

Ultrasonography for Diagnosis of Acute Appendicitis

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Abstract

Objective: The aim of this study is the comparison ultrasonography used as diagnostic tool preoperatively comparing it. Clinical assessment was used as diagnostic protocols.

Study design: This is a prospective observational study comparing the adverse outcome in two different groups of patients admitted with suspected acute appendicitis. The first group 100 patients were managed without ultrasonography. In the second group we use routinely graded compression abdominal ultrasonography preoperatively. Diagnostic accuracy of the protocol in each group was measured statistically and rates of negative appendectomy and perforation were determined.

Result: Addition of routine ultrasonography in clinical assessment for acute appendicitis decrease the sensitivity but significantly increases the specificity of the protocol there by reducing the false positive rate translating into decrease negative appendectomy rate. Rate of negative appendectomy was 22.5% in group one and 4.7% in group two. Perforation rate was 15.61 in group 1 and 15% in group 2.

Conclusion: Proper clinical assessment is the mainstay of diagnosis in acute appendicitis and by adding graded compression ultrasonography technique can improve the diagnostic accuracy and adverse outcome.

Keywords: Acute Appendicitis, physical exam, ultrasonography, Diagnosis.

1. Introduction

Acute appendicitis is one of the most frequent causes of abdominal emergency in nearly all age groups. Primary appendectomy is considered to be the most appropriate treatment [1].

Acute appendicitis present with a lifetime risk of 1 in 7, which means that 6% of the individuals suffer an attack during their lifetime. [2] However, an increased mortality rate of up to 15% has been observed in patient > 70 years of age and is mainly attributed to diagnostic & thus therapeutic delay. [3] The condition is difficult to diagnose especially during the early stages when the classical signs and symptom are subtle. [4]

The typical clinical signs and symptom of acute appendicitis are non-specific & may also cause by other abdominal or pelvic disorder which leading to pain in the right iliac fossa particularly in female patients. [5-6]

The diagnosis is mainly clinical and as a consequences of missed diagnosis are dire, the common surgical practice has been to operate on doubtful cases rather than to wait and see till the diagnosis is certain. This

resulted in Negative appendectomy rate of 20 to 30% has been considered acceptable. [7]

It has been observed that many patients undergoing appendectomy prove to be negative on his to pathology of the surgically removed appendix with is the gold standard for diagnosis of appendicitis. [8] Removing a normal appendix is a burden both on patients and health resources. [9]

However, early recognition of the condition and prompt operation have been the most important factors in reducing morbidity and cost of treatment. [10] Real – time compression ultra sound was first introduced by Puyleart in 1986. [11-12]

In graded compression technique, where a uniform pressure is applied in RIF by a hand held ultra sound transducer. Normal and gas filled loops of Intestine are either displaced from the field of vision or compressed between anterior & posterior abdominal walls. Inflamed appendix being incompressible is thus optimally seen the inflamed appendix is seen as a blind ended tubular structure with laminated wall arising from the base of Caecum. It is a

pre-stalactite non-compressible and its diameter should be more than 6 mm.

Appendicoliths appear as bright echogenic foci with distal acoustic shadowing, and their visualization is another contributory finding. Puylaert reported the sensitivity of 89% and specificity of 100% of his technique in the diagnosis of Acute Appendicitis.

1.1 Aim of this study

To evaluate the role of graded compression ultrasonography used as a diagnostic tool preoperatively comparing it with only clinical assessment was used as a diagnostic protocol.

2. Material & Method

2.1 Study design

This is A prospective observational study was conducted in Al-Furat teaching hospital from September 2016 to December 2017.

2.2. Patients

250 patients above age 14 years with suspected acute appendicitis were admitted.

2.3 Exclusion criteria

2-3-1: patient age < 14

2-3-2: patient with appendicular mass

2-3-3: patient with post-operative acute abdominal pain

2-3-4: patient with trauma

2-3-5: Signs of generalized peritonitis

We exclude 50 patients. The 200 patients are divided into 2 groups.

Group 1:

Group 1 includes 100 patients in which Alvarado scoring alone was used for decision to operate in this group.

All the patients with Alvarado score 7 or above were immediately operated upon. The patients with Alvarado score 4 or below were discharged on short follow up appointments. Patients with Alvarado score 5 – 6 were retained and reassessed at 4 hourly bases. Decision to operate or discharge was made within 24 hours depending on progress in their clinical course with score to act as cut off point. All non – operated patients were followed for one year.

