

# Should appendectomy be performed laparoscopically? Clinical prospective randomized trial

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## ABSTRACT

**Objective:** Laparoscopic appendectomy (LA) has been described in 1983, and its superiority over open appendectomy (OA) is still being debated. Currently, there is no agreement on the advantages of LA. Postoperative pain is reported to be lower along with a faster return to normal activities in LA. However, some studies do not support these findings. In our study, we aimed to compare the outcomes and cost effectiveness of LA and OA.

**Material and Methods:** Patients were prospectively randomized into LA (31 patients) and OA (32 patients) groups. Demographic data, pre- and postoperative C-reactive protein (CRP) levels, white blood cell (WBC) count, duration of surgery and hospitalization, complications, and pain scores (VAS) were recorded. Cost was calculated for both groups. Return to normal activities was evaluated by phone calls at the first and second week and 1 month after surgery.

**Results:** There was a significant postoperative decrease in WBC count in the LA group ( $p < 0.01$ ). There were no differences between LA and OA groups in terms of postoperative CRP levels ( $p > 0.05$ ). The rates of wound infection and abscess were similar ( $p > 0.05$ ), while post-operative pain and time to return to normal activities were higher in the OA group ( $p < 0.01$ ). There was a positive correlation between BMI and operative time in the LA group ( $p < 0.01$ ), while BMI and operative time did not show a correlation in the OA group ( $p > 0.05$ ). The average cost in the LA and OA groups were  $1960.5 \pm 339.05$  and  $687.115 \pm 159.5$  TL, respectively.

**Conclusion:** LA is an effective method in the treatment of acute appendicitis due to less pain and faster recovery. LA can be the choice of treatment in acute appendicitis, with utilization of re-useable and cheaper vascular sealing devices.

**Keywords:** Acute appendicitis, laparoscopic appendectomy, open appendectomy

## INTRODUCTION

The most common abdominal operation in the world is appendectomy (1) with a lifetime risk of 6% (2). Although laparoscopic approach has been reported to have diagnostic advantages especially in women, the role of laparoscopic management in acute appendicitis remains controversial. Open appendectomy that was first described by McBurney has long been applied as the gold standard procedure. With the widespread application of laparoscopy, more useful hand-tools were developed and it became possible to perform all gastrointestinal surgical procedures laparoscopically over time with increasing clinical experience.

Semm first described laparoscopic appendectomy (LA) in 1983; nevertheless, its superiority over open appendectomy (OA) is still being debated. Some investigators reported better results in LA when compared to OA (3, 4), while others determined that the clinical benefit obtained was inadequate, and emphasized that the technique had higher cost (5, 6). Currently, there is no consensus on whether LA should be routinely used or not.

In this study, we aimed to compare the clinical outcomes of patients who underwent LA and OA, and to determine the feasibility of LA in our country especially in terms of cost effectiveness.

## MATERIAL AND METHODS

Eighty-two patients who were admitted to the Istanbul Fatih Sultan Mehmet Training and Research Hospital, General Surgery Department with a preoperative diagnosis of acute appendicitis between April-July 2012 were enrolled in the study after obtaining both hospital ethics committee approval and patient consent. Nineteen patients who were either younger than 13 years or older than 65 years, class IV patients according to American Society of Anesthesiologists classification (ASA), those who have experienced abdominal pain for longer than 5 days, and those with a history of previous abdominal operation were excluded from the study.

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Teams experienced in laparoscopic and open surgical techniques performed all surgical procedures. Acute appendicitis was diagnosed with physical examination, laboratory and advanced radiologic methods when required. Study patients were randomized according to their study protocol numbers by using a randomization website that is serving through the internet, and 31 patients underwent LA, while OA was performed to 32 patients.

