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Optimal timing of appendectomy in the pediatric population

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ABSTRACT

Background: No consensus has been reached on optimal timing for performing appendectomies. We compared immediate and delayed appendectomies in pediatric patients presenting with suspected acute appendicitis to determine differences in postsurgical complications and perforation rates.

Methods: A retrospective cohort study was performed of all children who underwent appendectomy during a 4-y period. Cutoffs used were 6, 8, and 12 h from admission to operating room (OR). The Student *t*-tests and chi-square tests were performed to compare continuous and categorical variables, respectively. A logistic regression model was fitted to determine predictors of appendiceal perforation. *P* values <0.05 were considered significant.

Results: Analysis included 484 patients with mean elapsed time from admission to OR of 394 min, with 262 subjects in the immediate and 222 subjects in the delayed >6 h groups. Surgical site infections (SSIs), perforations, and small bowel obstructions were similar between groups, and no statistically significant differences were found for SSIs in the nonperforated delayed *versus* immediate groups ($P = 0.964$). Time from admission to the OR did not predict perforation ($P = 0.921$), although white blood cell count at the time of admission was a significant predictor of perforation (odds ratio, 1.08; $P < 0.001$).

Conclusions: For suspected acute appendicitis, delaying appendectomy after admission for >6 h demonstrated no differences in SSI or perforation rates compared with immediate appendectomy. Waiting to perform an appendectomy until the following day has equal outcomes to immediate surgical procedure and may improve overall quality of patient care by limiting surgeon fatigue.

1. Introduction

Appendicitis remains one of the most common acute conditions resulting in surgical intervention, yet no consensus has been reached on the benefit of immediate *versus* delayed appendectomy. Surgical dogma indicates that acute appendicitis, if left untreated, will usually progress to perforation [1]. Therefore, it has been postulated that waiting to perform an appendectomy will increase risk of perforation and postsurgical complications. Although some surgeons choose to manage appendicitis that presents at night with immediate surgical intervention, others believe that

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administering antibiotics and waiting to perform an appendectomy the following morning does not increase patient morbidity.

A recent study found that delayed appendectomy in adults did not increase risk of perforation, yet was associated with a higher risk of surgical site infections (SSIs) in nonperforated appendicitis when surgical procedure was delayed by >6 h [2]. These authors concluded that performing appendectomies at night reduced risk of SSIs and the morbidity associated with this postsurgical complication. Other studies examining this same issue have used information contained in large databases rather than performing chart reviews [3]. However, this methodology often limits analysis to 24-h intervals as shorter timeframes often cannot be gleaned from the databases, making the results less clinically applicable. The aim of our study was to compare immediate and delayed appendectomies in pediatric patients presenting with suspected nonperforated, acute appendicitis at a freestanding children's hospital to determine differences in postsurgical complications, specifically SSI, and perforation rates.

2. Methods

After obtaining Institutional Review Board approval (#138110), a chart review was performed for all patients who underwent appendectomy between January 2009 and December 2012 at a freestanding children's hospital. Medical charts, surgical reports, and final pathology were reviewed to collect patient demographic and medical information including comorbidities, time of admission, time of antibiotic administration, time of surgical procedure, surgical approach (open *versus* laparoscopic), acute *versus* perforated appendicitis, and postsurgical complications. Subjects were included if they were admitted to the pediatric surgery team, underwent appendectomy for suspected acute appendicitis, and had appendicitis confirmed on final pathology. Patients were considered to have a presurgical diagnosis of perforation and excluded from analysis if perforation was documented on presurgical imaging or listed as the presurgical diagnosis on the history and physical or surgical notes.

On admission to the surgical service for appendicitis, all patients were started on intravenous antibiotics (50 mg/kg ceftriaxone and 30 mg/kg metronidazole daily) when in the Emergency Department. Timing until appendectomy was calculated as the length of time that elapsed between admission to the hospital and arrival to the operating room (OR). Using 6 h from admission to OR as a cutoff, subjects were divided into immediate *versus* delayed appendectomy groups. The primary outcome evaluated was SSI as a function of time between admission and OR. Our definition of SSI included wound infections or intra-abdominal abscesses documented in the medical chart. Secondary outcomes included other adverse events such as perforation, bowel obstruction, and mortality, as well as identifying factors that would predict perforation. Subjects were also evaluated for differences in SSI and perforation rates using 8 and 12 h from admission to OR as cutoffs.

The Student *t*-tests and chi-square tests were performed to compare continuous and categorical variables, respectively. A logistic regression model was fitted to determine predictors of appendiceal perforation including gender, age, presence of comorbidities, surgical approach, white blood cell (WBC) count at the time of admission, body mass index, and time from admission to OR. *P* values <0.05 were considered significant.

3. Results

During the study period 711 patients underwent appendectomy, with 484 of these patients included for analysis. The immediate appendectomy group comprised 262 subjects and the >6 h delayed group included 222 subjects. Patients were excluded ($n = 227$) for the following reasons: 175 subjects with presumed perforated appendicitis before surgery, 45 subjects with negative pathology, five patients initially admitted to a nonsurgical team, and two patients who underwent interval appendectomies (Figure). Elapsed time from admission to the OR was calculated for those included in the study, with a mean of 394 ± 18 min. Sixty-seven patients (13.8%) underwent surgical procedure between 12 and 24 h after admission, and eight patients (1.7%) were operated on >24 h after admission. A comparison of the immediate and >6 h delayed cohort groups found no differences in patient baseline characteristics or surgical techniques (Table 1).

Outcomes were found to be similar between the two groups (Table 2). Specifically SSI, perforations, and small bowel obstructions were not statistically different. SSIs were further classified into wound infections and intra-abdominal abscesses, yet no differences were detected for either of these subgroup analyses. For nonperforated appendicitis, five SSIs were found in the immediate appendectomy group *versus* three SSIs in the delayed appendectomy group (Figure), which was not found to be significantly different ($P = 0.964$). No deaths occurred in any of the patients included in this study. An analysis of complication rates using 8 and 12 h cutoffs also yielded no differences in perforation or SSI rates (Table 3).

A logistic regression model was performed to look for factors that would predict perforated appendicitis (Table 4). WBC count at the time of admission was found to be a statistically significant independent predictor of perforation regardless of time until appendectomy was performed, with an odds ratio of 1.08. However, no other factors in the model were statistically significant predictors of perforation, including time from admission to the OR.

4. Discussion

Immediate appendectomy for acute appendicitis in this study was not found to reduce SSI or perforation rates when compared with those who underwent delayed appendectomy at >6, 8, or 12 h after admission. Furthermore, after controlling for gender, age, body mass index, WBC count, comorbidities, and surgical approach, we still found no difference in perforation rates between immediate and delayed appendectomy groups. More than 84% of all patients underwent surgical procedure within 12 h of admission, suggesting that our