

## Accuracy of Modified Alvarado Scoring System in Early Diagnosis of Acute Appendicitis

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### ABSTRACT

**Background and Objectives:** Appendicitis is a common surgical emergency. The patients with equivocal signs can present a diagnostic challenge. Early diagnosis and intervention is mandatory for prevention of complications. On the other hand negative appendicectomy should be avoided as much as possible. The aim is to evaluate the role of the modified Alvarado scoring system in early diagnosis of acute appendicitis.

**Methods:** During a period of 6 months from 1<sup>st</sup> February to 31<sup>st</sup> July 2008; 250 patients with right iliac fossa pain were admitted and observed in Emergency Hospital in Erbil. The age of the patients was ranged between 13-70 years (mean 22 years). The male to female ratio was 3:2. They were prospectively evaluated on admission using modified Alvarado scoring system to determine whether or not they had acute appendicitis. The results were correlated with the operative and histopathological findings.

**Results:** After first scoring; 179 (72%) patients were admitted and 71 (28%) patients were discharged. Rescoring by modified Alvarado scoring system was done after 6 hours from admission, only 162 (91%) patients were operated on, and the rest 17 (9%) patients were discharged. During operation we found that 142 cases (87.5%) had really acute appendicitis. Overall the modified Alvarado scoring system showed sensitivity of (93%) for [8-9] scores and (39%) for [1-7] scores.

**Conclusions:** The modified Alvarado scoring system is accurate in early diagnosis of acute appendicitis. Patients with 8-9 scores should be operated on immediately without hesitation. Patients with score 5-7 must be admitted and scored frequently. Score 1-4 can be discharged unless otherwise indicated.

**Key words:** modified Alvarado scoring system, acute appendicitis, Appendicectomy.

### INTRODUCTION:

Classical signs and symptoms of acute appendicitis were first reported by Fitz in 1886<sup>1</sup>. Since then it has remained the most common surgical emergencies<sup>2,3</sup>. Surgery for acute appendicitis is the most frequently performed operation. It forms 10% of all emergency abdominal operations<sup>4</sup>. Approximately 6% of the population will suffer from acute appendicitis during their lifetime; therefore much effort has been directed toward early diagnosis and intervention<sup>5</sup>. The diagnosis of acute appendicitis is based on history, clinical examination and a few laboratory

count, etc. Imaging techniques are not very useful and patients with equivocal signs can present a diagnostic challenge<sup>6</sup>. In all cases, however, a definitive diagnosis can only be obtained at surgery and after pathological examination of the surgical specimen<sup>7</sup>. Difficulties in diagnosis often arise in children, elderly and female patients of reproductive age because they usually have an atypical presentation<sup>8</sup>. Misdiagnosis and delay in surgery can lead to complications like perforation and subsequent peritonitis<sup>8</sup>. On the other hand removing a normal appendix is an economic burden on both the patients and health resources<sup>9</sup>. Various scoring systems

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have been devised to aid diagnosis. The Alvarado score was one of these, which was described in 1986<sup>10</sup>. It is simple and can be instituted easily as this scoring is clinical, non-invasive and can be used to support diagnosis of acute appendicitis<sup>11-13</sup>.

The classic Alvarado Score included left shift of neutrophil maturation (one score) yielding a total score of (10). Kalan et al [1994] omitted this parameter which is not routinely available in many laboratories, and they produced a modified score<sup>14</sup>.

The Aim of the study was to evaluate the role of the Modified Alvarado Scoring System for the early diagnosis of acute appendicitis.

#### **PATIENTS METHODS:**

This is a prospective study comprising 250 consecutive patients who attended the Emergency Hospital in Erbil, with suspected appendicitis during the period from 1<sup>st</sup> February 2008 to 31<sup>st</sup> July 2008. For each patient Alvarado score was calculated. For scoring of the patients we depended on modified Alvarado scoring system. The diagnosis of acute appendicitis, the decision for admission and the decision for surgery made clinically by the surgical on call team, who were unaware of the scoring system. The operations also were done by them. All patients were first scored at the time of receiving in the emergency department. Patients who were admitted to the hospital had a second scoring in the ward after 6 hours. Those who were not admitted and those who were discharged after 6 hours were told to attend on the next day for rescore. Patients with a score of 1-4 are considered unlikely to have acute appendicitis. Those with a score of 5-6 have a possible diagnosis of acute appendicitis, not considering enough to have urgent surgery, and those with score of 7-9 are regarded as probable acute appendicitis. Diagnosis of patients who underwent appendectomy was confirmed by both operative findings (gross) and

was sent for histopathological study, when a grossly non-inflamed appendix was removed at surgery. The patient's data were collected in a specially designed form and SPSS version 15 used for data entry and statistical analysis.

