Evaluation of Ultrasound and Alvarado Score Combination for the Diagnosis of Acute Appendicitis in Babylon Childrens

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ABSTRACT

Background: Acute appendicitis is the commonest cause of emergency abdominal surgeries in children and must be distinguished from other cases of acute abdominal pain. Acute appendicitis not easily diagnosed especially in early stages of the disease. Failure of early diagnosis can lead to progression of the disease with its morbidity and occasional mortality. Ultrasound (US) and The Alvarado score as trials to reduce the negative appendectomy rate without increasing morbidity and mortality. Both have been proven to be a helpful imaging modality and scoring system respectively, in the diagnosis of acute appendicitis in children. Objective: Our study aims to evaluate a combination of clinical scoring (Alvarado score) system and ultrasound findings for accurate diagnosis of acute appendicitis in children.

Patient & Method: The study was created in the Babylon Maternity and Pediatric Teaching Hospitals from January 2005 to January 2013. 260 children with right iliac fossa abdominal pain clinically suspected of having acute appendicitis were included in this study and clinically assessed to calculate the Alvarado score. Patients were referred to the radiology department for urgent abdominal US.

Results: In present study, 260 patients involved and 114 of them were diagnosed pre-operatively and operated on as acute appendicitis. Of the118 patients how were operated, 104 patients proved to have acute appendicitis intraoperatively. The percentage of appendicitis was 88.1% (104/118) and 10 (8.4%) patients had normal appendix. Ovarian cysts pathology was diagnosed in3 girls and another male with omental torsion. The prevalence of appendicitis among the patients of the study was 40% (104/260). Sensitivity of the ultrasound for clinical diagnosis of acute appendicitis was 98.0%, specificity, 96.1%, while that for Alvarado scores 93.0 % and 94.9% respectively.

Conclusion: A combination of Alvarado score and abdominal US findings is a good approach for the diagnosis of appendicitis in children to reduce the negative appendectomy rate without increasing morbidity and mortality. In the case of normal appendix or non-visualization of the appendix via abdominal US with a low Alvarado score, appendicitis can be safely excluded. If an inflamed appendix assured on US or a high Alvarado score, patient should be subjected for appendectomy without delay. Patients with low Alvarado scores and positive US findings or moderate and high Alvarado scores with negative US findings should be observed for 24 h and appendectomy is only done when manifestations persist.

Keywords: Ultrasound, Alvarado score, Appendicitis. Children

1. INTRODUCTION

Acute appendicitis remains the most common cause of emergency abdominal surgeries in children\textsuperscript{(1,2)}. Accurate and timely diagnosis of acute appendicitis is essential to reduce morbidity. Prompt surgical treatment may reduce the risk of the appendix perforation. The mortality rate of appendicitis jumps from less than 1% for the nonperforated cases to 5% or higher when the perforation occurs\textsuperscript{(3)}. Symptoms of appendicitis overlap with a number of other conditions, thus making diagnosis a challenge especially at an early stage of presentation\textsuperscript{(4)}. It is difficult to obtain a clear history in children as not all patients’ present classical symptoms and many disorders of the gastrointestinal tract mimic acute appendicitis\textsuperscript{(5)}.

Acute appendicitis remains a clinical diagnosis but when the diagnosis of acute appendicitis is difficult, there are several methods to assist the diagnosis: laparoscopy, scoring systems such as the Alvarado score, imaging studies like abdominal ultrasound (US), computed tomography (CT) and magnetic resonance imaging (MRI)\textsuperscript{(6,7,8,9,10,11)}. Abdominal ultrasound (US) has been proven to be a helpful imaging modality in patient evaluation, especially in children suspected of appendicitis\textsuperscript{(6,7)}.

However, sensitivity and specificity of CT in diagnosing appendicitis is higher than US\textsuperscript{(12,13)} and due to the long-term risk of ionizing radiation, the high cost limits and availability, CT scans still not be the favored imaging method as a routine imaging modality for the diagnosis of acute appendicitis especially in children\textsuperscript{(14)}. MRI does have its disadvantages, which include cost, time and potential need for sedation to obtain an accurate result\textsuperscript{(15)}.

