Laparoscopic appendectomy is an appropriate initial way in acute appendicitis surgery

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Aim and design
Appendectomy is the treatment of acute appendicitis and still has no standard surgical technique. The purpose of this study is to compare conventional open appendectomy (OA) and laparoscopic appendectomy (LA) techniques, in terms of different parameters.
Patients and methods
A total of 169 patients were retrospectively analyzed. The patients were divided into the OA (n=85) and the LA (n=84) groups. Groups were compared in terms of age, sex, BMI, Charlson comorbidity index, leukocyte levels, C-reactive protein levels, and operative findings.
Results
There was a statistically significant difference between the two groups in terms of sex (P=0.006) and leukocytosis (P=0.009). The number of female patients was found to be higher in the LA group, and more leukocytosis was seen in the OA group. The operation time was shorter in the OA group (P=0.001). Considering the complication rates, there was a statistically significant difference against the OA group (P=0.042).
Conclusions
LA has higher recovery rates, has fewer complication rates, requires shorter hospital stay, and provides advantage in patients with high comorbidity. In acute appendicitis, first option in surgical intervention should be LA. Therefore, it is recommended that LA learning curve of the general surgery residents should be increased.

Keywords:
abdomen, appendicitis, complication, laparoscopy, surgery

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Introduction

The first appendectomy for the treatment of appendicitis was performed by McBurney in 1864. Since then, this method has been accepted worldwide as the standard treatment for acute appendicitis [1]. The average annual incidence of appendicitis in the last 15 years is reported to be less than or equal to 81 to more than or equal to 150 per 1 00 000, which varies by country. The incidence is 100 per 1 00 000 in North America and 160 per 1 00 000 in Turkey [2]. In studies conducted in North America, it has been reported that the cumulative incidence rate for life is 9.0%, and it is seen mostly in males (52.9%), with a mean age of 36.4 years in the white race. In that study, the peak age range has been found to be 15–19 [2,3]. Nonperforated appendicitis is seen in 70% of patients [3].

According to recent studies in Turkey, acute appendicitis is seen mostly in men (85.4%) and in the mean age of 28 years [4]. Appendectomy has been accepted as the standard treatment method for acute appendicitis, although some authors recommend antibiotic treatment or percutaneous drainage treatment [5]. Appendectomy can be performed as open appendectomy (OA) or laparoscopic appendectomy (LA) [6].

Prospective randomized controlled trials comparing LA and OA have been performed up to date [2,3,7]. Some studies have reported that LA is superior to OA, as the recovery time and time to return to regular diet are shorter in LA. However, in some studies, no such benefit has been reported and even traditional appendectomy has been preferred [7–9]. The aim of this study is to compare conventional OA and LA techniques in terms of different parameters.

Patients and methods

First, approval was obtained from the Clinical Research Ethics Committee with the decision number 54/12, dated 12.02.2018. In this study, we

retrospectively analyzed patients who were operated for acute appendicitis between January 2017 and January 2018 in the general surgery clinic.

Selection criteria: pregnant women and patients under 16 years of age were excluded from the study. Patients with missing data, incomplete records and those who underwent two simultaneous procedures were excluded from the study. As the hospital where the study was conducted is a training and research hospital, there was no obstacle to finding the necessary equipment for laparoscopy, and the surgeons' LA experience was sufficient. The patients were informed about the techniques to be applied (laparoscopic or open). The surgeon's preferred technique was specified, but other techniques were applied at the request of patients who did not accept it.

The data and clinical outcomes of the patients were obtained from the hospital archives. A total of 169 patients who met the inclusion criteria and whose clinical data were available were included in the study. The patients were divided into two groups: the OA group (n=85) and the LA group (n=84). Groups were compared in terms of age, sex, BMI, and Charlson comorbidity index (CCI). Abdominal ultrasonography (USG) and abdominal computed tomography (CT) results were evaluated for radiological diagnosis. Leukocyte levels, presence of leukocytosis, and C-reactive protein levels were evaluated.

Furthermore, the use of drainage during the surgery, operation time (minutes), complication status, time to start eating regular food (days), and length of hospital stay (days) were evaluated. Patients were classified as having acute appendicitis, gangrenous appendicitis, and perforated appendicitis according to the pathological examination results of the appendix removed [2,4].

