ORIGINAL PAPER

Surg. Gastroenterol. Oncol. 2022;27(3):217-222 DOI: 10.21614/sgo-488

Interval Appendectomy Reduces Postoperative Hospital Stay in Patients with Uncomplicated Appendicitis

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ABSTRACT

Aim: Acute appendicitis is frequently encountered in gastroenterological field, and emergency appendectomy (EA) has been the principal treatment for those patients. In recent years, interval appendectomy (IA), which performs elective surgery after conservative treatment, has been widely accepted. However, guidelines for the adaptation of IA have not been established yet, and its effectiveness is still unclear. The purpose of this retrospective study is to evaluate IA or EA as the best practice for patients with acute appendicitis in our department.
Methods: From January 2017 to March 2021, we had 98 cases of appendectomy and divided those patients into two groups, IA group and EA group, and compared the pre-operative, surgical, and postoperative factors among both groups.
Results: There were 20 patients in the IA group and 78 patients in the EA group. Over 95% patients underwent laparoscopic appendectomy. In IA group, there were 10 females and 10 males, and the median waiting time till appendectomy was 51.5 days (14-172 days). In comparison between two groups, length of hospital stay after surgery was significantly shorter in IA group than in EA group (IA group; 5 days (3-7) vs EA group; 6 days (3-41), $p = 0.01$). The operation time was tended to be shorter in IA group than EA group, but was not significantly different. There was no difference between both groups regarding post-operative complications.
Conclusion: We suggest IA to be the preferred treatment method as it may shorten post-operative hospital stays for patients with acute appendicitis.
Key words: acute appendicitis, emergency appendectomy, interval appendectomy

INTRODUCTION

Acute appendicitis (AA) is a common cause of acute abdominal pain, and oftentimes requires surgery as a cure. Appendectomy is the most frequently performed treatment method for AA, and emergency appendectomy (EA) had been the gold standard treatment. Yet, the surgical treatment of AA has undergone a paradigm shift from open appendectomy to laparoscopic appendectomy (LA) in the last decade, for adults and is now also expanding for pediatric cases. Recently, several institutions are now proposing conservative treatment as an

Received: 19.06.2022
Accepted: 16.08.2022

alternative to surgery for the treatment of AA, for cases with or without complications. However, it is difficult to completely cure AA with conservative treatment alone. In order to avoid recurrence of appendicitis, some authors recommend routine elective interval appendectomy (IA) followed by conservative management (1-6). However, some authors states that routine IA leads to failure of conservative treatment in cases of uncomplicated AA (7-9). Currently, indication and effectivity of IA, and interval period criteria, are still controversial. In this retrospective study, we aim to assess whether IA was need for patients with AA admitted to our department.

METHODS

Our hospital initiated conservative treatment for AA patients since 2017. A diagnosis of AA was made based on physical examination findings, laboratory test and plain computed tomography (CT) imaging. Diagnostics of acute appendicitis was conducted using Alvarado score at the time of first admission (10).

We have experienced total of 98 cases of appendectomy from January 2017 to March 2021. For the current study, we have divided those patients into two groups; IA group and EA group. Assessment parameters for comparison were the following: preoperative characteristics (age, gender, white blood cell count (WBC), neutrophil percentage, lymphocyte percentage, C-reactive protein level (CRP), platelet count (PLT), blood sugar (BS), hemoglobin A1c (HbA1c), with/without diabetic merits (DM), with/without appendicolith on CT, and CT grade), Alvarado score, operation characteristics (operating time, blood loss, conversion, and procedure: laparoscopic or open), postoperative characteristics (pathological diagnosis, surgical-site infection (SSI), and Clavien-Dindo (C-D) classification (11), and length of hospital stay after surgery).

Ethics

This study was performed in accordance with the Declaration of Helsinki and approved by the Research and Ethics Committee of Tokyo Medical University (study approval no: T2021-0086). Informed consent was obtained from all of AA patients. If the patients were under 18 years old, we obtained informed consent from their parents on their behalf.