US as a diagnostic tool for appendicitis is desirable because it’s the cheapest and least invasive and radiation exposure method that has been reported to have an accuracy of 70%-95\%\textsuperscript{(16)}. US have its challenges as well; Appendix visualization rates vary and US exhibits significant user dependency\textsuperscript{(17)}.

The Alvarado score is a scoring system for the diagnosis of appendicitis, consisting of 10 points based on symptoms, clinical signs, and differential leukocyte count\textsuperscript{(18)}. However it was originally designed more than 3 decades ago as a diagnostic score, the feasibility for routine clinical use are still unclear\textsuperscript{(19)}. Therefore, the purpose of this study was to evaluate the use of US findings combined with Alvarado scores in diagnosing children with suspected appendicitis.

2. MATERIALS AND METHODS

In this prospective study 260 children (123 boys and 137 girls) with acute abdominal pain ( < 3 days) and clinically suspected of having acute appendicitis were admitted to Babylon maternity and Pediatric Teaching Hospitals from January 2005 to January 2016. All patients were clinically assessed for Alvarado score calculations, and their blood samples were taken for routine laboratory investigations including complete blood count (CBC), liver and kidney profiles. Patients were then referred for abdominal US. The mean age of 11.5 years (age range: 4–14 years).

Alvarado scores (Table 1) were calculated and patients were classified into three groups according to the score: (i) low Alvarado scores (Alvarado score ≤4); (ii) moderate Alvarado scores (Alvarado scores 5 and 6); (iii) high Alvarado scores (Alvarado score ≥7).

Table 1: Calculation of Alvarado scores

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migratory right iliac fossa pain</td>
<td>1</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
<td>1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signs</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenderness in the right iliac fossa</td>
<td>2</td>
</tr>
<tr>
<td>Rebound tenderness in the right iliac fossa</td>
<td>1</td>
</tr>
<tr>
<td>Elevated temperature</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratory findings</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukocytosis</td>
<td>2</td>
</tr>
<tr>
<td>Neutrophils shifted to the left</td>
<td>1</td>
</tr>
</tbody>
</table>

| Total                               | 10    |

All patients were referred to a radiologist for abdominal US. The radiologist had no idea about patients’ Alvarado scores. Criteria for the US diagnosis of inflamed appendix included identification of the appendix as a fluid-filled, non-compressible, blind-ended tubular structure with diameter ≥6 mm and hyperemia of the wall of the appendix. US findings in perforated appendicitis were target signs.
and tubular structures with inhomogeneous structures and/or missing layers in the wall. Other diagnoses found during US were also recorded. According to the abdominal US results, Patients were classified in four groups: group 1 with normal visualized appendix (diameter < 6 mm); group 2 with appendix not visualized but without secondary signs of appendicitis (i.e., local fluid (collections or local dilatation of the bowel without peristalsis, indicating focal peritonitis or increased echogenicity of the surrounding mesenteric tissues); group 3 with appendix not visualized but one or more of the secondary signs of appendicitis were present; and group 4 having appendicitis with visualization of an inflamed appendix or perforated appendicitis.

After clinical examinations, calculation of Alvarado scores, laboratory investigations and abdominal US, patients were either discharged (Alvarado score ≤4 in US groups 1 and 2) with follow-up appointments as an outpatient after three days and one week, instruction to return at any time if pain recurs were given; subjected to appendectomy (high Alvarado score ≥7); or admitted for 24-hour observation (patients with moderate Alvarado scores of 5 and 6, or patients with low Alvarado scores from US groups 3 and 4), after which they were re-evaluated.

The results counted as negative for appendicitis when patients’ complaints were either resolved upon re-evaluation in the outpatient clinic, patients had responded to conservative treatment of an alternative diagnosis, or when patients were already operated on and the presence of normal appendix or presence of other pathology was proven as operative finding. Patients who could not come to the outpatient clinic for follow-up and re-evaluation were excluded.

3. RESULTS

In this study, 260 patients included with suspected acute appendicitis. According to their Alvarado scores, patients were classified into three groups (Table 2):

1. Low Alvarado scores (≤4): 140 children were subclassified according to US findings with 40 patients from group 1, 96 patients with group 2, and 4 patients included in group 3. All patients with low Alvarado scores from US groups 1 and 2 were managed conservatively, and discharged with appointments in the outpatient clinic after three days to one week. Patients were informed to return if pain recurs at any time. All of them came for the follow-up appointment with no complaints.

