



Original Research

Prolonged operative time in laparoscopic appendectomy: Predictive factors and outcomes



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HIGHLIGHTS

- Five independent predictive factors for a prolonged operative time were identified.
- A prolonged operative time was associated with adverse postoperative outcomes in laparoscopic appendectomy.
- It is important to make an effort to reduce operative time by selecting an appropriate operator and type of surgery.

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ABSTRACT

Introduction: To our knowledge, this study is the first to identify the predictive factors and outcomes of prolonged operative time associated with laparoscopic appendectomy. We aimed to identify preoperative factors that influence operation time and to determine how operative time affects laparoscopic appendectomy outcomes.

Methods: The medical records of 3049 patients who had undergone laparoscopic appendectomy between January 2008 and December 2014 were retrospectively reviewed. Prolonged operative time was defined in the top 10% according to distribution (>90 min). A multivariate regression model was generated to assess potential predictive factors and outcomes of prolonged operative time.

Results: In laparoscopic appendectomy for non-perforated appendicitis, independent factors that predict a prolonged operative time as identified through multivariate analysis were elevated C-reactive protein levels, symptom duration of more than 3 days, and computed tomography findings indicating an appendiceal diameter of more than 10 mm. In laparoscopic appendectomy for perforated appendicitis, overweight, elevated C-reactive protein, symptom duration of more than 3 days, and computed tomography findings of abscess were independent predictive factors for prolonged operative time. Prolonged surgery increases the risk of complications, prolonged hospital stay, and readmission.

Conclusions: Overweight, elevated C-reactive protein, symptom duration of more than 3 days, appendiceal diameter of more than 10 mm, and abscess were independent predictive factors of prolonged operative time. Furthermore, prolonged operative time was associated with adverse postoperative outcomes after laparoscopic appendectomy.

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1. Introduction

Laparoscopic appendectomy was first performed by Semm [1] in 1983, and the frequency of this approach has increased for the

treatment of acute appendicitis as the concept of minimally invasive surgery is widely used [2]. The advantages of laparoscopic appendectomy include less postoperative pain, fewer wound infections, shorter hospital stay, and shorter recovery time in comparison with open appendectomy [3–8]. However, laparoscopic appendectomy has a longer operation time than open appendectomy, the operative time of the former approach ranges from 48 min to 67 min, whereas that of the latter approach is from 37 min to

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59 min [9,10].

Generally, laparoscopic appendectomy is a surgery that the residents perform as the first step of laparoscopic surgery training. It is also one of the most common surgeries that they perform during residency. However, in cases where severe inflammation or adhesions exist, laparoscopic surgery takes a longer time and inexperienced residents may find it challenging to perform. Some investigators have shown that operation time is a factor for assessing the technical difficulty of laparoscopic surgery [11,12].

An increased operative time has been recently shown to be associated with increased complication rates in various laparoscopic surgeries [13]. Moreover, a prolonged operative time is known to be associated with increased complication rates and hospital stays in laparoscopic cholecystectomy [14]. To our knowledge, this study is the first to identify the predictive factors and outcomes of a prolonged operative time in laparoscopic appendectomy.

Therefore, it is postulated that predicting the technical difficulty of laparoscopic appendectomy, and thus identifying the patients with a high possibility of prolonged surgery in advance may be helpful. In addition, if an experienced surgeon performs or observes the surgery in these patients, the operative time could be shortened. This study aimed to identify preoperative factors that influence operation time and to determine the association of operative time with outcomes in laparoscopic appendectomy.

2. Methods

2.1. Patients

A total of 4787 patients who underwent appendectomy at Bundang Jesaeng General Hospital from January 2008 to December 2014 were considered for the study. Patients were excluded if they had undergone interval appendectomies ($n = 15$), incidental appendectomies ($n = 26$), cecectomies or ileocecectomies ($n = 26$), open appendectomies ($n = 1579$), or open conversion ($n = 20$). Finally, we performed a retrospective study using the medical records of 3049 patients who had undergone laparoscopic appendectomy. Laparoscopic appendectomy was performed by eight surgeons. All surgeons were required to have performed more than 100 open appendectomies prior to study participation. Although the frequency of open appendectomy was high, the frequency of laparoscopic appendectomies increased as of 2010 when all surgeons were qualified to perform laparoscopic surgery (Fig. 1).