All patients were operated under general anesthesia and received preoperative antibiotic prophylaxis. Non-steroid anti-inflammatory drugs (NSAIDs) were used for analgesia. The abdomen was accessed by the McBurney muscle separation technique in patients undergoing open appendectomy. The appendix stump was double ligated with polyglycolic acid 2-0 sutures, and was not invaginated with purse-string sutures. All layers were closed with polyglycolic acid sutures. In patients who underwent laparoscopic appendectomy, the pneumoperitoneum was created by entering the abdomen with a Veress needle inserted through a 1 cm infra-umbilical incision, followed by one suprapubic 5-mm trocar and another 10-mm trocar at the intersection point of the right lateral border of the umbilicus and midclavicular line under direct camera view. Re-usable laparoscopic sets were used in all surgeries. The hand-tool introduced through the 5 mm trocar was used for positioning the appendix, while a vessel sealing and cutting apparatus was used for separating the mesoappendix through the other trocar. The appendix stump was ligated with a self-prepared knot using 2/0 polypropylene suture, appendectomy was performed and the appendix was extracted through the 10 mm port. The abdomen was explored for any additional pathology in all patients. The 10 mm trocar sites and the skin was closed with polyglycolic acid sutures. The extracted specimens were sent for pathological examination.

Patient age, gender, body mass index (BMI), anesthesia risk score (ASA), preoperative and postoperative C-reactive protein (CRP) level, white blood cell (WBC) count, duration of surgery, presence of complications, operative findings, length of hospital stay, histopathologic diagnosis, and visual analog scores (VAS) on the 1<sup>st</sup> post-operative day were recorded. The hospital operating system's account module was used to determine cost in both groups.

Patients were followed-up by phone calls at 1 week, 2 weeks and 1 month after surgery, and the time for returning to normal activities (i.e. their social life before surgery) was recorded. Patients were addressed questions like 'when did you get out of the house by yourself for the first time' and 'when did you perform your normal daily activities within home' to evaluate the exact time for returning to normal activities.

#### Statistical Analysis

Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) for Windows 15.0 program was used for analysis. Data were presented by using descriptive statistical methods (mean, standard deviation, frequency, percentage), and the comparison of qualitative data was performed by chi-square test.

Kolmogorov-Smirnov distribution test was used to examine normal distribution. For comparison of quantitative data between groups; the independent samples t-test was used for comparison of normally-distributed parameters, and Mann-Whitney U test was used for comparison of parameters that are not normally distributed. Inter-group comparison of parameters without normal distribution was performed by Wilcoxon signed rank test.

Results were evaluated in the 95% confidence interval and  $p < 0.05$  was set as significance level.

#### RESULTS

Within the study group of 63 patients, 28 were female (44.4%) and 35 were male (55.6%). Thirty-one patients underwent LA and 32 patients OA. 47 of the patients were ASA I; 14 were ASA II; and 2 were ASA III. The mean age was  $31.4 \pm 12.4$  years (min. 13 max. 63). There was no statistically significant difference between the groups in terms of patient demographic characteristics ( $p > 0.05$ ) (Table 1).

The decrease in WBC count after surgery in the group who underwent LA was statistically significant ( $p < 0.01$ ), while the decrease in WBC count after surgery in the group who underwent OA was not ( $p > 0.05$ ). In patients with LA and OA, the increase in postoperative CRP levels were statistically significant ( $p < 0.01$ ). There was no significant difference between the two groups in terms of duration of symptoms, operative time and length of hospital stay ( $p > 0.05$ ).

Wound infection and abscess were observed each in 2 patients (6.5%) in the LA group, but the differences between LA and OA groups was not statistically significant ( $p > 0.05$ ). The postoperative pain scores and time to returning to normal activities were significantly higher in the OA group as compared to the LA group ( $p < 0.01$ ).

There was no difference in the distribution of pathological findings between groups ( $p > 0.05$ ).

Table 1. Demographic properties of groups

Demographic properties	Laparoscopic appendectomy		Open appendectomy		p	
	Mean	SD	Mean	SD		
Age (years)	31.8	12.2	31.1	12.7	0.821	
Height (cm)	168.9	10.1	170.3	10.2	0.593	
Weight (kg)	74.1	14.1	73.3	14.9	0.831	
BMI (kg/m <sup>2</sup> )	25.9	3.97	25.3	4.16	0.789	
	n	%	n	%		
Gender	Male	14	45.2	21	65.6	0.102
	Female	17	54.8	11	34.4	
ASA	I	23	74.2	24	75	0.997
	II	7	22.6	7	21.9	
	III	1	3.2	1	3.1	

SD: standard deviation; ASA: American Society of Anesthesiology Score; BMI: Body mass index

There was a significant positive correlation at the level of 56.6% between duration of surgery and BMI in the LA group ( $p < 0.01$ ). In patients with LA, the operation time was increased parallel to an increase in BMI. There was no significant correlation between BMI and duration of surgery in patients with OA ( $p > 0.05$ ).