Group 2:

Group 2 includes 100 patients in which abdominal ultrasonography by graded Compression technique was performed routinely in all these 100 patients within two hours of admission.

Sonographic visualization of the cecal tip, the psoas Muscle, and iliac vessels were considered landmarks in the exploration of the appendix area.

The sonographic findings were regarded as positive and Negative for acute appendicitis. The criteria for positivity included visualization of non-compressible

tubular and blind-ended a prestalitic structure with diameter of 6mm or more in Right iliac fossa.

The demonstration of appendicoliths, probe tenderness, increased echogenicity of the periappendiceal fat, free intraperitoneal fluid particularly in RIF or pelvis.

The criteria of Negativity were non visualization of appendix or visualization of normal appendix with or without alternative diagnosis. The patients with Alvarado score 5 and above with positive ultrasonography were operated immediately. Patient with negative ultrasound but Alvarado score 8 or above were also operated upon. Patient with Alvarado score 4 or below with negative ultrasound were discharged immediately with short follow up appointment patients with Alvarado score 4 or below with positive ultrasound were retained for 48 hrs under observation and decision to operate was made then based on repeat scoring and sonographic scanning.

Operative findings in both groups were classified as negative, positive and perforated. Negative appendectomy was defined as normal looking appendix on operation and absence of acute inflammation on histopathology.

Positive cases included appendices showing acute or subacute inflammatory changes on histopathology. Perforation was described to occur when it was clearly visible on operation, gangrenous changes discerned on histopathology. Two by two table was used for statistical analysis to compare the accuracy of two diagnostic protocols in terms of their sensitivity, specificity, false Negative and positive values and their predictive values.

The 4 patients in group 1 and 6 patients in group 2, operated during follow up were also included in 2 x 2 statistical tables. Rate of negative appendectomy and perforation were calculated in both groups.

Negative appendectomy rate (NAR) was defined as the percentage of operated cases with normal appendix during their First admission. Perforation rate (PR) was defined as the percentage of operated patients with perforated appendix also during their first admission.

3. Results

There were 54 females and 46 males all the patients in group one. In second group there were 66 females and 34 males.

In the second group 5 patients with positive ultrasound were not operated upon because of clinical improvement & 6 among the non-operated patients returned with recurrent acute appendicitis and were operated upon. The four patients in group 1 and six in group 2 admitted subsequently during follow up were not considered for calculating these rates.

Figure 1 shows the overall profile of group one.

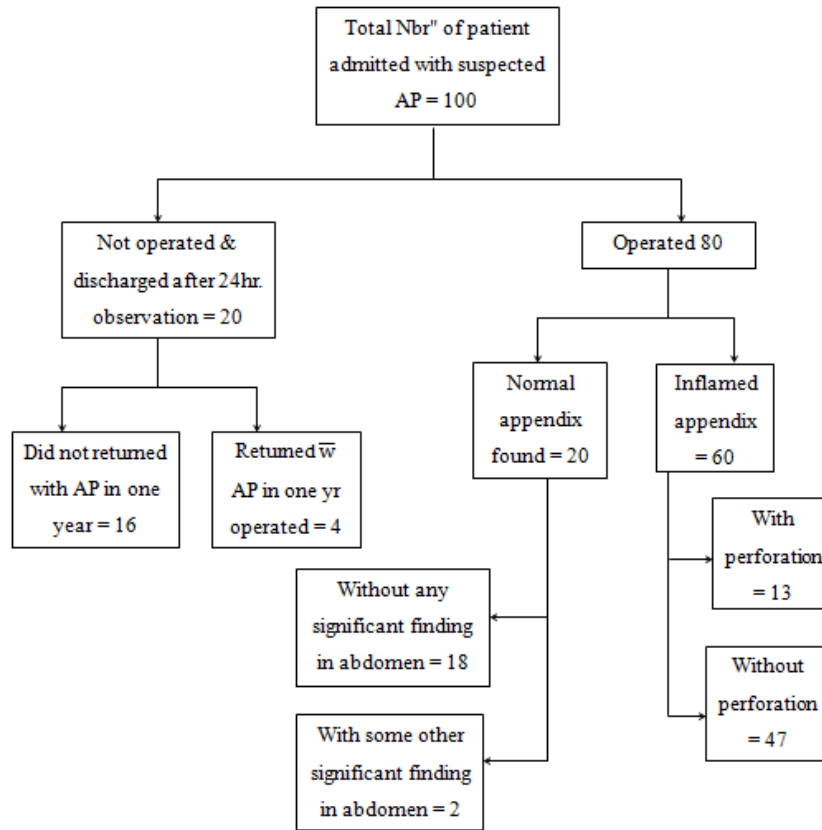


Figure 1: Profile Group 1 (AP = appendicitis)

The profile of second group of patients in shown in figure 2 a and b.