CT imaging classification and histopathological findings

The extent of inflammation caused by the appendicitis was graded using imaging features observed at any location of the appendix and in the peri-appendiceal region. A 6-point scale was used and scaled as follows reported by Abe et al (12). We classified as high risk appendicitis patients with grades 4 and 5 from the CT images, and uncomplicated appendicitis was in grade 1 to 3 or complicated appendicitis was grade 4 and 5.

Criteria (fig. 1)

Criteria of EA were as follows:

1. suspected perforated appendicitis on CT;

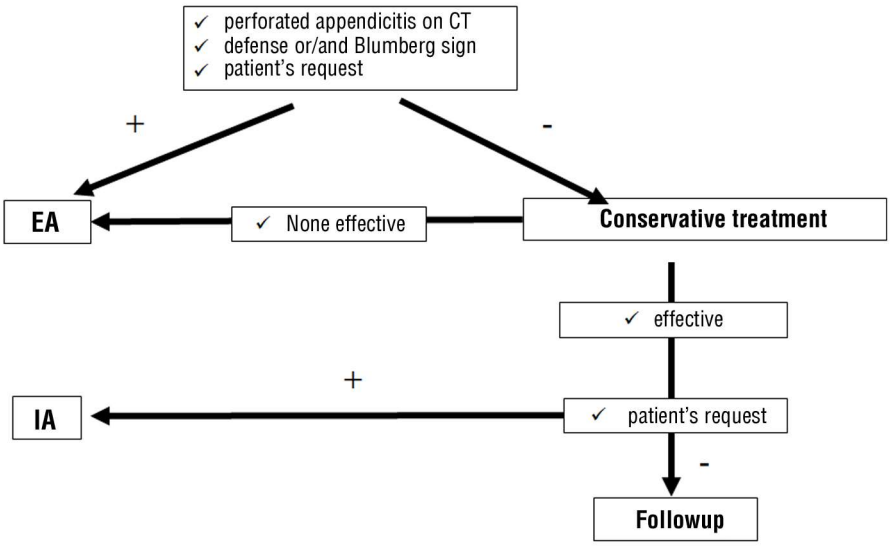

Figure 1 - Treatment stratagem for acute appendicitis in our institution

2. associated with severe abdominal findings: defense and/or Blumberg sign;
3. patient's request (if patients did not have 1 and/or 2).

But final decision was entrusted to each attending surgeon. After decision has been made the operation commenced within 24 hrs after admission.

Criteria of IA were as follows:

1. non perforated appendicitis on CT;
2. no severe abdominal findings;
3. no patient's request of EA.

Under the informed consent, we first infused second-generation cephem antibiotics two times per day at least 4 consecutive days until the inflammatory reaction disappeared. If patients never responded to the conservative treatments, we immediately performed appendectomy at initial admission. Fortunately, we have not experienced any cases of failure relating to conservative treatment during our study. After successful conservative treatments, informed consent was provided once more before discharge, and for patients who wished to have surgery, appendectomy was planned within 3 months after discharge.

SURGICAL TECHNIQUES

All cases were scrub in two surgeons. At least one surgeon had enough experience in the open as well as the laparoscopic approach, and the attending surgeon acted as a supervisor. Procedures of laparoscopic and open appendectomy were refer from previous our reports (13).

The first choice for surgical procedure was LA in both groups. If the patients had grade IV and V by CT findings, and severe inflammatory adhesion, or difficulty identifying the neck of appendiceal at the laparoscopically, surgeons were made to discreet to conversion to open or open appendectomy.

Statistics

Statistical analyses were performed with the SPSS statistical software package (version 27.0; SPSS Inc., Chicago, IL). Median was used to define laboratory and operative parameters such as, CRP, TP, Alb, WBC, PLt, BS, Hb A1c, operating time, amount of blood loss, and POHS. Univariate analyses were performed to clarify the laboratory parameter and clinical factors most significantly associated with each group. Univariate analyses, Mann-Whitney U-test, and Fisher's exact test were utilized. A p-value of less than 0.05 was considered to indicate a statistically significant difference between 2 groups.