#### **RESULT:**

The total number of the patients was 250 patients, 151 [60%] of them were males and 99 [40%] were females. Male to female ratio was 3:2. The age of the patients was ranged between 13-70 years (mean 22 years). They were scored at the time of receiving according to Modified Alvarado scoring system. Seventy one cases (28%) were discharged and 179 cases (72%) were admitted for 6 hours observation. After that another 17 patients (9%) were discharged and 162 patients (91%) were operated on. The modified Alvarado score of the patients who were discharged after first scoring, admitted, operated cases, and those who discharged after re-scoring shown in (Table 1).

The modified Alvarado scoring system of all operated patients shown in (Table 2). During operation we found that 142 cases (87.5%) had really acute appendicitis ranging between [inflamed appendix containing faecoeth, severely inflamed appendix, perforated, or gangrenous appendix]. In 20 patients (12.5%) with grossly normal appendix the histopathological study also showed normal appendix. In 11 out of these 20 cases (55%) no diagnosis was found. Six cases (30%) had complicated ovarian cyst. Only 1 case had ruptured ectopic pregnancy, and 1 case had perforated duodenal ulcer, Another case had ureteric stone.

The modified Alvarado scoring of the patients with three categories of (1-4), (5-6) and (7-9) scores; show a sensitivity of 2.6% , 60% and 88% respectively as shown in (Table 3).

Another categorization of (1-7) and (8-9) scores show sensitivity of (%39) and (93%) respectively table (4).

**Table (1):** The Modified Alvarado scoring system of different categories of patients and their eventual outcome.

<b>Alvarado Score</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>Total</b>
<b>Discharged after scoring</b>	15	16	15	14	4	3	3	1	0	71
<b>Admitted and rescored after 6 hours</b>	0	4	7	4	14	29	38	39	44	179
<b>Discharged after rescoring</b>	0	3	4	3	3	1	2	1	0	17
<b>Totally discharged cases</b>	<b>15</b>	<b>19</b>	<b>19</b>	<b>17</b>	<b>7</b>	<b>4</b>	<b>5</b>	<b>2</b>	<b>0</b>	<b>88</b>
<b>Operated cases</b>	0	1	3	1	11	28	36	38	44	162

**Table(2):** Modified Alvarado score of all operated cases.

<b>Alvarado score</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>Total</b>
<b>Positive appendicectomy 87.5%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>29</b>	<b>33</b>	<b>35</b>	<b>43</b>	<b>142</b>
<b>Negative appendicectomy 12.5%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>6</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>20</b>
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>35</b>	<b>37</b>	<b>38</b>	<b>44</b>	<b>162</b>

**Table (3):** Sensitivity of Modified Alvarado Score in 3 categories

<b>Score</b>	<b>No of Patients</b>	<b>Acute Appendicitis</b>	<b>Normal Appendix</b>	<b>Sensitivity</b>
7-9	125	110	15	88%
5-6	50	30	20	60%
1-4	75	2	73	2.7%
<b>Total</b>	<b>250</b>	<b>142</b>	<b>108</b>	

**Table (4):** Sensitivity of Modified Alvarado Score of two categories.

Score	No of Patients	Acute Appendicitis	Normal Appendix	Sensitivity
8-9	84	78	6	93%
1-7	166	64	102	39%
<b>Total</b>	250	142	108	

