

Laparoscopic versus Open Appendectomy: Results of a Retrospective Comparison in an Israeli Hospital

Jochanan G. Peiser MD MPH^{1,2} and Dan Greenberg MSc²

¹ Medical Management, Soroka University Medical Center, Beer Sheva, Israel

² Department of Health Policy and Management, Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel

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Abstract

Background: Acute appendicitis is one of the most common conditions requiring surgical intervention. Open appendectomy has been a safe and effective operation for acute appendicitis for more than a century. Recently, several authors proposed that the new technique of laparoscopic appendectomy should be the preferred treatment for acute appendicitis. However, unlike laparoscopic cholecystectomy, LA has not yet gained popularity.

Objectives: To compare open with laparoscopic appendectomy for length of operation, complications, postoperative pain control, length of hospitalization, and hospital costs.

Methods: A sample of 194 patients who underwent OA and LA during 1995 was randomly selected for the study. Patients' demographic data, preoperative laboratory and physical values, histopathologic diagnosis of removed appendix, mean operating time, length of hospitalization, and postoperative pain control and complications were reviewed.

Results: Acute appendicitis was confirmed in 66% of patients. The groups were similar demographically (gender and mean age). We could not find any statistical differences in intraoperative and postoperative complications and use of antibiotics. The operative time was longer in the OA group (62.4 vs. 57.3 minutes), but the difference was not statistically significant ($P=0.075$). The hospital stay was 2.5 days in the LA group and 2.7 days in the OA group. Higher operative costs were observed in the LA group.

Conclusion: Laparoscopic appendectomy is comparable to open appendectomy with regard to complications, length of operation, hospital stay, but it is more costly. Laparoscopic appendectomy does not offer any significant benefit over the open approach.

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Acute appendicitis is one of the most common conditions requiring surgical intervention and afflicts one in seven individuals. The disease may occur at any age, but predominantly presents in the second and third decades. Open appendectomy has been a safe, effective operation for acute

appendicitis for more than a century. Laparoscopic appendectomy was first performed by Semm in 1982 [1] who conducted the procedure on a normal appendix [1]. Pier and co-workers [2] published the first large series of laparoscopic appendectomies for acute appendicitis in 1990. They demonstrated that LA could be applied in most cases of appendicitis, with a high degree of success and operative speed and low complication rate compared to traditional open appendectomy. Since then, numerous retrospective and prospective randomized controlled trials have compared open with laparoscopic appendectomy. Although some of the randomized trials concluded that the LA is superior to OA, others did not find either method to be uniformly better [3].

The advantages of LA over OA are not as obvious as the advantages of laparoscopic cholecystectomy over open cholecystectomy, and the role of laparoscopy in the treatment of acute appendicitis is still controversial. Most of the criticism has focused on the increased technical difficulty and higher hospital costs, which have not yielded any significant improvement in the length of hospital stay or patient recovery.

Further research is needed to determine the safety, efficacy and long-term effects of LA relative to the traditional approach. The present study compared the outcomes of LA and OA performed in an Israeli hospital setting. The aim of this preliminary study, which to the best of our knowledge is the first in Israel, is to help medical decision-makers decide which of the two approaches is preferred.

Patients and Methods

Patients

One hundred patients (of 239) who underwent OA and 94 (of 186) who underwent LA at Soroka University Medical Center between January 1995 and December 1995 were randomly selected for the study. Ten of these patients (5%) were finally excluded from the analysis. The most common reason for their exclusion was failure to find their medical records or operating room data sheets. The total study group comprised 139 men and 45 women with a mean age of 32 years: 71 men and 26 women (mean age 32.8) in the OA group, and 68 men and 19 women (mean age 31.2) in the laparoscopic group. The patients' demographic data are presented in Table 1. Patients were assigned to open or laparoscopic appendectomy according to the surgical department (A or C) on duty. Each of these

LA = laparoscopic appendectomy

OA = open appendectomy

departments is on duty on alternate days. OA patients were assigned to department A and LA patients to department C.

OA and LA techniques

The technique of OA involves use of a standard transverse or McBurney right lower quadrant incision. The laparoscopic procedure involves the removal of the appendix through a minimal skin incision and under direct visualization through a video camera inserted into the abdominal cavity.

Data source and parameters for comparison

Laparoscopic and open appendectomies were compared according to the following parameters: data obtained from emergency department files, including patient's age and gender; preoperative laboratory and physical values (i.e., pulse, body temperature); date and time of arrival; and type of insurance. Data obtained from operating room protocol data sheets indicated the intraoperative diagnosis and complications. The length of operation, which equals the time that the operating room was occupied with the patient, was defined as the time from the patient's entrance into the operating room until his or her removal to the post-anesthetic care unit. Data on the length of hospital stay (from emergency department admission to hospital discharge), histopathologic diagnosis of removed appendix, preoperative and postoperative use of antibiotics, and postoperative pain and medications given to treat it, were obtained from the hospital's medical files. Postoperative complications (e.g., wound infection, vomiting, intraabdominal abscess) and postoperative clinic examination results (obtained from outpatient clinic files) were also included in the analysis.

Statistical methods

The data obtained were analyzed using Student's *t* test for the means, and a chi-square or Fisher exact test for testing proportions. The calculations were done using SPSS. The actual probability value is presented, unless there was no statistical significance. Statistical significance was set at $P < 0.05$.

Results

Patients

A total of 184 patients (out of 194) were finally enrolled in the study (87 in the laparoscopic and 97 in the open surgery group). The most common reason for patient exclusion was the failure to find patients' medical records. The ages of the patients ranged from 16 to 77 years with an average age of 32 (± 12.9) years and median age of 29.5. With regard to gender, 139 of the patients (75%) were men and 45 were women (25%).