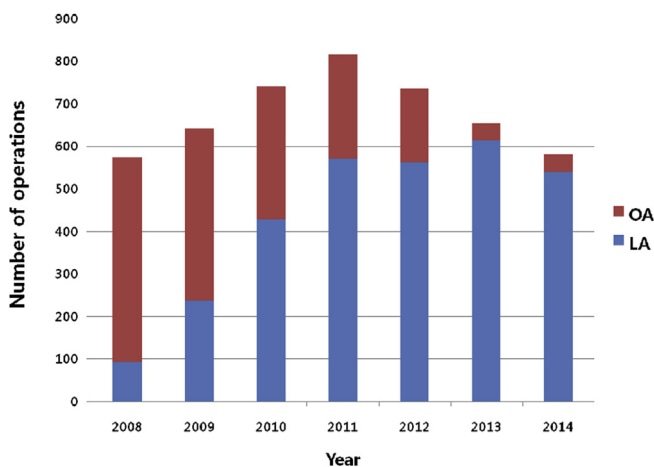


Fig. 1. Types of operation, laparoscopic appendectomy (LA) vs. open appendectomy (OA) over time.

2.2. Data collection and variables

Our database was accessed electronically using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes and Korean Standard Classification of Diseases, Sixth Revision (KCD-6) diagnosis codes. The ICD-9-CM codes for laparoscopic surgery (47.01) and open appendectomy (47.09), and the KCD-6 codes for acute appendicitis (K35.8) and perforated appendicitis (K35.2, K35.3) were used. Data were obtained from the operation records, anesthesia records, and progress notes of the wards and clinics responsible for each patient. The institutional review board of Bundang Jesaeng General Hospital approved this retrospective, observational, single-center study and waived the informed consent requirement.

Perforated appendicitis was defined based on spillage of appendiceal contents, peritonitis, or abscess observed at the beginning of the surgery, or was pathologically confirmed as an appendiceal wall defect caused by transmural necrosis. After patients were organized into perforated and non-perforated appendicitis groups, we investigated preoperative factors that influence operation time and the association of operative time with outcomes. Operative time was defined as the duration of the procedure from the initiation of skin incision to the completion of skin closure according to anesthesia records. Patients were divided into two groups according to the length of their surgery: patients with operative times ≤ 90 min and those with operative times > 90 min (upper 10%). The groups were then compared to determine preoperative predictors of prolonged operative time. Preoperative parameters included in our analysis were age, sex, body mass index (BMI), abdominal surgery history, white blood cell (WBC) count, neutrophil count, and C-reactive protein level, pulse rate, body temperature, comorbidities, symptom duration, appendix diameter, appendicoliths, and abscess on computed tomography (CT) findings. Comorbidities were classified according to a study by Charlson et al. [15]. Symptom duration was defined as the interval between symptom onset and surgery.

To identify the association of operative time with outcomes, we compared the complications, readmission, and length of hospital stay of both groups. Complications included wound infection, intraabdominal abscess, postoperative ileus, incisional hernia, internal organ injury, bleeding, cardiovascular disease, and pulmonary disease. Wound infections were defined using Centers for Disease Control and Prevention guidelines [16]. An intraabdominal abscess was diagnosed based on the presence of fever, abdominal pain, and/or gastrointestinal dysfunction, and was confirmed by radiological evidence of intraabdominal fluid accumulation [17]. Postoperative ileus was diagnosed if two or more of the following criteria were met on or after postoperative day 4: nausea or vomiting, inability to tolerate oral intake during the preceding 24 h, the absence of flatus over the preceding 24 h, abdominal distension, and/or radiologic confirmation [18].

2.3. Surgical procedure

The determination criteria for type of surgery were not definitively established as this was a retrospective study. The type of surgery was determined according to the propensity of the corresponding surgeon until 2009. Beginning in 2010, the type of surgery was determined after the pros and cons of laparoscopic versus open procedures, surgeon's preference and proficiency, and costs were explained and discussed with patients as well as their caregivers during the consent process for surgery. Under general anesthesia, laparoscopic appendectomy was performed using a standardized 3-trocar approach. A 10-mm optic port was inserted into the umbilicus or subumbilical position, and two additional 5-

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