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Computed tomography to operating room in less than 3 hours minimizes complications from appendicitis

Laura A. Harmon, M.D.[a], Matthew L. Davis, M.D.[a], Daniel C. Jupiter, Ph.D.[b], Richard C. Frazee, M.D.[a], Justin L. Regner, M.D.[a,*]

[a]*Department of Surgery, Scott and White Memorial Hospital, 2401 S 31st Street, 7th Floor Brindley Circles, Temple, TX 76508, USA;* [b]*Department of Surgery, University of Texas Medical Branch, Galveston, TX, USA.*

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Abstract

BACKGROUND: The aim of our study is to select patients with nonperforated appendicitis verified by computed tomography (CT) scan and to determine if there is a temporal component to perforation.

METHODS: A retrospective cohort study of patients with CT scan evidence of nonperforated appendicitis from 2007 to 2012.

RESULTS: 411 patients, aged 39.7 ± 16.25 years (47.5% male) were included in the study. 330 patients (80.3%) were nonperforated at surgery. Analysis of 3-hour intervals from CT scan to operating room (OR) revealed an absolute reduction in the rate of perforation from 27% at the 6- to 9-hour interval, to 17% and 10% at the 3- to 6-hour and 0- to 3-hour intervals, respectively, ($P < .04$). All organ space infections occurred in patients who were delayed to the OR greater than 3 hours. Mean length of hospitalization was .93 days and 2.81 days, respectively, in nonperforated and perforated appendicitis patients ($P < .001$).

CONCLUSIONS: Delays to the OR were associated with increased risk of perforation. Patients with uncomplicated appendicitis had shorter hospitalization and fewer postoperative wound infections.

Appendectomies are a common surgical intervention, exceeding 250,000 procedures per year in the United States alone.[1] As the acute care surgery model continues to evolve, the goals for the management of appendicitis demand persistent analysis of current practice patterns to optimize both patient outcomes and hospital resource utilization.

A recent series of studies have focused on the prevention of appendiceal perforation.[2–8] Specifically, they analyzed the hypothesis that in-hospital time delays to the operating room (OR) increase the risk of perforation. Eko et al[2] assessed time to the OR for uncomplicated acute appendicitis and found that timing of surgery did not affect the incidence of purulent peritonitis or perforation when comparing time to the OR less than 18 hours to greater

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* Corresponding author. Tel.: (254) 724-7017; fax: (254) 724-7489.
E-mail address: Justin.Regner@BSWHealth.org

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than 18 hours from initial hospital presentation. Busch et al[3] narrowed the time window by assessing patients at the 12-hour mark, and they found that there was a significantly higher rate of perforation when comparing operative time less than 12 hours versus greater than 12 hours. Dr. Teixeria et al[4] evaluated appendiceal perforation rates at the 6- and 12-hour mark. They found that patients with delays to the OR greater than 6 hours had increased risk of surgical site infection; however, there was no difference in perforation rate. Currently, there remains dispute regarding the acceptable duration of in-hospital time delay to the OR needed to minimize perforation and complication rates. The common shortcoming in earlier studies was the failure to differentiate between patients who were perforated at presentation and patients who would perforate in the hospital while awaiting surgical intervention.

The aim of our study was to select patients with nonperforated appendicitis verified by computed tomography (CT) scan and determine if in-hospital delay to the OR, specifically time delays greater than 3 hours, increased the risk of perforation. A secondary aim was to determine the effect of time delay on incidence of surgical site infections. We hypothesize that patients with previously nonperforated appendicitis on CT scan will have a lower incidence of perforation with shorter delays to the OR.

Methods

An institutional review board approved the analysis of a retrospective cohort of consecutive patients with nonperforated appendicitis identified by CT scan from 2007 to 2012 that presented or were transferred to Scott and White Memorial Hospital, Temple, Texas. All patients with CT scan (General Electric 64 or 254 slice helical tomography, Waukesha, WI, USA) and diagnosis that suggested unperforated appendicitis were included. Nonperforated appendicitis was defined by the Radiologic Society of North America to include no free air, no obvious phlegmon, no abscess, nor excessive inflammation.[9] Patients with known perforation, abscess, pregnancy, or no preoperative CT scan were excluded from the study. CT scans were interpreted by senior radiology staff and confirmed by senior surgical staff. Readers were blinded to the clinical results.

Patients were stratified based on time from CT scanner to OR. We chose to analyze patients from the time of CT scan, as this time point established both a definitive diagnosis and verified nonperforated appendicitis. Three-hour intervals from time of CT were evaluated. We elected to evaluate patients based on 3-hour intervals as previous literature[4–6] focused on 6-, 12-, and 18-hour intervals. We felt that the 3-hour time mark point serves as the earliest time that surgeons are generally contacted for treatment of appendicitis in today's acute care model. Patient comorbid demographics, antibiotic use, CT findings, operative procedure, findings of perforation, length of hospitalization, postoperative complications, and time sequence were included for analysis. Diagnosis of perforation was made by clinical discretion at time of the operation and included a visible hole in the appendix, associated phlegmon, or gross contamination. Perforation was confirmed by pathology reports.

Statistical analysis

Variables were compared between those with perforated versus unperforated appendicitis using chi-squared and/or Fisher's exact or *t* test for categorical variables and continuous variables, respectively. A multivariate logistic regression including demographics and time from CT scan to operation was used to assess the influence of time on perforation. Specifically, those variables associated with perforation at a *P*-value of .2 or less were included in the regression model. Less than 10% of data were deficient for any category.

Results

Four hundred eleven patients were diagnosed with nonperforated appendicitis preoperatively by CT criteria. Eighty (19.5%) of 411 patients, aged 39.7 ± 16.25 years were perforated at surgery. Median time from CT to operation was 5.5 and 6.5 hours for unperforated versus perforated appendicitis (Table 1), whereas the mean time was 7.6 and 8.8 hours, respectively, ($P = .21$). There was no significant difference in patients' medical comorbidities when comparing perforated to nonperforated patients, with the exception of coronary artery disease and dyslipidemia (Table 1). Patients with symptoms greater than 72 hours were more likely to be perforated ($P < .001$). Eighty-seven percent (n = 356) of patients received antibiotics in the emergency room at the time of diagnosis, and 100% of patients received perioperative antibiotics within one hour of incision.

Analysis of 3-hour intervals from CT scan to OR, specifically 0 to 3, 3 to 6, 6 to 9, and greater than 9 hours of intervals, revealed an absolute reduction of perforation from 27% at the 6 to 9-hour interval to 17% and 10% at the 3 to 6 and 0 to 3 hours of intervals, respectively, (Table 2). There was a slight decrease in perforation rates from 6 to 9 hours (27%) to greater than 9 (23%) hours, but this was not statistically significant ($P = .5$). Analysis comparing the 0 to 3-hour interval to greater than 3 hours and greater than 6 hours confirmed the increased risk of perforation with delay to the OR ($P = .05$, .02; Table 3). Multivariate analysis suggested length of symptoms was the strongest predictor of perforation. When comparing the length of symptoms in the 0 to 3 hour population, 68% patients with nonperforated appendicitis had symptoms for less than 24 hours, whereas only 31% of patients with perforated appendicitis had symptoms for less than 24 hours ($P = .01$). This trend was not demonstrated at the 3 to 6 hour mark with 43% of patients with perforated