Surgical techniques

All patients were operated under general anesthesia. The same antibiotic prophylaxis (Cefazolin 1 g intravenous) was administered preoperatively as a part of the clinical protocol. In the OA group, the abdomen was entered via McBurney's incision to access the appendix. The mesoappendix was separated and the stump was ligated. Then, the appendix was cut and stump was buried. The intraabdominal area was checked as far as could be seen from the incision, and the abdominal layers, including the peritoneum, were closed.

In the LA group, a 10-mm camera port was placed under the umbilicus and 10-mm and 5-mm ports were placed from the left iliac fossa and median suprapubic region, respectively. A 5 mm LigaSure (Covidien, Boulder, Colorado, USA) was used to dissect the mesentery of the appendix. The mesentery of the appendix was ligated using Vicryl Endoloop-0 (Ethicon Endo-surgery, Cincinnati, Ohio, USA) or two hem-o-lok clips, size XL (Hem-o-lock; Weck Closure Systems, Research Triangle Park, North Carolina, USA), depending on the condition of the appendix and the supply of the material and was, then, cut with the help of LigaSure from its 4–5 mm above. Endo-GIA 45 mm (U.S. Surgical Corp., Norwalk, Connecticut, USA) was used in only one patient because the appendix mesentery and cecum base were highly destructed. The specimen was then removed from the trocar using a glove endobag sent into the abdominal cavity. The port locations were then closed. In both groups, a closed aspiration drainage Jackson-Pratt with a 10-mm lumen diameter was used in the presence of appendiceal abscess. Appendix specimens from both groups were sent for pathological examination.

According to the postoperative general condition of the patients, liquid foods were started to be given after 24 h. Cefazolin (1 g intravenous twice a day) was continued for patients with perforated appendicitis and plastron appendicitis during their stay in the hospital. Patients were discharged after 1–10 days depending on their clinical course.

Statistical analysis

All data were analyzed by using the SPSS software package, version 22 (IBM Corp., Armonk, New York, USA). Frequency and percentage distributions of the data are given. Student's t test and Mann–Whitney U test were used to evaluate quantitative data in comparative analyses. Categorical data were evaluated by the χ^2 test. The statistical analysis was conducted at a 95% confidence level and a P value of 0.05 was considered statistically significant.

Results

The mean age of 169 patients included in the study was 34.9 years. The female to male ratio was 0.69, and mean BMI was 29 kg/m^2. The demographic characteristics (age, sex, and BMI) of LA group and OA group are shown in Table 1. According to the results, there was no statistical difference between the two groups in terms of age and BMI. However, there was a statistically significant difference between the two groups in terms of sex (P=0.006). The number of female patients was found to be higher in the LA group.

Table 1 Demographics of patients undergoing open appendectomy and laparoscopic appendectomy

Demographic characteristics	LA group (*N*=84)	OA group (*N*=85)	*P*
Age (years)	16–77 (mean: 35.8)	16–78 (mean: 33.9)	0.354[a]
Female/male ratio	1.04	0.44	0.006[b]
BMI (kg/m^2)	20.1–37.8 (mean: 29.4)	18.9–32.8 (mean: 28.6)	0.272[a]

LA, laparoscopic appendectomy; OA, open appendectomy. [a]Student's *t* test. [b]χ^2 test.

Table 2 Charlson comorbidity index status of patients undergoing open appendectomy and laparoscopic appendectomy

CCI status	LA group (*N*=84)	OA group (*N*=85)	*P*
CCI 0	76.2% (*n*=64)	80% (*n*=68)	
CCI 1	10.7% (*n*=9)	14.1% (*n*=12)	
CCI 2	8.3% (*n*=7)	2.4% (*n*=2)	0.451[a]
CCI 3	4.8% (*n*=4)	3.5% (*n*=3)	

CCI, Charlson comorbidity index; LA, laparoscopic appendectomy; OA, open appendectomy. [a]Mann–Whitney *U* test.

The CCI status of patients undergoing OA and LA is demonstrated in Table 2. Almost 80% of the patients had a comorbidity index of 0. No statistically significant difference was found between the groups.

Of the patients in the LA group, 21.4% (*n*=18) were diagnosed with abdominal USG and 78.6% (*n*=66) were diagnosed with CT. Of the patients in the OA group, 14.1% (*n*=12) were diagnosed with abdominal USG and 85.9% (*n*=73) were diagnosed with CT. The laboratory findings of groups are represented in Table 3. There was a statistically significant difference between the two groups in terms of the presence of leukocytosis. (*P*=0.009). More leukocytosis was seen in the OA group.

