most common age groups for appendicitis.¹⁶
¹⁷ The present study had an overall adverse outcome of 10.89% cases, including the 5 cases of negative appendectomy. The remaining 6 cases had perforation. In this study, pain in RIF was the symptom present in all cases. In addition, anorexia (91.09%) and nausea (82.18%) were present in majority of cases. These findings were similar to other studies.¹⁸⁻²⁰ There were 3.96% patients who complained of loose motion and 6.93% had dysuria. Only 35.64% of patients had the classic migration of discomfort from the umbilical area to the right lower quadrant. The pain in the majority of instances of acute appendicitis did not follow the conventional visceral-somatic sequence. The moderate central pain may occur while sleeping and be ignored by the patient who is focused with the parietal ache. The site of the appendix also determines the presentation, and retrocecal appendicitis might cause right flank discomfort. Tenderness in the right lower quadrant was the most often seen physical symptom, and it was present in all patients. It was not considered to be important, however, because it was present in all 5 negative appendectomies as well. A study by John et al found lower quadrant tenderness to be significantly more common in patients with appendicitis.²¹ During pre-operative findings, 73.27% patients had macroscopically non suppurative inflammation. In 12.87% cases appendices were found to be gangrenous. During the follow up at 30 days post operation, the overall post-operative complication rate was 13.86%. This finding correlates well with the study of Ashmawy et al who found post-operative complication in 11.9% cases.²² There was no post-operative complication in negative appendectomy group and no death occurred. Minor wound infection was the most common complication. The infection was limited to subcutaneous tissues. These patients complained of pain and fever. The accuracy, sensitivity, specificity, positive predictive value and negative predictive value of modified Alvarado scoring system were 90.09%, 93.75%, 20.00%, 95.75% and 14.29% respectively. These findings correlated well with the study of Kanumba et al who reported 87.6% accuracy, and 88.3% sensitivity in female.⁹ The reason for high sensitivity but low specificity in this series was that only operated cases were included in the study. Inclusion of patients who were treated conservatively might have improved the specificity. The accuracy, sensitivity and specificity of ultrasound were found to be 29.47%, 25.56% and 100% in our study. There were a high number of false negatives, there being 72 cases where the appendix was not visualized on ultrasound. This led to a low accuracy in the USG findings of our study. Non-visualization was present in 41% of cases in a study by John et al while Adam et al stressed that although ultrasound was specific in diagnosing acute appendicitis, the high incidence of false negatives precluded its use as a screening procedure for acute appendicitis.²¹ Moreover, accuracy of ultrasound diagnosis in appendicitis is likely to be very operator dependent in various centers in developing countries. Poor tolerance by the patient,

obesity, presence of gas and unusual location of the appendix are also contributory factors to false negative results. The combined use of clinical diagnosis incorporating MASS and USG in decision making for appendectomy, has high sensitivity and accuracy; that led to a significant reduction in the two main adverse outcomes that surgeons seek to avoid in cases of suspected appendicitis; first is the number of non-therapeutic operations and second is the number of perforated appendicitis. The accuracy, sensitivity, specificity, PPV and NPV of this diagnostic approach were 95.05%, 98.96%, 20.00%, 95.96% and 50.00% respectively. These findings were consistent with the findings of Ashmawy, where sensitivity and specificity of combined modality were 98.4% and 61.6% respectively.²² The findings in the present study correlates well with the results of other studies that reported significant reduction in the adverse outcomes when using ultrasonography as an adjunct in the evaluation of acute right lower quadrant pain in women.²³

Limitations

The study was conducted in a single hospital with small sample size. So, the results may not represent the whole community. The study findings could have been more precise if we would have included all patients with RIF pain, who did not undergo surgery

CONCLUSION

The modified Alvarado scoring system had a much higher accuracy compared to the ultrasonography findings, but had lower specificity and positive predictive value. The combination of both modalities gave the highest sensitivity and accuracy rates.

Recommendations

Further study should be carried out to analyze the various pathologies causing negative appendectomies in female, including the follow up of patients who are discharged after conservative management. All hospitals should keep a record of their negative appendectomy frequency with routine histopathological examination as this is a good measurement of quality assurance and could be recorded easily.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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