Clinical and ultrasound correlation in the diagnosis of acute appendicitis: A retrospective study

M.A.B. Fernando[1], H.P. Dias[2], N.A. Perera[1], M. Kulasingham[3], C.R.U. Priyadharshika[4]
[1]Consultant General Surgeons Base Hospital Dambulla
[2]Consultant General Surgeon District General Hospital Nuwara Eliya
[3]Consultant Radiologist Base Hospital Dambulla
[4]Consultant Pathologist Base Hospital Dambulla

Abstract

Introduction

Ultrasonography (USG) has been increasingly used to help in the diagnosis of acute appendicitis with the aim of minimizing both underdiagnosis and overdiagnosis of acute appendicitis. The aim of this study is to ascertain whether USG could change the decision making in the management of acute appendicitis.

Methods

This is a retrospective analysis of prospective data on 100 patients who underwent appendicectomy either open or laparoscopic. These 100 patients were divided in to two groups; those with equivocal appendicitis and those with strongly suspected appendicitis based on clinical assessment. Modified Alvarado Score (MAS) was used for clinical assessment.

All of them had USG as the sole mode of imaging. The accuracy of each mode of assessment was confirmed by macroscopic and/or microscopic appearance of the appendix. Based on the findings it was judged whether performing USG has made any changes to the clinical decision.

Results

There were 61 males and 39 females with a mean age of 25 (7-86) years. Total number of patients admitted with modified Alvarado score (MAS) of 2-6 was 39 and those with MAS of 7-9 was 61. True positive cases of acute appendicitis in the former group were 33. While ultrasonography detected acute appendicitis correctly in 30 patients, only 3 patients were correctly diagnosed clinically. Out of 59 true positive cases of acute appendicitis in the latter group, USG detected only 41 cases whereas all 59 patients were correctly identified clinically. While USG has helped change the clinical decision in the equivocal appendicitis, clinical decision takes precedence over USG in patients with typical appendicitis.

Conclusion

While USG has definite place in the evaluation of suspected appendicitis with low clinical probability, it has little value in changing the clinical decision to undertake appendicectomy in patients getting admitted with typical history of appendicitis.

Introduction

Acute appendicitis is one of the commonest acute surgical emergencies and the diagnosis can often be made clinically (1, 2). Although in its typical presentation, diagnosis of acute appendicitis poses little challenge, it is not always straightforward in atypical presentation and thus patients may end up in either negative appendicectomies (i.e. false positive cases) or the surgery may be delayed with adverse outcome (2). Alvarado introduced a scoring system to help minimize either eventuality which was later modified by Kalan et al (3, 4). Adding imaging to clinical diagnosis has been considered to improve the positive predictive value of acute appendicitis thus minimizing the negative appendicectomy rates (5, 6). Both Ultrasound scan and computed tomography have been shown to be effective in this regard.

The aim of this study is to find out accuracy of clinical and radiological assessment in diagnosing acute

Correspondence: M. A. B. Fernando
E-mail: mabfernando@hotmail.com

appendicitis and thus to ascertain whether performing preoperative ultrasonography would change the clinical decision in the management of suspected acute appendicitis. Since the body habitus is considered to have effect on the accuracy of the abdominal ultrasound scan findings, body mass index of each patient too was calculated.

All 100 patients had appendicectomy performed irrespective of finding a macroscopically normal looking appendix intraoperatively. This approach had to be undertaken to avoid future diagnostic confusion by leaving a macroscopically normal appendix in case of open appendicectomy. The same policy was followed in our unit in laparoscopic approach too in the absence of alternative diagnosis since microscopic appendicitis in the background of macroscopically normal appendix has been a recognized entity although its clinical significance and natural history is not well defined (7). We, however, were equally aware of both sides of the debate in removing a macroscopically normal appendix (8, 9).