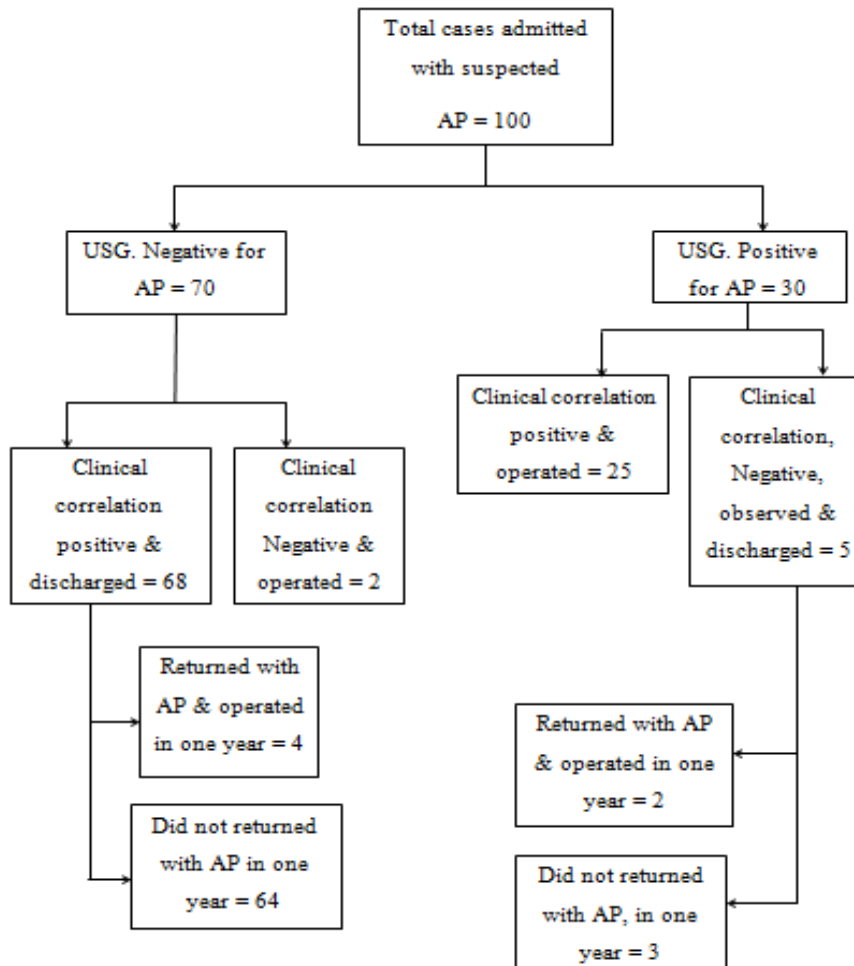


Figure 2(a): Profile of Group 2

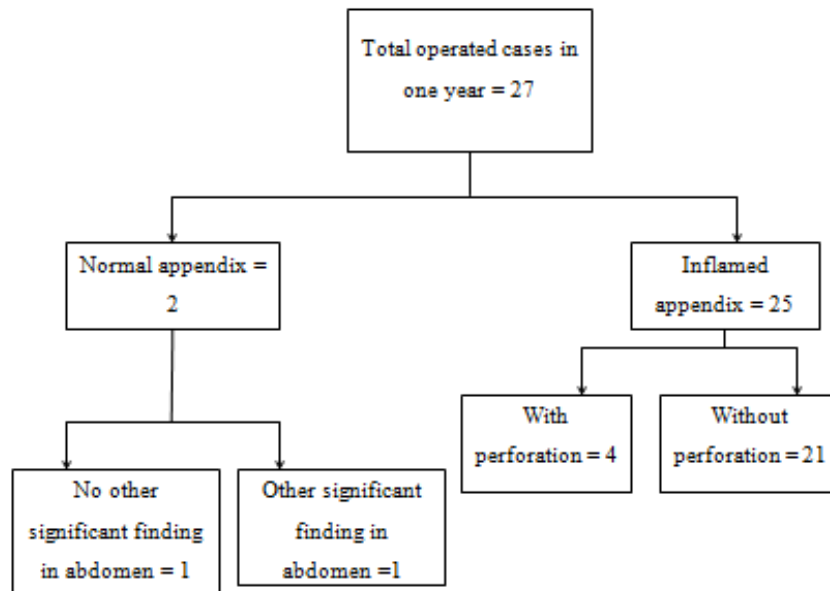


Figure 2 (b): Operative finding of Group 2

Table 1: summary of results in group 1

	Ac. Appendicitis + (D +)	Ac. Appendicitis(D -)	
Clinical Diagnosis +(T +)	60 (TP)*	20 (FP)**	80 (All tests positive)
Clinical Diagnosis -(T -)	4 (FN)***	16 (TN)****	20 (All test negative)
Total	64 (all diseased free)	36 (All disease)	100 G. total