In the US group 3, 1 girl showed complex right ovarian cyst with right iliac fossa collection and were operated for that diagnosis. The remaining 3 patients were admitted for observation: 2 patients operated (proven intraoperatively to have acute appendicitis and omental torsion respectively) due to the persistence of symptoms and increased leukocyte count after 24 h, while the other patient was discharged after 24 h observation and was free from pain on conservative treatment.

2. Moderate Alvarado scores (5 and 6): 18 patients, with no patient from US group 1 and 8 patients from group 2 –of which 2 girls were diagnosed with complex ovarian cysts on US and operated on. The remaining 6 patients were admitted for follow-up and reassessed after 24 h. 4 patients were relieved of pain and discharged with a follow-up appointment after one week. 2 patients were reassessed and Alvarado score became more than 7, and therefore suggested for appendectomy. Operative findings and pathology proved acute appendicitis in 1 patient and the other had normal appendix. 10 patients from groups 3 and 4 were admitted for 24 h follow-up and reassessed within 24 h. 1 were relieved of pain and discharged with a follow-up appointment after one week while 9 patients had reassessment scores of more than 7 and were suggested for appendectomy. Operative findings and pathology proved acute appendicitis in 8 patients and normal appendix in 1.

3. High Alvarado scores (Alvarado score ≥7): 102 patients, with no patient from US group 1, 8 patients from group 2, and 94 patients from groups 3 and 4. All patients with high Alvarado scores were operated for appendectomy. 7 patients in group 2 and 1 patient in groups 3 and 4 each proved to have normal appendix in the operative finding.
Table 2: Alvarado scores combined with US findings for decision and final diagnosis

<table>
<thead>
<tr>
<th>US group &amp; No</th>
<th>Alvarado score</th>
<th>Decision and final diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Group 1</td>
<td>40/260 (15.3%)</td>
<td>40/260 (15.3%)</td>
</tr>
<tr>
<td>US Group 2</td>
<td>112/260 (43%)</td>
<td>96/260 (36.1%)</td>
</tr>
<tr>
<td>US Groups 3 &amp; 4</td>
<td>108/260 (41.5%)</td>
<td>4 (1 were operated, +ve for appendicitis; 1 for omental torsion; 1 for ovarian cyst and 1 for conservative treatment)</td>
</tr>
</tbody>
</table>

Total 260 140 18 102

Of the 118 patients how were operated, 104 patients proved to have acute appendicitis intraoperatively. The percentage of appendicitis confirmed upon surgery and/or pathology was 88.1% (104/118) while 10 (8.4%) patients had normal appendix. 3 girls were diagnosed with complex ovarian cysts and another patient with omental torsion. The prevalence of appendicitis among patients of the study was 40% (104/260). The diagnostic accuracy of US for clinical diagnosis of acute appendicitis was as follows (Table 3): sensitivity, 98.0% (102/104); specificity, 94.9% (151/159); positive predictive value, 94.4% (102/108); negative predictive value, 98.6% (150/152); and accuracy, 96.9% (252/260).

Table 3: Diagnostic accuracy of US for the clinical diagnosis of acute appendicitis

<table>
<thead>
<tr>
<th>US finding –ve Group 1 and 2</th>
<th>Confirmed appendicitis</th>
<th>No appendicitis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>150</td>
<td>152</td>
</tr>
<tr>
<td>US finding +ve Group 3 and 4</td>
<td>102</td>
<td>6</td>
<td>108</td>
</tr>
</tbody>
</table>

Diagnostic accuracy of Alvarado scores for the clinical diagnosis of acute appendicitis was as follows (Table 4): sensitivity, 93.0% (94/101); specificity, 94.9% (151/159); positive predictive value, 92.1% (94/102); negative predictive value, 95.5% (151/158); and accuracy, 94.2% (245/260). When patients’ Alvarado scores were combined with US findings, specifically low grade Alvarado scores with US groups 1 and 2, results showed no false negative cases and diagnosis was accurate by 100%. The combination of high Alvarado scores and US groups 3 and 4 showed only one false positive case with an accuracy of 99% (93/94).
Table 4. Diagnostic accuracy of Alvarado scores for the clinical diagnosis of acute appendicitis