Method

This was a retrospective analysis of a prospectively maintained data and hence no ethical clearance was sought for. Records of patients who had appendicectomy undertaken between March 2013 to September 2014 at the Base Hospital Dambulla were analysed. A total of 100 patients who had full records of Modified Alvarado score (MAS) as assessed by a consultant, ultrasound scan findings, body weight and height were selected. The components of MAS together with values assigned to each parameter are as follows,

- Migratory right iliac fossa pain (1 point)
- Tenderness in the right iliac fossa (2 points)
- Rebound tenderness in the right iliac fossa (1 point)
- Anorexia (1 point)
- Nausea/vomiting (1 point)
- Fever >37.5°C (1 point)
- Leukocytosis (2 points)

Ultrasound was performed by either a consultant radiologist or a medical officer of radiology unit who has adequately been trained for this purpose. Ultrasound detection of a non-compressible blind ending tubular structure of more than 6mm in diameter noted in the right iliac fossa (RIF) or right hypochondrium (RHQ), free fluid in RIF, presence of appendicolith and or increase appendicular vascularity were considered positive for acute appendicitis radiologically. Failure to spot appendix or detection of normal appendix was regarded as criteria for negative ultrasound scan.

These 100 patients included 3 categories of patients. First group were those who scored 7 or more points in MAS and they were considered as having clinical appendicitis and proceeded to appendicectomy irrespective of ultrasound scan findings whereas others with a lesser score had appendicectomy done only if the ultrasound scan made a positive diagnosis. The third group comprised those who had appendicectomy despite MAS of 4-6 and negative ultrasound scan findings. This category of patients had been observed without starting antibiotics for progression of symptoms. Since their score either remained the same or increased over the ensuing 1-2 days they too were considered clinically positive for acute appendicitis.

Those who proceeded to surgery had their BMI calculated and had the surgery done either laparoscopically or by conventional open method depending on the feasibility of the emergency list. All laparoscopic appendicectomies were undertaken by a consultant surgeon while open appendicectomy was performed either by a consultant surgeon or by an experienced SHO grade doctor. Definitive diagnosis of appendicitis was made either macroscopically intra-operatively and/or histologically in case of less obvious macroscopic findings. Macroscopic appearance of a non compressible distended appendix with red serosa and prominently distended vessels coursing along appendix constituted grossly inflammed appendix whereas only distended appendix with dilated vessels coursing along the appendix was considered minimally inflammed appendix.

Transmural infiltration of appendix with neutrophils or scattered neutrophils in appendeceal mucosa was considered histological proof of appendicitis.

Results

Over the study period, 100 patients aged 7 years to 86 years had preoperative ultrasonography. While median age was 25 years mean age was 27.6. Male to female ratio was 61:39. Ultrasonography was performed by a consultant radiologist in 61 (61%) cases. The rest was undertaken by a medical officer in the radiology department. While 36 patients underwent laparoscopic appendicetomy, 64 patients had open appendicectomy.

Patients who underwent appendicectomy included those from Modified Alvarado Score of 2-9 (Table 1)

Ð ÑÏ ÍÍÎ Í Alvarado Score	Number of Patients	Findings of Ultrasonography	Inflammed Appendix	Non Inflammed Appendix (Macroscopic or Microscopic)
2	-	Positive (1)	1	-
E	—	Positive USS (6)	4	2
		Negative USS (0)	-	-
F	—	Positive USS (3)	3	0
		Negative USS (2)	1	1
G	- –	Positive USS (11)	10	1
		Negative USS (2)	1	1
H	- —	Positive USS (13)	12	1
		Negative USS (1)	1	0
I	–_	Positive USS (17)	17	0
		Negative USS (11)	9	2
J	–-	Positive USS (15)	15	0
		Negative USS (6)	6	0
K	- –	Positive USS (9)	9	0
		Negative USS (3)	3	0

Table 1. Summary of Distribution of Patients in Each Category of MAS

There were 12 patients who scored MAS of 2 to 4. Although USG rated 10 of them having acute appendicitis, only 8 of them had acute appendicitis. One of 2 patients with negative sonographic findings, in fact had inflammed appendix.

Twenty four patients, out of 27 patients in the category of MAS 5-6, were detected to have sonographic evidence of inflammed appendix. However, only 22 patients had truly inflamed appendices. Two out of 3 patients with negative sonography had inflammed appendices.