The average cost of patients was calculated as 1960.5±339.05 TL in the LA group, and as 687,115±159,5 TL in the OA group. Results are summarized in Table 2.

## DISCUSSION

Acute appendicitis is a pathology requiring emergent surgical intervention (1). However, the utilization of LA in this setting remains to be controversial (7). Currently, there is no consensus on the advantages and disadvantages of the laparoscopic technique over the open technique. While many retrospective and prospective studies reported less pain and shorter hospitalization and return to normal activities with LA, there are studies contradicting these findings and not supporting these benefits (8, 9).

Laparoscopic appendectomy was reported to be superior to OA in terms of diagnostic benefits, especially in young women (2, 3). Many surgeons argue that LA is not superior to OA, especially in men, and do not prefer LA. In a prospective randomized study, Tzovaras et al. (10) did not detect any advantage of LA in male patients along with a longer operative time. Nevertheless, LA has been shown to be superior in morbidly obese patients (4). This advantage is especially evident in the recovery period after surgery, but LA has been shown to take longer in obese patients as compared to patients with normal BMI (5, 6). In our study, evaluation of BMI and duration of surgery revealed that BMI increased operative time in LA. Possible reasons for this include the difficulty in introduction of the first trocar as compared to thin patients and the difficulty in identifying the anatomy due to increased intra-abdominal fat tissue. We believe that it may be useful to conduct new prospective studies that assess the operation time in patients with normal BMI and obese patients.

As determined in our study, there is less postoperative pain in LA as compared to open surgery. In a study by Ortega et al. (11), the linear analogue pain scores of 135 patients were recorded and the pain scores were found to be significantly lower in the LA group after blind randomization. The main reason for this difference may be disruption of the anatomy by the muscle separation technique more as compared to a 10 mm trocar incision.

It was reported that patients undergoing LA show better recovery after surgery (2). Reduced trauma to the abdominal wall is an important reason for the reduced post-operative discomfort. The decreased distortion of abdominal muscles and consequent early mobilization also decrease the risk of complications such as pneumonia and embolism. In a multicenter prospective study, Hellberg et al. (12) emphasized that patients with LA showed a much faster recovery after surgery than patients with OA. Hong-Bo Wei et al. (13) found that pa-

Table 2. Laboratory results, duration of symptoms and operation, length of hospital stay, pain scores, time to return to daily activities and cost

	Laparoscopic appendectomy		Open appendectomy		p
	Mean	SD	Mean	SD	
Preoperative WBC	15864.5	5704.2	15096.9	4166.8	0.665
Postoperative WBC	13425.8	5374.0	14018.8	4429.0	0.445
Preoperative CRP	3.80	4.48	3.63	3.62	0.788
Postoperative CRP	6.54	5.75	6.33	5.08	0.929
Symptom duration (hour)	29.77	21.53	27.97	20.52	0.732
Operation duration (minute)	41.42	10.32	46.25	18.84	0.386
Length of hospital stay (day)	1.40	0.84	1.50	0.67	0.256
Postoperative VAS	1.61	0.95	2.78	1.29	<0.0001
Return to daily activities (day)	5.06	2.31	8.06	2.15	<0.0001
Cost (TL)	1960.5	339.05	687.1	159.5	<0.0001

SD: standard deviation; WBC: white blood cell; CRP: C reactive protein; VAS: visual analogue score

tients who underwent LA had a shorter time to return to normal daily activities as compared to those with OA. However, Kocataş et al. (14) did not detect a difference in postoperative pain scores, length of hospital stay, and quality of life scores between open and laparoscopic methods in uncomplicated appendicitis. In our study, the postoperative time to returning to normal activities was significantly higher in the OA group than in the LA group.

