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The impact of operative timing on outcomes of appendicitis: a National Surgical Quality Improvement Project analysis

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Abstract

BACKGROUND: Surgery is indicated for acute uncomplicated appendicitis but the optimal timing is controversial. Recent literature is conflicting on the effect of time to intervention.

METHODS: We queried the American College of Surgeons National Surgical Quality Improvement Project dataset for patients undergoing laparoscopic and open appendectomy between 2007 and 2012. Logistic regression was used to evaluate 30-day morbidity and mortality of intervention at different time periods, adjusting for preoperative risk factors.

RESULTS: A total of 69,926 patients undergoing appendectomy were identified. Groups were divided by time to intervention: group 1, less than 24 hours (n = 55,839; 79.9%); group 2, 24 to 48 hours (n = 13,409; 18.6%); and group 3, greater than 48 hours (n = 1,038; 1.5%). After adjustment, the risk of complication remained increased for group 3 versus group 1 or 2 (odds ratio 1.66, 95% confidence interval 1.34 to 2.07).

CONCLUSIONS: These data demonstrate equivalent outcomes between time to appendectomy of less than 24 and 24 to 48 hours. There was a 2-fold increase in complication rate for patients delayed longer than 48 hours.

Early surgical intervention has long been accepted as the standard for acute uncomplicated appendicitis. Although precise timing for appendectomy remains controversial, it is recognized that delay in operative intervention increases morbidity.[1,2] Furthermore, a delay in definitive surgery in acute appendicitis is believed to result in progression of disease toward perforation or other complication.[3,4] Although new randomized controlled trials suggest antibiotic therapy alone is sufficient for acute uncomplicated appendicitis, surgery remains the gold standard.[5,6] A Cochrane meta-analysis on the use of antibiotics versus early surgical intervention could not conclude that antibiotics alone were inferior to surgery.[7] Despite technological advances made in the realm of diagnostic imaging including the increased use of computed

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tomography, the diagnosis of acute appendicitis remains clinical and any uncertainty may inevitably lead to delay in definitive treatment. The aim of this study was to elucidate the role of time to intervention in patients undergoing appendectomy at participating hospitals.

Methods

Data acquisition

The American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) dataset was used to obtain data for this study. It includes information regarding patient demographics, preoperative risk factors, comorbid conditions, and laboratory data, as well as perioperative outcomes and 30-day morbidity and mortality data. The dataset was queried for patients undergoing laparoscopic and open appendectomy between 2007 and 2012. Patients with the following Current Procedural Terminology codes as their primary procedure were included: 44,950 (appendectomy), 44,960 (appendectomy; for ruptured appendix with abscess or generalized peritonitis), and 44,970 (laparoscopy, surgical, appendectomy). These patients were then divided into groups based on time to surgical intervention: less than 24, 24 to 48, and greater than 48 hours.

Outcomes

Primary outcome measurements included 30-day all-cause morbidity and mortality. These were defined as the following ACS-NSQIP complications: return to the operating room, respiratory (pneumonia, unplanned intubation, pulmonary embolism, ventilator for >48 hours), urinary tract (acute renal failure, progressive renal insufficiency), central nervous system (cerebral vascular accident, coma >24 hours, peripheral nerve injury), cardiac (cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction), and other (intraoperative transfusion, transfusion within 72 hours, vein thrombosis, sepsis, septic shock).

Statistical analysis

Demographic characteristics, overall morbidity, and complications were compared using chi-square tests for categorical variables and 2-sided *t* tests for continuous variables. Primary outcomes of 30-day morbidity and mortality of operative intervention at different time periods were further analyzed using logistic regression. We report odds ratios (ORs) with 95% confidence intervals (CIs) for unadjusted analyses as well as those adjusted for covariates. Covariates included were those significantly related to outcome at level .05 in univariate analyses. Backward and forward selection algorithms included the same variables in all cases. The significance was set at *P* value less than .05. All calculations were performed using SAS version 9.2 software (SAS Institute, Inc, Cary, NC).

Results

Of the patients identified from the ACS-NSQIP dataset, only those with complete records were used for analysis. A total of 69,926 patients undergoing appendectomy between 2007 and 2012 were identified. These were divided by time to surgical intervention into 3 groups: group 1, less than 24 hours (n = 55,839; 79.9%); group 2, 24 to 48 hours (n = 13,409; 18.6%); and group 3, greater than 48 hours (n = 1,038; 1.5%). Preoperative characteristics of the 3 groups are shown in Table 1. Those cases where operative intervention was delayed greater than 48 hours included older patients who were more likely to have comorbid conditions, while early intervention was most likely to be performed on younger patients with lower body mass index and fewer pre-existing comorbidities.

In an unadjusted model, the rate of complication was higher in group 3 versus group 1 with an OR of 3.18 (95% CI: 2.69 to 3.76), while this was not increased for group 2 versus group 1 (OR 1.03, 95% CI: .95 to 1.12). The delayed intervention group had a higher rate of 30-day mortality, as well as higher rates of return to OR, pneumonia, reintubation, ventilator requirement, renal failure/insufficiency, urinary tract infection, transfusion, sepsis, and septic shock (Table 2). After adjustment, the risk was attenuated but remained increased for group 3 versus group 1 (OR 1.66, 95% CI: 1.34 to 2.07), while there was still no increased risk for group 2 versus group 1 (OR .91, 95% CI: .83 to 1.01). Preoperative patient characteristics that increased morbidity in the adjusted model included increased age (OR 1.01, 95% CI: 1.01 to 1.02), hyponatremia (OR .95, 95% CI: .94 to .97), elevated creatinine (OR 1.21, 95% CI: 1.15 to 1.27), hypoalbuminemia (OR .57, 95% CI: .53 to .62), hyperbilirubinemia (OR 1.18, 95% CI: 1.12 to 1.24), increased leukocytosis (OR 1.06, 95% CI: 1.05 to 1.07), decreased hematocrit (OR .98, 95% CI: .97 to .99), male sex (OR 1.28, 95% CI: 1.17 to 1.40), minority (OR 1.16, 95% CI: 1.06 to 1.27), and existence of any preoperative condition (OR 1.40, 95% CI: 1.27 to 1.54).

Comments

The time to intervention from the diagnosis of appendicitis, whether clinical or radiographic, has been the subject of much scrutiny. Traditional surgical teaching involves an expeditious operative approach; however, this has been challenged. Although there is evidence to support delay of appendectomy, it is unclear what this interval should be. Short delays less than 12 to 24 hours have not been associated with an increase in morbidity or mortality[1,2,8,9] and our data would suggest that surgical management may be delayed up to 24 to 48 hours without a significant increase in adverse outcome. Although some believe that operative intervention may be avoided altogether in certain cases of uncomplicated acute appendicitis,[5,6] more investigation is needed to identify which