### DISCUSSION:

The diagnosis of appendicitis can be difficult, sometimes even for the most experienced surgeon<sup>15</sup>. The decision to admit or discharge these patients is not always straightforward. This may be compounded by the relative lack of surgical experience of many junior doctors who may need to make this decision at the emergency department<sup>14</sup>. Avoiding a negative laparotomy would result in saving the patient from economic loss as well as operative morbidity associated with the procedure. At the same time missing an acute appendicitis could result in perforation and peritonitis that definitely increases the morbidity and mortality<sup>15</sup>. Attempts to increase the diagnostic accuracy in acute appendicitis have included laboratory investigations as WBC count and C-reactive protein<sup>16-21</sup>, computer aided diagnosis<sup>11</sup>, imaging by ultrasonography<sup>3,22-32</sup>, CT scan<sup>28, 33-46</sup>, MRI<sup>6</sup>, laparoscopy<sup>47</sup>, and even radioactive isotope imaging.<sup>15,48-54</sup> Some surgeons believe that Good clinical assessment and skills of the surgeon remains the mainstay of establishing the diagnosis of acute appendicitis.<sup>55</sup> Other surgeons believe that scoring systems seem to be ideal for supporting the diagnosis of acute appendicitis because they are accurate, non-invasive, and require no special equipment.<sup>9, 12-14,56,57</sup> The Alvarado scoring system was one of these systems which was described in 1986<sup>1</sup>. Chan et al (2001) in their study found that patients with low Alvarado score (less than 5) did not have

perforated appendicitis in patients with a score of less than 6, and suggested the use of the score by general practitioners<sup>9</sup>. The classic Alvarado Score included left shift of neutrophil maturation (one score) yielding a total score of 10, but Kalan et al [1994] omitted this parameter which is not routinely available in many laboratories, and produced a modified score.<sup>14</sup> In our study modified Alvarado score system sensitivity was 93% in patients with 8-9 scores, while it was 2.6% , 60% in patients with 1-4, 5-6 scores respectively (Table 3). We conclude that the Modified Alvarado score system is accurate in early diagnosis of acute appendicitis. It can be used as an objective criterion in selecting patients for admission. Patients with 8-9 scores should be operated on immediately with out hesitation. Patients with score 5-7 must be admitted and scored frequently. Score 1-4 can be discharged unless otherwise indicated.

### REFERENCES:

1. Fitz R.H. Perforating inflammation of the vermiform appendix: with special reference to its early diagnosis and treatment. *Am. J. Med. Sci.* 1886;92: 321-346
2. Kim MK, Strait RT, Sato TT, Hennes HM. A randomized clinical trial of analgesia in children with acute abdominal pain. *Acad Emerg Med* 2002;9(4):281-7.
3. Puylaert JB. Acute appendicitis: US evaluation using graded compression. *Radiology* 1986;158 (2):355-60.
4. Sivit CJ, Dudgeon DL, Applegate KE, et al. Evaluation of suspected appendicitis in children and young adults: helical CT. *Radiology* 2000; 216(2):430-3.
5. Anonymous. A sound approach to the diagnosis