RESULTS

Total of 108 cases were accrued in this retrospective study. We have performed appendectomy on 98 of the 108 cases, and have grouped 20 patients in the IA group and 78 patients in the EA group. Ten patients did not wish appendectomy after conservative treatment. Ninety-four patients were grouped in laparoscopic appendectomy group, and 4 patients were grouped in the open appendectomy group.

In IA group, there were 10 females and 10 males, median age was 41years old (range 8 to 76 years), median waiting time to appendectomy was 51.5 days (range 14 to 172 days), and total length of hospital stay was 12.5 days (7-23 days). There were 3 cases of complicated appendicitis and 17 cases of uncomplicated appendicitis. LA was performed in all cases, and we did not have any case of conversion of LA to open appendectomy. There was no case of SSI, and only one case had C-D II.

In comparison between two groups, CRP and Alvarado score were significantly higher in EA group than in IA group (p=0.0001 and p=0.001) (*table 1*), and length of hospital stay after surgery was significantly shorter in IA group than in EA group (IA group; 5 days (3-7 days) vs EA group; 6 days (3-41 days), p = 0.01). The operation time and amount of bleeding tended to be shorter and lower in IA group than in EA group, also, C-D II and III cases and SSI cases were tended to be lower in IA groups than in EA group, but with no significant difference (*table 2*). As for pathological findings, EA group tended to have more preoperative complications than IA group (p=0.0001), (*table 2*).

DISCUSSION

Since surgeons started performing EA in the 19th century, appendectomy has been the most widely accepted method of management, with over 60,000 appendectomies performed annually in JAPAN. This is based on the traditional model of appendicitis where initial obstruction leads to inflammation, and delay to appendectomy causes increased tension in the wall with ischemia, necrosis, and perforation. On the other hand, first successful use of antibiotic therapy for AA as an alternative was reported in 1950's (14). From early 21st century (15-17) several reports explored methods of conservative treatment that could potentially avoid appendectomy. However, those reports had several

Table 1 - Characteristics of the patients in both groups before surgery

	IA G group (n = 20)	EA G (n = 78)	p-value
Age (years)	41 (8-76)	37 (8-84)	0.4*
Gender(F/M)	10/10	34/44	0.6†
CRP (mg/dL)	0.05 (0.01-4.1)	3.5 (0.01-28.8)	0.0001*
WBC (10^3 /μL)	12.8 (5.5-18.7)	13.6 (3.4-28.2)	0.5*
PLt (10^3/μL)	240 (123-364)	237 (52-540)	0.5*
Neutro. (%)	80.4 (41-93)	87.6 (64.7-96.9)	0.1*
Lymph. (%)	5.3 (5.8-6.8)	8.7 (3.5-18.7)	0.05*
TP (g/dL)	7.2 (6.4-8.2)	7.2 (5.1-8.4)	0.5*
Alb (g/dL)	4.4 (2.8-5.3)	4.3 (2.2-5.2)	0.4*
HbA1c (%)	6.1 (5.8-7.0)	5.5 (5.0-7.3)	0.1*
BS (mg/dl)	110 (90-206)	116 (89-222)	0.9*
DM (yes/no)	8/10	30/39	1.0†
CT grade (1-3/4 and 5)	17/3	62/14	1.0†
Alvarado score	7 (4-9)	9 (3-10)	0.001*
Appendicolith (yes/no)	11/9	47/31	0.8†

Data are shown as medians and interquartile ranges.
*Tested by the Mann-Whitney U-test; †tested by the Fisher exact test
CRP: c-reactive protein, WBC: white blood cell count, PLt: platelet count, Neutro: neutrophil, Lymph: lymphocyte, TP: total protein, Alb: albumin, HbA1c: hemoglobin A1c, BS: blood sugar, DM: diabetic merits.