The risk of wound infection is lower in LA as compared to OA. In a randomized meta-analysis including 2877 patients, wound infection was significantly less in the LA group (15). On the other hand, Rohr et al (16) reported more frequent wound infections in the LA group. In our study, wound infection was detected in 2 patients (6.5%) in the LA group, but the difference between LA and OA groups was not statistically significant. The wound infection developed at the trocar site where the appendix was removed in both of these patients. The underlying cause may be contamination of the skin while extracting an enlarged appendix that did not fit within the trocar. In such cases, the appendix may be removed within a protective bag, in order to reduce wound infection risk.

Some studies demonstrated that the rate of intra-abdominal abscess increased with LA in patients with perforated appendicitis (17-21). A recent meta-analysis has reported that the likelihood of intra-abdominal abscess was higher in OA as compared to LA (22). In our study, symptomatic intra-abdominal collection developed in 2 patients (6.5%) in the LA group, and they were both treated with percutaneous drainage.

The operation time has been shown to be significantly longer for LA (8, 23, 24). The learning curve is suggested to be

the main reason. Currently, the learning curve for LA is stated as at least 20 cases (25). In our cases, the operative time was shorter in the LA group, but the difference between the two surgery groups was not statistically significant. This situation may be due to the fact that our team has enough experience with LA.

C-reactive protein is an important tool in the laboratory diagnosis of acute abdominal pain, and the level of appendix inflammation may be monitored with changes in CRP levels. It might even help in the decision-making process of either conservative management or surgical treatment in selected patients (26, 27). CRP is useful in evaluating surgical stress. In one study, CRP and IL-6 levels were evaluated in venous blood samples 12 hours after OA and LA in children, and it was identified that CRP levels significantly decreased in the LA group as compared to OA group (28). The abdominal organs do not come into contact with atmospheric air in LA, therefore the heat loss is less and the acute phase response is minimal (29). Tsugawa et al. (30) conducted a study in cirrhotic patients by evaluating CRP levels at the 1<sup>st</sup>, 3<sup>rd</sup> and 7<sup>th</sup> postoperative days and reported that CRP levels were significantly lower in the LA group as compared to the OA group. In our study, the postoperative decrease in WBC count was significant in the LA group, while the postoperative decrease in WBC count did not reach statistical significance in the OA group. The postoperative increase in CRP levels was found to be statistically significant in both the LA and OA groups. Based on these findings, it may be suggested that the decrease in WBC count may be used as a marker to evaluate the speed of recovery in patients undergoing LA. The lack of significant association between groups in terms of increased CRP levels in both groups may suggest that both surgical techniques cause similar inflammatory effects in the body. However, combinations of different laboratory and clinical variables can be more effective in demonstrating the degree of surgical stress.

Memişoğlu et al. (31) examined the value of clinical, laboratory and radiological studies in the diagnosis of acute appendicitis, and reported the negative appendectomy rate as 27% in female and as 11.5% in male patients. Diagnostic laparoscopy that is a natural step in LA can decrease these rates as well as enabling diagnosis and treatment of the main pathology.

It was emphasized in various studies that LA increased cost (32). The hand tools are accepted as the main reason for this cost increase. Various techniques have been tried to reduce cost such as one or two trocar techniques (33) or ligation of the appendix stump by instruments (34). We used a kit specially prepared for LA. This set contained reusable trocar and tools. Along with this set, we used self-prepared loops from 2.0 polyglycolic acid instead of ready-to-use knots in an effort to reduce the cost further. The evaluation of average cost in both groups revealed that the difference was created mainly by vascular closure and sealing devices. According to the Health Practice Directory (*Sağlık Uygulamaları Tebliği- SUT*), the reimbursement package price for OA is 674.54 TL and is 1146.71 TL for LA in our country. Excluding the cost of vessel sealing devices, LA seems to be more advantageous in terms of fi-

nance. However, despite efforts to reduce all costs, payments in the treatment of acute appendicitis remain well below the expenses in both the OA and the LA group.

## CONCLUSION

Laparoscopic appendectomy is an effective method in the treatment of acute appendicitis in experienced hands due to advantages such as less pain and faster recovery. Its additional diagnostic and therapeutic advantages cannot be ignored in suspicious cases. We believe that with the utilization of re-useable and cheaper vascular sealing devices parallel to advances in technology, LA may become the choice of treatment in acute appendicitis.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of Istanbul Fatih Sultan Mehmet Training and Research Hospital.

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

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