During the ligation of appendix root, Vicryl Endoloop-0 was used in 95.2% (*n*=80) of the patients, Hem-o-lok plastic clips were used in 3.6% (*n*=3), and Endo-GIA 45 mm was used in 1.2% (*n*=1). The base of the appendix was ligated with silk sutures in all patients in the OA group. Perioperative characteristics (operation time and drain placement) of the patients are indicated in Table 3. The operation time was shorter in the OA group, and this was statistically significant (*P*=0.001). The Jackson-Pratt drain was placed in four patients in both groups.

Liquid food was started on the first postoperative day for all patients. In the LA group, no complication was observed in 94% (*n*=79) of the patients during the follow-up, whereas umbilical port site infection, subileus, and appendectomy site abscess developed in 2.4% (*n*=2), 1.2% (*n*=1), and 2.4% (*n*=2) of the patients, respectively. No complication was observed in 90.5% (*n*=77) of the patients in the OA group, during the follow-up, whereas wound infection, ileus, and appendectomy site abscess developed in 5.9% (*n*=5), 2.35% (*n*=2), and 1.17% (*n*=1) of the patients, respectively (Table 4). Considering the complication rates, there was a statistically significant difference against the OA group (*P*=0.042).

When the length of hospital stay and pathology report results were obtained, it was observed that there was no significant difference between the two groups (Table 4). Based on the specimen pathologies, acute catarrhal appendicitis was the most pathological result in both groups.

Discussion

The pathogenesis of appendicitis is still not fully understood, although it is one of the most common abdominal emergencies with a lifetime risk of ~8% depending on the geographical and seasonal conditions [2,10]. Genetic predisposition, low-fiber diet, fecalith, presence of foreign bodies, parasites, and obstructing tumors are reported to be effective in its etiology [10]. Epidemiological studies have shown that it is frequently seen in the white race, males, and within the age range of 15–19 years [10]. In studies conducted with adults, 53.7% of the patients have been reported to be male and the mean age has been reported to be 39 years [11]. In the present study involving adults, 59.1% of the patients were male, and the mean age was 34.9 years. However, in this study, it was observed that the female/male ratio was quite low in the OA group. Most of the surgeons prefer LA in female patients. The reason for this is gynecological pathologies that can occur in suspicious cases.

Appendicitis, which was first described by Dr Fitz in 1886, is a global disease [2]. OA was the standard treatment for acute appendicitis for more than a century. However, LA has become a new treatment standard for the last two decades [11,12]. In the early years of LA application, cases that were considered to be uncomplicated were especially preferred. Today, 67% of complicated appendicitis cases are treated with LA [13]. However, as in this study, patients undergoing open surgery in our clinic are slightly more than the number of patients undergoing LA. The reason why there are many open cases is to enable

Table 3 Laboratory and perioperative characteristics of patients undergoing open appendectomy and laparoscopic appendectomy

Laboratory and operative characteristics	LA group (*N*=84)	OA group (*N*=85)	*P*
Presence of leukocytosis	82.1% (*n*=69)	94.1% (*n*=80)	0.009[a]
CRP elevation	97.6% (*n*=82)	100% (*n*=85)	0.245[a]
Operation time (min)	13–115 (mean: 59.4)	15–135 (mean: 44.4)	0.001[a]
Use of drain	4.8% (*n*=4)	4.7% (*n*=4)	1.000[b]

CRP, C-reactive protein; LA, laparoscopic appendectomy; OA, open appendectomy. [a]Mann–Whitney *U* test. [b]χ^2 test.

Table 4 Postoperative course and pathological characteristics of patients undergoing open appendectomy and laparoscopic appendectomy

Postoperative course and pathological characteristics	LA group (*N*=84)	OA group (*N*=85)	*P*
Presence of complications	5.95% (*n*=5)	9.41% (*n*=8)	0.042[a]
Length of hospital stay (days)	1–6 (mean: 2.1)	1–8 (mean: 2.4)	0.073[b]
Acute catarrhal appendicitis	72.6% (*n*=61)	78.8% (*n*=67)	
Gangrenous appendicitis	16.7% (*n*=14)	10.6% (*n*=9)	0.506[a]
Perforated appendicitis	10.7% (*n*=9)	10.6% (*n*=9)	

LA, laparoscopic appendectomy; OA, open appendectomy. [a]χ^2 test. [b]Mann–Whitney *U* test.

the general surgery residents in training hospitals to gain open surgery experience.

