Decreased Use of Computed Tomography With a Modified Clinical Scoring System in Diagnosis of Pediatric Acute Appendicitis

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Hypothesis: Use of a modified clinical grading score improves accuracy in diagnosing acute appendicitis in the pediatric population while decreasing the use of computed tomography (CT).

Design: Retrospective medical records review after approval by the institutional review board. We determined the Alvarado score for each patient and correlated it with the pathological findings and imaging studies to evaluate the efficacy of CT and its attendant radiation exposure.

Setting: Community teaching hospital.

Patients: Sixty-one patients, aged 3 to 16 years, admitted with suspected acute appendicitis.

Main Outcome Measures: Sensitivity, specificity, and accuracy of the modified Alvarado scoring system.

Results: The standard Alvarado score for acute appendicitis had a sensitivity of 92% and a specificity of 82%, with an accuracy of 92%. In the modified Alvarado scoring system, CT findings were substituted for Alvarado scores in the ranges of 5 or 6, 5 to 7, 5 to 8, and 5 to 9. The modification resulted in the greatest accuracy (98%) in diagnosing appendicitis in patients with scores in the range of 5 to 7. This modification theoretically would have decreased the use of CT by about 27% in this group of retrospectively studied patients. Furthermore, in patients with Alvarado scores of 1 to 4, another diagnosis should be considered; in patients with scores of 5 to 7, CT should be performed; and, in patients with scores of 8 to 10, an appendectomy should be performed promptly without further studies.

Conclusions: The modified Alvarado score is useful as an aid in diagnosing acute appendicitis in the pediatric population. This scoring system eliminates unnecessary use of CT and the attendant potential cancer-inducing radiation in the pediatric population.


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igns and symptoms of early acute appendicitis in the pediatric population overlap with many other disease processes, making an accurate and timely diagnosis very challenging. Since the advent of computed tomography (CT) and its inception in the 1970s, its use has increased exponentially. In addition, the technology has improved in a similar logarithmic fashion, allowing better visualization of the anatomy and identification of pathophysiological processes while reducing the exposure time in the scanner. Moreover, the greatest increase in the relative number of CT examinations performed in the past decade has occurred in the pediatric population. Recently, serious safety concerns have been raised as more data continue to be derived from atomic bomb survivors and other groups exposed to irradiation (eg, at Chernobyl) that document an increased prevalence of fatal malignant neoplasms among these individuals than in comparable populations, even at low doses of ionizing radiation.

Attempts have been made to develop clinical scoring systems to improve the diagnostic accuracy of appendicitis, and one such system is the Alvarado scoring system, which has been validated for its accuracy in several adult patient groups. The Alvarado clinical scoring system can also be valuable in reducing the number of CT examinations used in the diagnostic workup of suspected appendicitis, thus reducing the risk of lifetime radiation-induced fatal cancer in patients who otherwise would ordinarily be subjected to further radiological evaluation.

A study published in the Annals of Emergency Medicine by Alvarado in 1986 demon-
Positive Appendectomy during the past few years. With the addition of helical CT, its use has become virtually standard in the evaluation of an acute abdomen, including its routine use in the diagnosis of acute appendicitis. Increasing numbers of publications suggest more widespread use of CT as the primary imaging technique in multiple clinical scenarios, especially in children with suspected acute appendicitis. Proportionally, the increase in CT use has led to an increase in radiation exposure. Radiation dose is particularly important in children because of the relatively increased lifetime cancer risk of children compared with adults. Furthermore, it has been shown that the rate of appendectomies with negative findings has not decreased with the liberal use of CT but, in fact, may lead to increased hospital costs, delays in diagnosis, and increased unnecessary radiation exposure. The standard Alvarado system has been validated by several studies in the adult population; however, not as much attention has been given to the pediatric population. We believe that, by implementing the modified Alvarado scoring system (Figure 1), the use and risk of radiation can be minimized in the pediatric population.