Proof of acute appendicitis by USG was observed in only 41 patients out of 61 admitted with MAS of 7, 8 and 9. While all of them had acute appendicitis, all of the remaining patients in this category, except 2, i.e. 18 patients, too had inflamed appendices although they were missed by the USG.

Overall, 75 patients of 100 were reported positive by ultrasonography while only 71 of them had appendicitis. Therefore four patients had false positive findings by sonography. Out of 25 negative sonography, 21 patients had inflammed appendices while only 4 had normal appendices. Therefore ultrasonography in our study had an overall sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of 77%, 50%, 94.6%, 16% and 75% respectively (Table 2).

	Ultrasonography		Clinical Examination	
	Positive	Negative	Positive	Negative
Inflammed	71	21	62	30
Non Inflammed	4	4	4	4
Sensitivity	77.1%		67.4%	
Specificity	50%		50%	
PPV	94.6%		94%	
NPV	16%		11.8%	
Accuracy	75%		66%	
PPV=positive predictive value; NPV=negative predictive value				

Table 2. Summary of Overall Comparison of USG and Clinical Findings of 100 Patients

Clinical evaluation was positive for appendicitis in 66 patients while inflammed appendices were discovered in 62 patients. Thirty out of 34 clinically negative patients had inflammed appendices. Overall, our results show sensitivity, specificity, PPV, NPV and accuracy of 67.4%, 50%, 94%, 11.8% and 66% respectively for clinical examination (Table 2).

While there were 39 patients (39%) who belonged to the normal weight group, the number of underweight and overweight patients were 48 (48%) and 12 (12%) respectively. Only one patient belonged to class 1 obesity group, whose USS was inconclusive (hence taken as negative) due to excess body fat.

Discussion

Decision to undertake appendicectomy is based on clinical grounds and appendicectomy is therefore undertaken without preoperative imaging in most cases. However, this approach is likely to result in negative appendicectomies especially in atypical presentation. It is widely believed that preoperative imaging with USG

and or computerized tomography (CT) scan help reduce negative appendicectomy rate (5, 6). We did retrospective analysis to find whether performance of routine USG would help change clinical decision to undertake appendicectomy.

Hundred patients included in our study were analyzed in terms of two groups namely those belonging to MAS of 2-6 where suspicious for acute appendicitis is low and MAS of 7-9 in which probability of acute appendicitis is high.

There had been 39 patients (39%) admitted belonging to MAS of 2-6. Five of 39 patients had negative findings in USG. However, in view of persistent pain over the ensuing 1-2 days they too, were suspected to have appendicitis clinically despite normal USG and hence underwent appendicectomy. Three of them had appendicitis.

Thirty four of these 39 patients did not have strong clinical features to warrant appendicectomy on clinical grounds alone (all of these patients had their Full Blood Count done as a part of MAS and also urine full reports which excluded urinary tract infection as the source of abdominal pain). Nevertheless their USG suggested acute appendicitis and hence all of them (34 patients) proceeded to appendicectomy. While 30 of them had appendicitis, 4 had normal appendices. Since these 34 patients with MAS of 2-6 did not have compelling features to undergo appendicectomy on clinical grounds alone, they, if not for the positive USG findings, would have either prematurely discharged home or have observed which may further increase the hospital stay. Therefore it could be assumed that those 34 patients had the operation undertaken timely due to the additional evidence provided by the USG. Accordingly, USG in this category of patients has allowed not only timely intervention with overall presumed benefit of reduced hospital stay it also has allowed to minimize potential complications associated with delayed diagnosis. Accordingly, it could be argued that ultrasonography, in our study, has positively contributed to change the management of 30 patients (30%) in otherwise clinically unsuspected acute appendicitis. Although this approach, ie, USG directed surgical decision in this category has given rise to negative appendicectomy rate of 11.8 % (4/34) it still lies within the acceptable negative appendicectomy range (10). Moreover it is far below the negative appendicectomy rate of 40% (2/5) observed for clinically guided appendicectomy in this cohort of patients.

Ultarasonography, in evaluating this group of patients had shown superior sensitivity, PPV, NPV and accuracy compared to those of clinical examination (Table 3).