* TP = True positive ** FP = false positive, *** FN = False negative, **** TN = True negative

Sensitivity = True positive rate (TPR) = Diseased with positive test/All diseased = 60/64 = 0.93
 Specificity = True negative rate (TNR) = Disease free with negative test/All disease free = 16/36 = 0.444
 False negative rate (FNR) = Diseased with negative test/All diseased = 4/64 = 0.062
 False positive rate (FPR) = Diseased free with positive test/All disease free = 20/36 = 0.555
 Negative predictive value (NPV) = Disease free with negative test/All with negative test = 16/20 = 0.8
 Positive predictive value (PPV) = Diseased with positive test/All with positive test = 60/80 = 0.75

Table 2: Summary of results in group 2

	Ac. Appendicitis + (D +)	Ac. Appendicitis (D -)	Total
USG Diagnosis + T +ve	27 (TP)*	3 (FP)**	30 (All tests positive)
USG Diagnosis - T -ve	6 (FN)***	64 (TN)****	70 (All test negative)
Totals	33 (all diseased)		100 total

* TP = True positive ** FP= false positive, *** FN = False negative, **** TN = True negative

Sensitivity = True positive rate (TPR) = Diseased with positive test/All diseased = 27/30 = 0.9
 Specificity = True negative rate (TNR) = Disease free with negative test/All disease free = 64/67 = 0.955
 False negative rate (FNR) = Diseased with negative test/All diseased = 6/33 = 0.18
 Positive predictive value (PPV) = Diseased with positive test/All with positive test = 27/30 = 0.9
 Negative predictive value (NPV) = Disease free with negative test/All with negative test = 64/70 = 0.914

Table 1 & 2 summarize result in group 1 & 2 using 2 x 2 contingency table. Diagnosis of Acute appendicitis was taken as positive when confirmed on operation, histopathology or both.

Diagnosis was considered negative, when patient recovered completely without operation, did not return during follow- up or normal appendix removed on operation. Accuracy and predictive values for both diagnostic protocols are compared in Table 3.

Table 3: comparison of two diagnostic protocols in statistical terms

Statistical value	Group 1	Group 2
Sensitivity	0.93	0.9
Specificity	0.444	0.955
FNR	0.06	0.18
FPR	0.555	0.044
PPV	0.75	0.9
NPV	0.8	0.914

Comparison of performance values of the two protocols show that diagnostic specificity in Group 2 is significantly higher and FPR is significantly lower than the corresponding values in Group 1. These mean that very few cases of Acute Appendicitis will be missed.

Negative appendectomy rate (NAR) was significantly higher in Group 1 table 4 Compares negative appendectomy rate in two groups.

Table 4: Negative appendectomy rate (NAR)

	Group 1	Group 2
Total Nbr. Of admitted cases	100	100
Total Nbr. Of operation	80	27
Nbr. Of normal appendices	20	2
NAR	25%	7.4%

Perforation rate was also higher in group 1 but the difference was not marked. Table 5 illustrates this difference.

Table 5: Perforation rate in two groups

	Group 1	Group 2
Total Nbr. of admitted cases	100	100
Nbr. of operation	80	27
Nbr. of patients with perforated appendix	13	4
PR	15.6%	15%

Both negative appendectomy and perforation are adverse clinical outcome. An overall adverse outcome in each protocol can be measured by adding both these indices table 5 analysis this difference.

Table 5: Perforation rate in two groups

	Group 1	Group 2
NAR	25%	7.4%
PR	15.6%	15%
Total adverse outcome	40.6%	22.4%

4. Discussion

The diagnosis of appendicitis can be challenging even in the most experienced hands and is predominantly a clinical one.