- of acute appendicitis (editorial). *Lancet* 1987;1:198-200
6. Orr RK, Porter Eyvazzadeh AD, et al. MR imaging evaluation of acute appendicitis in pregnancy. *Radiology* 2006;238(3):891-9.
  7. Tzanakis NE, Efstathiou SP, Danulidis K, et al. A new approach to accurate diagnosis of acute appendicitis. *World J Surg.* 2005;29(9):1151-1157.
  8. Lin HF, Wu JM, Tseng LM, et al. Laparoscopic versus open appendectomy for perforated appendicitis. *J Gastrointest Surg* 2006;10(6):906-10.
  9. Owen T.D., Williams H., Stiff G., Jenkinson L.R., Rees B.I. Evaluation of the Alvarado score in acute appendicitis. *J R Soc Med* 1992;85: 87-88
  10. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med* 1986;15: 557-564.
  11. Arnbjörnsson E. Scoring system for computer-aided diagnosis of acute appendicitis: the value of prospective versus retrospective studies. *Ann Chir Gynecol* 1985;74:159-166
  12. Teicher I., Landa B., Cohen M., Kabnick L.S., Wise L. Scoring system to aid in diagnosis of appendicitis. *Ann Surg* 1983;198: 753-759
  13. Fenyö G. Routine use of a scoring system for decision-making in suspected acute appendicitis in adults. *Acta Chir Scand* 1987;153: 545-551
  14. Kalan M., Rich A.J., Talbot D., and Cunliffe W.J. Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis: a prospective study. *Ann R. Coll. Surg. Eng* 1994;176:418-419
  15. Clarke P.J., Hands L.J., Gough M.H., Kettlewell M.G.W. the use of laparoscopy in the management of right iliac fossa pain. *Ann R Coll Surg Engl* 1986;68: 68-69
  16. Yang HR, Wang YC, Chung PK, et al. Role of leukocyte count, neutrophil percentage, and C-reactive protein in the diagnosis of acute appendicitis in the elderly. *Am Surg.* 2005;71(4):344-7.
  17. Rypins EB, Evans DG, Hinrichs W, et al. Tc-99m-HMPAO white blood cell scan for diagnosis of acute appendicitis in patients with equivocal clinical presentation. *Ann Surg.* 1997;226(1):58-65.
  18. Gronroos JM, Gronroos P. Leucocyte count and C-reactive protein in the diagnosis of acute appendicitis. *Br J Surg.* 1999;86(4):501-4.
  19. Gurleyik E, Gurleyik G, Unalmiser S. Accuracy of serum C-reactive protein measurements in diagnosis of acute appendicitis compared with surgeon's clinical impression. *Dis Colon Rectum.* 1995;38(12):1270-4.
  20. Albu E, Miller BM, Choi Y, et al. Diagnostic value of C-reactive protein in acute appendicitis. *Dis Colon Rectum.* 1994;37(1):49-51.
  21. Eriksson S, Granstrom L, Olander B et al. Sensitivity of interleukin-6 and C-reactive protein concentrations in the diagnosis of acute
  22. Skaane P, Amland PF, Nordshus T, et al. Ultrasonography in patients with suspected acute appendicitis: a prospective study. *Br J Radiol.* 1990; 63(754):787-93.
  23. Sivit CJ, Newman KD, Boenning DA, et al. Appendicitis: usefulness of US in diagnosis in a pediatric population. *Radiology.* 1992;185(2):549-52.
  24. Schulte B, Beyer D, Kaiser C, et al. Ultrasonography in suspected acute appendicitis in childhood-report of 1285 cases. *Eur J Ultrasound* 1998;8(3):177-82.
  25. Rice HE, Arbesman M, Martin DJ, et al. Does early ultrasonography affect management of pediatric appendicitis? A prospective analysis. *J Pediatr Surg.* 1999;34(5):754-8; discussion 758-9.
  26. Lee JH, Jeong YK, Park KB. Operator-dependent techniques for graded compression Sonography to detect the appendix and diagnose acute appendicitis. *AJR Am J Roentgenol.* 2005;184(1):91-7.
  27. Pickuth D, Heywang-Kobrunner SH, Spielmann RP. Suspected acute appendicitis: is ultrasonography or computed tomography the preferred imaging technique?. *Eur J Surg.* 2000;166(4):315-9.
  28. Balthazar EJ, Birnbaum BA, Yee J, et al. acute appendicitis: CT and US correlation in 100 patients. *Radiology.* 1994;190(1):31-5.
  29. Barloon TJ, Brown BP, Abu-Yousef MM, et al. Sonography of acute appendicitis in pregnancy. *Abdom Imaging* 1995;20(2):149-51.
  30. Garcia Pena BM, Mandl KD, Kraus SJ, et al. Ultrasonography and limited computed tomography in the diagnosis and management of appendicitis in children. *JAMA.* 1991; 282(11):1041-6.
  31. Schwerk WB, Wichtrup B, Rothmund M, et al. Ultrasonography in the diagnosis of acute appendicitis: a prospective study. *Gastroenterology.* 1989;97(3):630-9.
  32. Pearson R.H. Ultrasonography for diagnosing appendicitis. *Br Med. J.* 1988;297:309-310
  33. Yuksekkaya R, Akgul E, Inal M, et al. [Unenhanced spiral CT in the diagnosis of acute appendicitis]. *Tani Girisim Radyol.* 2004;10(2):131-9.
  34. Tamburrini S, Brunetti A, Brown M, et al. CT appearance of the normal appendix in adults. *Eur Radiol.* 2005;15(10):2096-103.
  35. Mun S, Ernst RD, Chen K, et al. Rapid CT diagnosis of acute appendicitis with IV contrast material. *Emerg Radiol.* 2006;12(3):99-102.
  36. Kaiser S, Finnbogason T, Jorulf HK, et al. Suspected appendicitis in children: diagnosis with contrast-enhanced versus nonenhanced Helical CT. *Radiology.* 2004; 231(2):427-33..
  37. Iwahashi N, Kitagawa Y, Mayumi T, Kohno H. Intravenous contrast-enhanced computed

