The American Journal of Surgery (2017) 213, 731-738

The American Journal of Surgery®

Predictive factors and outcomes of negative appendectomy

Byeong Geon Jeon, M.D.*

Department of Surgery, Daejin Medical Center Bundang Jesaeng General Hospital, Sungnam-si, Gyeonggi-do, Republic of Korea

KEYWORDS:
Negative appendectomy;
Predictive factor;
Outcome

Abstract

BACKGROUND: The aim of this study was to assess predictive factors for negative appendectomy and to evaluate the outcomes of negative appendectomy.

METHODS: A retrospective chart review of 4,878 patients who underwent appendectomy at our institution from January 2008 to December 2014 was performed.

RESULTS: Younger age ($\leq$15 years), normal white blood cell count, appendix diameter of less than 6 mm on computed tomography (CT), and CT grade less than 3 were found to be independent predictive factors for negative appendectomy. When complications were investigated according to the results of pathologic diagnosis, negative appendectomy had more complications than appendectomy for nonperforated appendicitis, and this was statistically significant.

CONCLUSIONS: When CT findings are equivocal, in deciding to operate for acute appendicitis, additional ultrasonography can be performed. Furthermore, if the patient is younger than 15 years and the white blood cell count is normal, it is recommended to monitor changes in symptoms a little longer rather than operating hastily.

Acute appendicitis is the most common disease within the abdominal cavity that requires emergency operation. Clinical findings are unclear, and many diseases must be eliminated by differential diagnosis. This delays diagnosis and operation, which can lead to secondary problems, including complications such as peritonitis or abscess from perforation.[1,2] Conversely, when surgery is performed hastily in an attempt to prevent complications, this can lead to an unnecessary operation, which is called negative appendectomy. This refers to cases in which there are no findings of pathologic inflammation in the excised appendix itself after appendectomy.

To minimize the risk of negative appendectomy, the best diagnostic method used to be careful and cautious physical examination and history taking, but recently radiologic tests, such as ultrasonography (US) or computed tomography (CT), have been used effectively, and most studies report that they can reduce the rate of negative appendectomies by 2% to 14%.[3–6] However, in some studies, there are reports that the negative appendectomy rate does not decrease even after radiologic tests.[7,8] Moreover, in cases of equivocal appendicitis, negative appendectomies are still being performed even after these tests.[7]

As negative appendectomy is reported to decrease patient satisfaction and cause unnecessary medical expenses and to be highly associated with increased length of stay, postoperative complications, and mortality, rapid and

The authors declare no conflicts of interest.

* Corresponding author. Tel.: +82-31-779-0170; fax: +82-31-779-0467.

E-mail address: bgjeon78@gmail.com

Manuscript received February 22, 2016; revised manuscript May 2, 2016

0002-9610/$ - see front matter © 2016 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.amjsurg.2016.05.020

precise diagnosis of acute appendicitis is an essential part of treatment.[7,9–11] Therefore, it is important to identify clinical predictive factors of appendicitis to reduce negative appendectomy rates. The aim of this study was to assess predictive factors for negative appendectomy and to evaluate the outcomes of negative appendectomy.

Methods

Patients

In total, 4,878 patients underwent appendectomy at the Bundang Jesaeng General Hospital between January 2008 and December 2014. After excluding 15 patients who underwent interval appendectomy and 26 patients who underwent incidental appendectomy, 4,746 patients were finally included and their medical records used for a retrospective study. The organization's institutional review board approved this retrospective, observational, single-center study and waived the informed consent requirement.

Data collection and variables

Patients' clinical characteristic data, laboratory findings, radiology reports, and pathology reports were collected. Clinical factors, including age, sex, body mass index, abdominal surgery history, comorbidities, pulse rate, body temperature, and symptom duration, were investigated. Comorbidities were classified according to the study by Charlson et al.[12] Symptom duration was the interval between symptom onset and surgery. Symptom onset time was recorded using the emergency room admission notes, and the surgery time was defined as the time of incision according to the anesthesia records. Preoperative laboratory findings included white blood cell (WBC) counts, neutrophil shifts, and C-reactive protein (CRP) levels.

Radiologic tests were confirmed through US and CT reports. The CT results were classified into 5 grades as follows: (1) definitely absent; (2) nonvisualized appendix with no secondary signs of inflammation; (3) equivocal; (4) probable; and (5) definitely present. Data using this scoring system were previously reported by Stengel et al[13] in a study of false-positive CT for appendicitis. These 5 grades were evaluated based on the 5 criteria reported in the literature[14]: distended appendix, more than 6 mm; periappendiceal fat stranding and infiltration; appendiceal wall enhancement or thickening; cecal apical wall thickening compared with the normal thickness of the wall of the ascending colon; and presence of extraluminal fluid collection or gas bubbles around the appendix.[15] If 3 or more of the findings were present, the patient was diagnosed as grade 5. If 2 findings were present, the patient was diagnosed as grade 4. The presence of only 1 finding was considered as equivocal CT finding for appendicitis. If the appendix was not seen or not traced entirely, it was determined that the patient probably did not have appendicitis.[16]

All US examinations included in this study were performed by 3 experienced abdominal radiologists and 2 residents (with 2 and 3 years' training). When a resident performed the US examination, the attending abdominal radiologist immediately reviewed and confirmed the results. Off-hour studies performed by 2 residents (with 2 and 3 years' training) were reviewed and confirmed by an experienced abdominal radiologist on the morning of the next business day, based on the US images and documentation.

The pathologic confirmation of appendicitis was based on the patients' pathology report. Pathologic diagnosis of acute appendicitis was based on neutrophil infiltration of the submucosa or muscularis propria. Negative appendectomy was defined as nonincidental appendectomy with no inflammatory cells in the excised appendix. However, when appendiceal neoplasms were discovered, even without inflammation, these cases were excluded from the negative appendectomies because the patient clinically required appendectomy.

End points

The main purpose of this study was to find predictive factors for negative appendectomy. Analyses were performed by dividing groups according to the normality of the appendix, with additional analysis done for patients showing equivocal CT findings. For patients who underwent a negative appendectomy, the metrics of treatment success were reduction in white cell count and general symptom reduction. Multivariate analyses were performed for groups with and without complications to study the outcomes of negative appendectomy. Complications included wound infections, intra-abdominal abscesses, postoperative ileus, incisional hernias, internal organ injuries, bleeding, cardiovascular diseases, and pulmonary diseases.

Statistical analysis

Categorical variables were presented as numbers and percentages, whereas continuous variables were presented as the mean and standard deviation or the median and interquartile range. The chi-square test or Fisher's exact test were used to compare the categorical variables. Student t test was used to compare the continuous variables. Multivariate logistic regression analysis was used to study the independent factors affecting negative appendectomy and the outcomes of negative appendectomy. The odds ratios (OR) and 95% confidence intervals (CI) are reported. P values less than .05 indicated statistical significance. The statistical analyses were performed using PASW Statistics for Windows, version 18 (SPSS Inc., Chicago, IL).