METHODS

After approval by the institutional review board, medical records were reviewed retrospectively for 61 consecutive patients aged 3 to 16 years who were admitted to a community teaching hospital with suspected appendicitis and underwent abdominal CT. Additional data derived from these patients from October 1, 2000, through September 30, 2003, were reviewed and are listed in the Table. Alvarado scores were calculated for each patient and correlated with final pathology reports and CT results. Two patients were excluded from the study owing to incomplete records and the inability to calculate the Alvarado score. We used 2×2 contingency tables to correlate standard and modified Alvarado scores with the outcomes. Appendectomy or discharge home was considered the end point of this study. A Fisher exact test analysis was performed on the data, and P<.05 was considered significant.

RESULTS

When it was applied to the 59 patients in this study, the standard Alvarado score for appendicitis had a sensitivity of 92%, a specificity of 82%, and an accuracy of 92%.
Twenty-two patients (37%) had indeterminate Alvarado scores of 5 or 6, and all 22 patients underwent CT (Figure 2). Computed tomography alone had a sensitivity of 93%, a specificity of 97%, and an accuracy of 95%. Use of the modified Alvarado score and substitution of CT results for scores of 5 or 6 resulted in a sensitivity of 92%, a specificity of 90%, and an accuracy of 95%. If this modification had been used in this group of patients, the number of unnecessary CT scans could have been reduced by 34%. When the Alvarado method was modified for scores of 5 to 7, there was a sensitivity of 100%, a specificity of 97%, and an accuracy of 98%. The number of CT scans could have been reduced by 27% in this patient group if this modification had been used. Substituting CT results for scores of 5 to 8 resulted in a sensitivity of 97% and a specificity of 97%, with an accuracy of 97%. If this range of values had been used in this patient group, the number of CT scans could have been reduced by 14%. When the Alvarado method was modified for scores of 5 to 9, there was a sensitivity of 93%, a specificity of 97%, and an accuracy of 95%. This would have resulted in only a 1% reduction in the number of CT scans used.

Thus, the modification resulting in the greatest accuracy was with modified Alvarado scores of 5 to 7. Use of the modified Alvarado method would have decreased the number of CT scans by 27% while maintaining 98% accuracy. Overall, the rate of appendectomies with negative findings was 3%. Of the 34 patients (58%) who were taken to the operating room for an appendectomy, which proved to be positive for appendicitis, one of these patients was taken to the operating room for other pathological findings positive for appendicitis. The other patient was observed and eventually underwent ultrasound, the results of which supported the clinical findings. This patient also had acute inflammatory changes on pathological examination of the specimen. The other patient was observed and eventually underwent ultrasound, the results of which supported the clinical findings.

This study demonstrates a modification by which the Alvarado scoring system can be implemented in the pediatric population to reduce the number of CT scans performed while maintaining a timely and accurate diagnosis and treatment of acute appendicitis (Figure 2). We believe that patients with Alvarado scores of 1 to 4 should be discharged home or that another diagnosis should be considered. For patients with scores of 5 to 7, CT should be performed. If the finding is negative, then another diagnosis should be considered; if the finding is positive, then the patient should undergo appendectomy. Patients with scores of 8 to 10 do not need further imaging; these patients should undergo laparoscopy/laparotomy for appendectomy. Performing CT in this group of patients will only delay the diagnosis and may even lead to an error in diagnosis. According to this study, only 2 of 16 patients with scores of 8 to 10 had a negative CT finding with pathological findings positive for appendicitis. Because of strong clinical suspicion for acute appendicitis, one of these patients was taken to the operating room for an appendectomy, which proved to be positive for appendicitis on histologic examination of the appendix. This study demonstrates that time spent waiting for and performing CT in a patient with a high Alvarado score (8-10) only delays the diagnosis and definitive treatment of the patient. At the same time, pediatric patients are exposed to the unnecessary use of CT and its attendant high levels of radiation, which has been shown to increase the lifetime incidence of fatal malignant neoplasms in this sensitive and vulnerable group. This study is limited by its small size, and we advocate for a larger randomized prospective study to validate our findings using the modified Alvarado score in the evaluation of the acute abdomen and especially in the diagnosis of acute appendicitis in pediatric patients.
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REFERENCES