- tomography in the diagnosis of acute appendicitis. *World J Surg* 2005;29(1):83-7.
38. Harswick C, Uyenishi AA, Kordick MF, Chan SB. Clinical guidelines, computed tomography scan, and negative appendectomies: a case series. *Am J Emerg Med*. 2006;24(1):68-72.
39. Anderson BA, Salem L, Flum DR. A systematic review of whether oral contrast is necessary for the computed tomography diagnosis of appendicitis in adults. *Am J Surg*. 2005;190(3):474-8.
40. Ashraf K, Ashraf O, Bari V, et al. Role of focused appendiceal computed tomography in clinically equivocal acute appendicitis. *J Pak Med Assoc*. 2006;56(5):200-3.
41. Ege G, Akman H, Sahin A, et al. Diagnostic value of unenhanced helical CT in adult patients with suspected acute appendicitis. *Br J Radiol*. 2002;75(897):721-5.
42. Fuchs JR, Schlambert JS, Shortsleeve MJ, Schuler JG. Impact of abdominal CT imaging on the management of appendicitis: an update. *J Surg Res*. 2002;106(1):131-6.
43. Funaki B, Grosskreutz SR, Funaki CN. Using unenhanced helical CT with enteric contrast material for suspected appendicitis in patients treated at a community hospital. *AJR Am J Roentgenol*. 1998;171(4):997-1001.
44. Hoecker CC, Billman GF. The utility of unenhanced computed tomography in appendicitis in children. *J Emerg Med*. 2005;28(4):415-21.
45. Mullins ME, Kircher MF, Ryan DP, et al. Evaluation of suspected appendicitis in children using limited helical CT and colonic contrast material. *AJR Am J Roentgenol*. 2001;176(1):37-41.
46. Lane MJ, Liu DM, Huynh MD. Suspected acute appendicitis: nonenhanced helical CT in 300 consecutive patients. *Radiology*. 1999;213(2):341-6.
47. Bresciani C, Perez RO, Habr-Gama A, et al. Laparoscopic versus standard appendectomy outcomes and cost comparisons in the private sector. *J Gastrointest Surg*. 2005;9(8):1174-80; discussion 1180-1.
48. Kipper SL. The role of radiolabeled leukocyte imaging in the management of patients with acute appendicitis. *Q J Nucl Med*. 1999;43(1):83-92.
49. DeLaney AR, Raviola CA, Weber PN, et al. Improving diagnosis of appendicitis. Early autologous leukocyte scanning. *Arch Surg*. 1989;124(10):1146-51; discussion 1151-2.
50. Foley CR, Latimer RG, Rimkus DS. Detection of acute appendicitis by technetium 99 HMPAO scanning. *Am Surg*. 1992; 58(12):761-5.
51. Henneman PL, Marcus CS, Butler JA, et al. Appendicitis: evaluation by Tc-99m leukocyte scan. *Ann Emerg Med*. 1988;17(2):111-6
52. Navarro DA, Weber PM, Kang IY, et al. Indium-111 leukocyte imaging in appendicitis. *AJR Am J*
53. Balthazar E.J., Megibow A.J., Hulnick D., Gordon R.B., Naidich D.P., Beranbaum E.R.: CT of appendicitis. *AJR* 1986;6:185-193
54. Takada T., Yasuda H., Uchiyama K., Hasegawa H., Shikata J.I.: Ultrasonographic diagnosis of acute appendicitis in surgical indication. *Int Surg* 1986;71: 9-13
55. Reza F.saidi,Mitra Ghasemi,Role of Alvarado score in diagnosis and treatment of acute appendicitis, *Surg Clin of North Am* 1997;77:1355-70
56. Fenyo G., Lindberg G., Blind P., Enochsson L., Oberg A. Diagnostic decision support in suspected acute appendicitis: validation of a simplified scoring system. *Eur J Surg* 1997;163(11): 831-838
57. Ohmann C., Yang Q., Franke C. Diagnostic scores for acute appendicitis. Abdominal pain study group. *Eur J Surg* 1995;161: 273-281
58. Chan M Y P,Toe B.S,NG BL.The Alvarado score and acute appendicitis. *Anna. Acad Med Singapore* 2001;30:510-512