Sometime presentation in so a typical that even the most experienced surgeon may remove normal appendix or sit on the perforated one. [13]

Clinical decision to operate leads to removal of 20% of normal appendices to avoid the complications of missed or delayed diagnosis in equivocal cases. [14]

This was said to be the optimum balance between negative appendectomy and rate of perforation which were thought to be reciprocally related. [7]

The most widely studied new diagnostic modalities are CT scan, ultrasonography, and laparoscopy. [15 – 16]

The main advantages of ultrasound over other modalities are that it is non-invasive quick to perform, relatively cheap.

Can be used to identify other alternative causes of abdominal pain and has real- time capability, mobility and lack of ionizing radiation makes USG safer for patient, and operators.[17]

In our first group of patients ultrasound was not used decision was purely clinical the sensitivity of diagnostic protocol in this group was 93% but dropped to 90% in second group when ultrasound was routinely used in diagnostic process.

This explains the relatively higher FNR in group two.

The specificity is significantly higher in group two, being 95% as compared to 44% in group 1. This reflected in low FPR and consequently low NAR in group 2. Predictive values, both positive & negative were higher in group two patients this observation. Again reflect the usefulness of ultrasonography in statistical language.

The improved performance parameters in group two were translated in better clinical outcome.

Both NAR and PR were lower in this group although decrease in NAR was more significant statistically. NAR was 25% in group 1 but dropped to 7.4% in group 2.

Perforation rate was 15.6% in group 1 and decrease to 15% in group 2 this different is very small but it is in sharp contest to many other studies where PR. Was observed to incline with the decline of NAR. [18]

Most of the workers have reported the same rates of negative appendectomy and perforation when decision to operate was clinical. [19]

Some workers have reported lower values of NAR and PR then our observation with Alvarado score.

This might be due to their extended period of observation, more female patients in their study or cut off point of the score for decision to operate.

Our cut off point for operation in group 1 was Alvarado score 6 similarly lower PR in some studies are also due to differences in definition of perforation.

In one such study gangrenous appendix was not counted as perforated and separate rate of perforation and gougers were reported as 7.8% and 10.9% respectively. [20]

Our result in consistent with many other observers. [21,22]

When ultrasound was incorporated in diagnostic work up in our second group of patient, NAR was dropped to 7.4% and PR dropped to 15% this finding refutes the concept of reciprocal relationship between negative appendectomy and perforation rates.

In corporation of ultrasound decreased the negative appendectomy significantly without increasing the perforation rate.

Contrarily perforation rate was also dropped our finding are in consistence with many other reports where

preoperative ultrasound improved the clinical outcome favorably. [22,23]

Stefan pug *et al* in 2003 has reported 36.6% NAR without USG and 13.2% after USG. However their perforation rates were significantly more in USG group testifying the hypothesis of inverse relation.

Vlyanovich V and Satava R (1992) in their study of 10.000 patients have also reported the same concept of inverse relationship. [19]

Our low PR in group 2 might be due to low cut off point of Alvarado score in this cohort of patients. Our cut off point in group 1 was 6 but 2 in group 2.

Both negative appendectomy and perforation are adverse outcome.

We can add both event and calculate the adverse outcome without any reference to their mutual relationship adverse outcome dropped from 40.6% to 22.4% this improved clinical outcome signifies the importance of ultrasonography in diagnostic workup of the patients. [24].

Since Puylaert described the role of ultrasound (ULS) as diagnostic method for acute appendicitis in 1986, a number of workers have studied the role of ultrasound in the management of suspected acute appendicitis. Most of these authors have reported increased diagnostic accuracy when ultrasound was added to the clinical work up of these patients.

An important additional advantage of ultrasound in acute appendicitis is the diagnosing of alternative condition in abdomen, Mimicking acute appendicitis. [27]

As some of this condition do not need surgery, so operation can be avoided.

There are certain draw backs in ultrasonography for acute appendicitis. The foremost important is the experience of the sonologist, as the procedure is highly operator dependent.

The sonologist involved in this study has experience of 20 years with special interest in graded compression technique.

This is the main reasons of our better outcome. There are reports in the literature against the usefulness of ultrasound in diagnosis of acute appendicitis. Operates dependency of the techniques may also be the reason for these reports with poor outcome. [28- 29]

Mufti TS *et al* [30] concluded that use of graded compression ultrasonography as preoperative diagnostic technique has a good sensitivity (84.3% & 81%) but poor Specificity implying that the value of ultrasonography may remain unclear in reducing the negative appendectomies.

In conclusion ultrasound by graded compression technique is a useful adjunct to the clinical examination of the present day surgeon. It can reduce the negative appendectomy rate without adversely affecting the perforation rate particularly in equivocal cases.

Ultrasound finding should be correlated carefully with clinical finding.

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