INTRODUCTION

Appendicitis is one of the important surgical emergency among children. Both pediatrician and surgeons should be aware the possibility of appendicitis in children with appendicitis. Despite its high incidence, diagnosis is difficult due to non specific symptoms and atypical presentations1.

Variety of different approaches are recommended to decrease negative appendectomies such as predictive scoring system2, computer aided diagnosis, inflammatory marker3, ultrasonography4, and computed tomography.

Alvarado described a clinical scoring system on the basis of eight predictive clinical factors to improve the accuracy of physicians’ clinical assessments in diagnosing acute appendicitis. This scoring system produces a maximum total score of 10 points and includes clinical symptoms (nausea and anorexia), signs (fever, shifting pain, right lower quadrant pain, and rebound tenderness) and laboratory findings (leukocytosis and neutrophilia). Right lower quadrant pain and leukocytosis contribute 2 points while the rest contributes 1 point2. Kalan et al. omitted shift to left parameter because is not routinely available in many laboratories, and produced a modified score1. The modified Alvarado score (MAS) has been widely accepted after it was successfully tested in different studies1.

The aim of this study was to evaluate sensitivity, specificity, positive predictive value, and negative predictive value of modified Alvarado score in children who underwent appendectomy.

METHODS

This study was approved by research affairs of Ahvaz Jundishapur University of Medical Sciences. This cross sectional study was carried out in Imam Khomeini Hospital, Ahvaz-Iran. It included 400 children with diagnosis of appendicitis during 2006-2012. Of children who
underwent appendectomy. 400 children were randomly selected. Appendicitis was confirmed according to pathology report. Modified Alvarado score was used to evaluate appendicitis. Modified Alvarado score is based on three symptoms, three signs, and one laboratory investigation and ranged from 1-9 (Table 1). Appendicitis was confirmed using histopathology evaluation.

**Table 1 - Modified Alvarado score**

| Migratory right iliac fossa pain | Yes | No |
|----------------------------------|-----|----|
| Anorexia                         | 119(35.3%) | 48(76.2%) |
| Nausea and vomiting              | 89(26.4%) | 31(49.2%) |
| Tenderness of right lower quadrant | 284(84.3%) | 2(33.3%) |
| Elevated temperature             | 29(8.6%) | 22(33.3%) |
| Leukocytosis                     | 119(35.3%) | 48(76.2%) |
| Modified Alvarado Score          | 9     | 9   |

**Table 2 - Signs and symptoms of modified Alvarado score in the sample**

| Symptoms                          | Appendicitis(+) | Appendicitis(-) | P-value |
|-----------------------------------|-----------------|-----------------|---------|
| Shifting pain                     | Yes             | No              | 0.1     |
| Anorexia                          | Yes             | No              | <0.001  |
| Nausea and vomiting               | Yes             | No              | <0.001  |
| RLQ Pain                          | Yes             | No              | 0.3     |
| Rebound tenderness                | Yes             | No              | <0.001  |
| Fever                             | Yes             | No              | 0.4     |
| Leukocytosis                      | Yes             | No              | 0.1     |

**Table 3 - Sensitivity, specificity, PPV, and NPV of Alvarado score components**

| Symptom                           | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) |
|-----------------------------------|-----------------|-----------------|---------|---------|
| Migratory right iliac fossa pain  | 93.5            | 28.7            | 46.4    | 23.8    |
| Anorexia                          | 88.5            | 25.8            | 73.5    | 50.7    |
| Nausea and vomiting               | 88.1            | 32.1            | 84.2    | 11.2    |
| RLQ tenderness                    | 88.2            | 43.1            | 91.3    | 65.1    |
| Rebound tenderness                | 91.1            | 23.6            | 57.8    | 30.1    |
| Fever                             | 85.9            | 17.3            | 49.2    | 42.8    |
| Leukocytosis                      | 92.1            | 50.6            | 89.3    | 41.2    |
| MAS                               | 91.3            | 38.4            | 87.7    | 51.2    |

PPV=positive predictive value; NPV=negative predictive value; MAS=modified Alvarado score system

**Table 4 - Distribution of modified Alvarado scores among children**

| Alvarado score | Appendicitis(+) | Appendicitis(-) |
|----------------|-----------------|-----------------|
| 1-4            | 30(9.0%)        | 45(71.4%)       |
| 5-6            | 104(30.9%)      | 18(28.6%)       |
| 7-9            | 230(68.2%)      | 0               |

**Discussion**

In this study, 400 children aged <12 years with primary diagnosis of appendicitis were included. Of these cases, 337(84.3%) had confirmed appendicitis. Of all cases, 63(15.8%) had negative appendectomy. As seen in Table 2, anorexia, nausea and vomiting, and rebound tenderness were significantly more common in children with appendicitis than children without appendicitis. Migratory right iliac fossa pain was the most sensitive part of MAS (Table 3). Of 48 children with score 1-4, 45 had negative histopathology (Table 4). As seen in Table 4, all children with MAS ≥7, had appendicitis according to pathology report. In our study, 100% of children scored >7 had positive appendicitis. In the study by Kanumba et al., among children with MAS ≥7, 97.3% had appendicitis which is slightly lower than our study. This difference may be due to age of the patients.

**Conclusion**

Modified Alvarado score has high sensitivity but low specificity for diagnosis of acute appendicitis in children.

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