Undoubtedly, one of the most important factors in the scoring systems used in the diagnosis of acute appendicitis is the presence of leukocytosis. In this study, patients in both groups had absolute leukocytosis. However, it was observed that the rate of leukocytosis was significantly higher in the OA group. The probable reason for this difference may be that in cases that are considered to be perforated or complicated in the preoperative period, the surgeon prefers OA for better exploration.

Recent studies have suggested that nonoperative medical treatment with antibiotics may be a good alternative treatment at least in some clinical conditions, such as high comorbidity rates [4,14]. Although surgical operations are risky in patients with high CCI, OA and LA was safely performed in these patients. In this study, we found that surgeons did not consider this factor too much while choosing a surgical procedure. However, open surgery with regional anesthesia is less risky, especially in cases with advanced heart and chronic lung disease.

The LA technique is considered to be superior to OA in terms of technical aspects as surgical site infection rate is lower, less pain occurs on the first postoperative day, and length of hospital stay is shorter in LA [15]. Perhaps more importantly, it will allow the surgeon to examine the entire abdominal cavity. Therefore, it leads to less adhesion-induced ileus in the short and long term as well as detecting other causes mimicking appendicitis [16]. Furthermore, LA has been shown to have significant benefits in obese patients (BMI>30) and in patients with ASA scores III and IV, compared to OA [17]. However, laparoscopy has some serious and sometimes fatal risks, especially in patients with general peritonitis, such as postoperative intestinal ileus, abdominal abscess, and intestinal injuries.

On the contrary, OA has also some advantages: the intraabdominal abscess development rate is lower, operation time is shorter, and it is more cost-effective. One of the advantages of OA is that it can be performed under local anesthesia. However, this may change with the more widespread use of laparoscopy, the further increase in the learning curve, and the further development of the technique [8,12]. In the present study, the operation time of the patients in the LA group was longer but the complication rate was lower. In the LA group, an appendectomy site abscess developed in two patients and subileus in one. A drainage catheter was placed under the guidance of USG for these patients with intraabdominal abscess, and broad-spectrum empirical antibiotics were administered for 5 days. The patient with subileus was not given oral feed and were fed via parenteral nutrition for 2 days. Following the parenteral treatment, subileus was observed to regress, and oral food was started. Reoperation was not required in any of the patients. A total of eight patients in the OA group had postoperative complications during the follow-up, including surgical site infection, ileus, and appendectomy site abscess. A patient who developed limited abscess in intraabdominal appendectomy site was given

broad-spectrum empirical antibiotics for 6 days. The patients with ileus was not given oral feed and was fed via parenteral nutrition for 3 days. Following the parenteral treatment, ileus was observed to regress and oral food was started. Surgical site infections in five patients were treated within 6–13 days with drainage and daily dressing. No new surgical intervention was required also in these patients.

In uncomplicated appendicitis, it is necessary to take the patient into operation without delay within 48 h to prevent the progression of the clinical manifestation to surgical site infection and other complications [10,12]. Although the use of antibiotics in this process delays the formation of perforation, the timely application of the appendectomy will help the patient recover faster [18]. The timing of the operation in patients with complicated appendicitis varies according to the clinical condition of the patient, the type of perforation and in some cases, and the treatment strategy preferred [2,12]. Urgent appendectomy should be performed in severe cases with free perforation or generalized peritonitis [10,12]. Postoperative complications can be prevented by antibiotherapy given after complicated appendectomy [12,19].In stable patients with closed perforation, right lower quadrant periappendicular abscess, or phlegmon, conservative treatment with percutaneous drainage should be performed as an initial treatment instead of surgical treatment to avoid surgical complications such as postoperative abscess or enterocutaneous fistula [12,20]. In such cases, interval appendectomy can be performed following the regression of inflammation [12,21]. In the present study, similar successful results were obtained both from LA and OA in patients with gangrenous and perforated appendicitis.

Conclusion

In last two decades, LA has become the main treatment strategy in the surgical treatment of acute appendicitis owing to its potential advantages. LA is a minimally invasive procedure such as having higher recovery rates, requiring shorter hospital stay, having fewer complication rates, and providing advantage in patients with high comorbidity such as obesity. Although surgical operations are risky in patients with high CCI, LA can be performed safely. In patients with acute appendicitis, the first option in surgical intervention should be LA. Therefore, in this rapidly changing technologic era, it is recommended that LA learning curve of the general surgery residents should be increased.

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Conflicts of interest

There are no conflicts of interest.

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