<table>
<thead>
<tr>
<th></th>
<th>Confirmed appendicitis</th>
<th>No appendicitis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low and intermediate Alvarado Scores</td>
<td>7</td>
<td>151</td>
<td>158</td>
</tr>
<tr>
<td>High Alvarado Scores</td>
<td>94</td>
<td>8</td>
<td>102</td>
</tr>
<tr>
<td>TOTAL</td>
<td>101</td>
<td>159</td>
<td>260</td>
</tr>
</tbody>
</table>

4. DISCUSSION

Acute appendicitis is the most common cause for surgical emergencies in the pediatric age group. It is no more acceptable to perform appendectomy on normal appendix with the availability of well-trained surgeons and with the evolution of imaging tools such as the US, CT scan and MRI. Ultrasound and CT have been reported to improve accuracy in the diagnosis of acute appendicitis. Although CT is reported to have a higher sensitivity than US, ongoing concerns have been raised regarding radiation exposure. Projections estimated that a solid cancer will result at a rate of 25.8 to 33.9 cases per 10,000 abdominal CT scans in girls and, 13.1 to 14.8 cases per 10,000 abdominal CT scans in boys. Furthermore, high costs and the need for sedation would limit the use of CT and MRI for diagnosing appendicitis in children. US as a diagnostic imaging tool for acute appendicitis are increasingly desirable to reduce radiation exposure and lessen costs. However, US have its own challenges as well. Appendix visualization rates vary and US has the disadvantage of user dependency. Miglioretti et al reviewed, that the sensitivity of US for the diagnosis of acute appendicitis in children varied between 78% and 100%, and the specificity from 88% to 98%. Recent studies have reported sensitivity of 91% to 99% and specificity of 97% to 98%.

In this study, the diagnostic accuracy of US for clinical diagnosis of acute appendicitis was as follows: sensitivity, 98.0% (102/104); specificity, 96.1% (150/156); positive predictive value, 94.4% (102/108); negative predictive value, 98.6% (150/152); and accuracy, 96.9% (252/260).

In diagnosing acute appendicitis, surgeons balanced the risk of removing a normal appendix against the risk of perforation. The Alvarado clinical scoring system is a convenient tool for aiding the diagnosis of appendicitis and decrease the number of appendectomies for normal appendix. Alvarado scores have been previously shown to be relatively sensitive and specific in adults with lower right quadrant pain. As a diagnostic tool for the diagnosis of acute appendicitis in the pediatric age group, Ohle et al. and Mandeville et al. reported fairly sensitive (99% and 89.7% respectively) for lower scores (>6). Scores of 7–10 have shown sensitivities ranging from 72% to 92% and specificities ranging from 64.4% to 82.0%.

In this study, the diagnostic accuracy of Alvarado scores for the clinical diagnosis of acute appendicitis was as follows: sensitivity, 93.0% (94/101); specificity, 94.9% (151/159); positive predictive value, 92.1% (94/102); negative predictive value, 95.5% (151/158); and accuracy, 94.2% (245/260). Alvarado clinical scores and ultrasound findings combined in our study to identify children with a high or low probability of appendicitis. In this study, combining low grade Alvarado scores with US groups 1 and 2 (negative US findings) showed no false negative cases and diagnosis was accurate by 100%. Moreover, combining high Alvarado scores with US groups 3 and 4 (positive US findings), resulted in only one false positive case with an accuracy of 99% (93/94).

In this study the limitation was the lack of pathological diagnosis in patients for whom no appendectomy was performed. The results were counted as true negatives when patient’s complaints resolved or if patients had a successful response to conservative treatment of an alternative diagnosis.

5. CONCLUSION

A combination of Alvarado scores and abdominal US is a good approach for the diagnosis of acute appendicitis in children, reducing negative appendectomy rate without increasing morbidity and mortality.

In the case of normal appendix or non-visualization of the appendix via abdominal US with a low Alvarado score, appendicitis can be safely excluded. If an inflamed appendix assured on US or a high Alvarado score, patient should be subjected for appendectomy without delay. Patients with low Alvarado scores and
positive US findings or moderate and high Alvarado scores with negative US findings should be observed for 24 h and appendectomy is only done when manifestations persist.

REFERENCES