	Ultrasonography		Clinical Examination	
	Positive	Negative	Positive	Negative
Inflammed	30	3	3	30
Non Inflammed	4	2	2	4
Sensitivity	90.9%		9%	
Specificity	33%		66.6%	
PPV	88.2%		60%	
NPV	40%		11.7%	
Accuracy	82%		18%	
PPV=positive predictive value; NPV=negative predictive value				

Table 3. Summary of Comparison of USG and Clinical Findings of 39 Patients with MAS of 2-6

By contrast, USG paints a different picture in assessing patients having high probability of acute appendicitis. Total number of patients belonging to this category (MAS of 7-9) was 61 (61%) and all of them underwent appendicectomy on clinical diagnosis alone. All, except 2 patients, had inflammed appendices.

Ultrasonography, however, picked up inflammed appendix in only 67% cases (41/61), all of whom had appendicitis. Only 2 of remaining 20 patients had normal appendix while all others (18 patients) had clearly inflammed appendices. The assessment of patients with USG in this cohort of patients seems to be inferior to clinical assessment as shown by high sensitivity, PPV and NPV for clinical examination, each rated above 95% (Table 4).

Although USG has marginally higher PPV and over clinical examination, it has got very low NPV of 10%. Therefore normal USG in this cohort of patients is unreliable and as such negative findings on USG unlikely to change the management in this category (with AS of 7-9) of patients. This finding in our study supports the notion of performing appendicectomy on clinical grounds alone irrespective of USG findings in those admitted with typical history of acute appendicitis.

	Ultrasonography		Clinical Examination	
	Positive	**Negative**	**Positive**	**Negative**
Inflammed	41	18	59	0
Non Inflammed	0	2	2	0
Sensitivity	69.5%		100%	
Specificity	100%		0%	
PPV	100%		96.7%	
NPV	10%			
Accuracy	70.5%		96.7	
PPV=positive predictive value; NPV=negative predictive value				

Table 4. Summary of Comparison of USG and Clinical Findings of 61 Patients with MAS of 7-9

While, overall sensitivity and accuracy of sonographic evaluation is better than clinical judgment, both mode of assessments have almost similar specificity, PPV, and NPV in the evaluation of patients (Table 2).

The sensitivity and specificity of our study are comparable to those of Ozkan et al (11) who had sensitivity and specificity of 71.2% and 46.7% respectively.

Others (12, 13) have reported sensitivity, PPV, and accuracy similar to our study; however, their specificity and NPV stand at 78% and 33-39% respectively. Literature survey has shown a range of sensitivity and specificity for USG indicating the gross operator dependency of the final result of USG. In our study USG was undertaken by 2 doctors with different level of experience whose accuracy has been in the range of 68-85%.

Furthermore amount of abdominal fat is known to interfere with the accuracy of the USG. However, majority (87%) in our study was in the underweight or normal weight group, while 12% were in the overweight range. None of them posed any problem in the sonographic assessment of the abdomen. Out of 12 overweight patients only 3 patients had discordant ultrasound scan and macroscopic/microscopic appearance, a finding applicable to patients in normal body weight group too. Only one patient (1%) had BMI of 32.2Kg/m2, interfering with the accuracy where USG was reported inconclusive due to excessive abdominal fat. Therefore it could be reasonably assumed that physical nature of patients enrolled in the study had little impact on the final result of our study.

However, the ultrasound scan machine used does not belong to the current generation and hence the sonographic assessment is likely to be suboptimal. This perhaps had some bearing on the final result considering the significantly low overall NPV (16%) of our study, whereas most of other studies reported NPV ranging from 31%-97% (11,12,13, 14).

Overall negative appendicectomy rate in our study was 16% which is comparable to others (13) although a rate as low as 3%-6% has been reported in some studies (15, 16).

Conclusion

Ultrasound scan is an important imaging modality in evaluating patients with suspected acute appendicitis with equivocal presentation with MAS of less than 6 points. It is likely to deliver important and decision making findings to the overall management of patients in this category. Therefore performing USS in these patients is advocated.

Patients getting admitted with typical history of appendicitis with MAS of 7-9 are unlikely to benefit from the findings of USS and performing scan in this group is perhaps not necessary.