limitations such as exclusion of complicated appendicitis, small sample size. In 2020, couple of important reports were released that evaluated conservative treatment for uncomplicated AA. First, World Society of Emergency Surgery Jerusalem guidelines recommended nonoperative management with antibiotics as a safe alternative to surgery in patients with uncomplicated AA with absence of appendicolith, advising of the possibility of failure and misdiagnosis of complicated appendicitis (1). They also recommended against appendectomy for AA needing surgery beyond 24hrs from the admission. Second, The CODA Collaborative reported cases with uncomplicated AA that the conservative treatment had been effective, but apparently 30% of such cases required appendectomy within 90 days (6). Some reports suggested that conservative treatment that had been effective for complicated AA, may include interventional management of a periappendiceal abscess. Some centers proceeded to conduct elective appendectomy even after successful conservative management. At present, no consensus exists among surgeons regarding the optimal treatment for patients with complicated AA (4,5).

Perhaps, for certain cases of AA, performing elective appendectomy ('interval appendectomy (IA))', may become a standard manner if the limitations of conservative management becomes clear. Yet we need further discussion about the duration of conservative management, identification of the risk factors independent of conservative management, and the

Table 2 - Characteristics of the patients in both groups operative and postoperative parameters

	IA G group (n = 20)	EA G (n = 78)	p-value
Age (years)	41 (8-76)	37 (8-84)	0.4*
Operating time (min.)	47 (20-90)	60 (30-340)	0.06*
Blood loss (g)	1(1-1)	1 (1-150)	1.0*
POHS (days)	5 (3-7)	6 (3-41)	0.01*
Lap/Open	20/0	74/4	0.6†
Conversion (yes/no)	0/20	2/72	1.0†
C-D (I/II,III)	19/1	73/5	1.0†
SSI (yes /no)	0/20	6/72	0.3†
Pathology (Gang, Phleg/ others)	3/17	70/8	0.0001†

Data are shown as medians and interquartile ranges.
*Tested by the Mann-Whitney U-test; †tested by the Fisher exact test
POHS: post-operative hospital stays, TLHS: total length hospital stays, Lap: laparoscopic, C-D: Clavien-Dindo classification, SSI: surgical site infection, gang: gangrenous, Phleg: Phlegmonous.

best or better timing of appendectomy. Currently those issues are still unclear and depends on each surgeon's decision (18,19).

In recent years, couple of reports, including randomized control study, has been published and have shown the effectiveness of IA in comparison with EA. IA is associated with significantly decreased operative time and lesser risk of unplanned bowel resection (ileocolic and right hemicolectomies) compared to EA. IA also is feasible with complicated appendicitis and has advantages in terms of postoperative complications, especially regarding long-term obstruction events. Our present study also confirmed this result. On the other hand, IA is not advantageous regarding the risk of postoperative complications such as surgical site infection, molarity, and morbidity (2,20,21). It will take some more time to derive conclusion regarding the superiority of IA to EA.

Current evidence shows LA to be the most effective surgical treatment, being associated with a lower incidence of wound infection and post-intervention morbidity, shorter hospital stay, and better quality of life scores when compared to open appendectomy (OA) (1). Di Saverio et al recommends LA as the preferred approach over OA for AA with or without complications, provided laparoscopic specialized facility and specialists are available (1). Furthermore, it is estimated that indication of LA will expand to IA in the future.

This study had several limitations. It was retrospective analysis, and patient population was limited. There were also very few cases of complicated appendicitis in the IA group, and the severity of AA differed among the groups. For IA to be standardized, additional multicenter investigations involving larger patient populations are needed before definitive conclusions can be drawn.

In Conclusion, we have conducted a retrospective analysis of the IA and EA cases experienced in our medical center, and have clarified IA to be the more effective procedure to avoid long hospital stay after surgery than EA.

Authors' Contributions

Made substantial contributions to conception and design of the study and performed data analysis and interpretation: N Orimoto, Y Kuboyama

Performed data acquisition, as well as provided administrative, technical, and material support: N Orimoto, Y Kuboyama and S Suzuki

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

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