Limitations

This study takes into account only the patients who actually had appendicectomies, however, in reality there were some patients with right iliac fossa pain whose clinical assessment and USG were both negative for acute appendicitis (i.e., seemingly true negative cases) and hence discharged without being enrolled into the study. Although this has undoubtedly contributed to relatively low overall specificity, NPP and accuracy of USG and clinical assessment, we believe that overall conclusion of the study is unlikely to be affected by this exclusion.

Moreover, in this study, failure to spot an appendix ultrasonically constituted a negative ultrasound scan. Although failure in identification of the appendix ultrasonically does not necessarily mean normal appendix, this could, at least, be argued as inability to provide an ultrasonic diagnosis of acute appendicitis for the purpose of this study. Therefore, this non conclusive result by USG is likely to affect negative predictive value to certain extent.

Furthermore, being a retrospective analysis, this study is likely to have drawbacks inherited to retrospective studies.

References

1. Markar SR, Karthikesalingam A, Cunningham J, Burd C, G Bond-Smith, Kurzawinski TR Increased use of pre-operative imaging and laparoscopy has no impact on clinical outcomes in patients undergoing appendicectomy *Ann R Coll Surg Engl* 2011; 93: 620–623
2. Petroianu A Diagnosis of acute appendicitis *International Journal of Surgery* 2012;10 115-119
3. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med* 1986; 15:557.
4. Kalan M, Talbot D, Cunliffe WJ, Rich AJ. Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis: a prospective study. *Ann R Coll Surg Engl* 1994; 76:418.
5. Raja AS, Wright C,Sodickson AD et al. Negative appendicectomy in the era of CT: an 18-year perspective. *Radiology* 2010; 256: 460-465.
6. Guller U,Rosella L, McCall J et al. Negative appendicectomy and perforation rates in patients undergoing laparocopic surgery for suspected appendicitis. *Br J Surg* 2011; 98:589-595
7. Lee M, Paavana T, Mazari F, Wilson TR The morbidity of negative appendicectomy *Ann R Coll Surg Engl* 2014;96:517-520
8. Van den Broek WT, Bijnen AB, de Ruiter P, Gouma DJ. A normal appendix found during diagnostic laparoscopy should not be removed. *Br J Surg* 2001;88: 251-254
9. Garlipp B, Arlt G. Laparoscopy for suspected appendicitis. Should an appendix that appears normal be removed? *Chirurg*. 2009; 80:615-21.
10. Binnebösel M, Otto J, Stumpf M, Mahnken AH, Gassler N, Schumpelick V, Truong S. Acute appendicitis. Modern diagnostics--surgical ultrasound) *Chirurg* 2009 Jul; 80(7):579-87.
11. Ozkan S, Duman A, Durukan P, Yildirim A, Ozbakan O. The accuracy rate of Alvarado score, ultrasonography, and computerized tomography scan in the diagnosis of acute appendicitis in our center *Niger J Clin Pract* 2014; 17(4):413-8
12. Sezer TO, Gulece B, Zalluhoglu N, Gorgun M, Dogan S. Diagnostic value of ultrasonography in appendicitis. *Adv Clin Exp Med* 2012; 21:633-6.
13. Pastore V, Cocomazzi R, Basile A, Pastore M, Bartoli F. Limits and advantages of abdominal ultrasonography in children with acute appendicitis syndrome. *Afr J Paediatr Surg* 2014; 11(4):293-6.
14. Park JS, Jeong JH, Lee JI, Lee JH, Park JK, Moon HJ. Accuracies of diagnostic methods for acute appendicitis. *Am Surg* 2013 Jan; 79(1):101-6.
15. Van Breda Vriesman AC, Kole BJ, Puylaert JB. Effect of ultrasonography and optional computed tomography on the outcome of appendectomy. *Eur Radiol* 2003; 13: 2278-82 6.
16. Hernandez JA, Swischuk LE, Angel CA, Chung D, Chandler R, Lee S. Imaging of acute appendicitis: US as the primary imaging modality. *Pediatr Radiol* 2005; 35:392-5.