Preoperative laboratory and physical values

Laboratory and physical values were obtained on the patient's admission to the emergency ward. We could not find significant differences in body temperature, pulse measures and white blood cell count between the two surgery groups. Preoperative laboratory and physical values are presented in Table 2.

Operating time

The mean (SD) operating times in the LA and OA groups were

Table 1. Patients' demographic characteristics

	Laparoscopic appendectomy (n=87)	Open appendectomy (n=97)	P
Gender (male/female)	68/19	71/26	NS
Age (average years)	31.2	32.8	NS

NS = not significant

Table 2. Preoperative laboratory and physical values

	Laparoscopic appendectomy (n=87)	Open appendectomy (n=97)	P
Body temperature			
Oral	37.17	37.04	NS
Rectal	37.86	37.73	
Pulse rate	90	89	NS
White blood cell count	11,471	12,423	NS

NS = not significant

57 min (16.9) and 62 min (21.8), respectively ($P = 0.075$). However, the median operating times were equal in both groups (55 min). The mean operating time in patients with inflamed appendices was similar to that in patients with a normal appendix.

Histopathologic diagnosis of removed appendix

Data on the histopathologic diagnosis of the removed appendix was available for 182 patients (87 for laparoscopic and 95 for open surgery patients). A total of 121 (66%) appendices were inflamed (including suppurative, gangrenous and perforated appendix). The rate of normal appendices was similar using both surgical approaches. However, we found a normal appendix in 44% of women undergoing appendectomy compared to only 30% in men ($P = 0.073$).

Complications

Patients' admission charts as well as files from the outpatient clinic were reviewed by one of the authors (J.P.). Intraoperative and postoperative complications are presented in Table 3. In one patient in the LA group the laparoscopic trocar perforated the small bowel, and this was considered the only intraoperative complication. One trocar site hemorrhage was encountered in this group. In both groups, conditions like wound infection, abdominal abscess and prolonged paralytic ileus were considered postoperative complications. There were two re-admissions in the OA group and five in the LA group (one patient needed two re-admissions), resulting in 5 hospital days and 21 days, respectively.

Outpatient clinic follow-up

Only 109 patients (59%) were examined in the hospital's outpatient clinics after hospital discharge. The compliance rate was similar in both groups. Five postoperative complications were encountered and treated in the outpatient clinic and did not require inpatient care. Two mild wound infections and one stitch abscess were seen among the LA group patients, and one

Table 3. Intraoperative and postoperative complications

	Laparoscopic appendectomy	Open appendectomy
Intraoperative complications	Perforation of the small bowel (1), trocar site hemorrhage (1*)	–
Postoperative complications	Intraabdominal abscess (3), major scrotal hematoma (1*)	Wound infection (6) Urinary tract infection (2), prolonged paralytic (adynamic) ileus (1)
Outpatient	Mild wound infection (1), stitch abscess (1)	Mild wound infection (2), stitch abscess (1)
Re-admission (No./total days)	5 (21 days)	2 (5 days)

Numbers in parentheses represent the number of patients.

* One patient required two re-admissions. This patient suffered from trocar site hemorrhage, as well as intraabdominal abscess and scrotal hematoma.

Table 4. Summary of results

	Laparoscopic appendectomy (n=87)	Open appendectomy (n=97)	P
Mean operating time (min)	57.3	62.4	0.075
Mean length of hospitalization (days)	2.5	2.7	NS
Appendix diagnosis			
Inflamed	56 (64%)	65 (68%)	NS
Normal	31 (36%)	30 (32%)	
Intraoperative complication	2(2.3%)	0 (0.0%)	NS
Postoperative complication*	5 (5.7%)	9 (9.3%)	NS
Use of antibiotics (cost in shekels)			
Preoperative	12.3	11.0	NS
Postoperative	60.5	67.9	NS
Use of postoperative analgesia (cost in shekels)	5.1	8.4	<0.001
Operating room materials and equipment	\$300 more than OA	–	

* Only complications that resulted in inpatient care. NS=not significant

mild wound infection and one stitch abscess in the OA group. These conditions were treated topically with EUSOL (Edinburgh University solution) irrigation and dressing.

Preoperative and postoperative use of antibiotics

In both groups about 98% of the patients were treated prophylactically with antibiotics. Gentamicin and metronidazole were given about 30 minutes prior to surgery. Following surgery 89% of patients were treated with antibiotics. Some were given only one postoperative dose, while in others the prophylactic antibiotic was converted into a therapeutic dose for the treatment of the infectious process found during surgery. Statistical significance correlation was found between the intraoperative diagnosis of the removed appendix and administration of antibiotic drugs following surgery ($P < 0.01$).

Postoperative use of analgesia

We evaluated the costs of postoperative pain control medications. Patients in the LA group received mostly diclofenac

suppositories, while patients in the OA group were treated with meperidine injections given intramuscularly. The average cost is presented in Table 4.

Length of hospital stay

There was no significant difference in length of hospital stay between the two surgery groups. The average time to discharge was 2.5 days for the laparoscopic group and 2.7 days for the open appendectomy group.

Discussion

Recently, several authors have proposed that the advantages of using laparoscopy for the treatment of cholelithiasis could be extended to treat appendicitis [4,5]. These authors believe that LA should be the preferred treatment for appendicitis because of the predicted similar morbidity and mortality, decreased hospital stay, earlier return to normal activity, and decreased negative appendectomy rate. Although predating laparoscopic cholecystectomy by 4 years, LA has not gained the same widespread popularity and enthusiasm, even though an increased number of surgeons are becoming comfortable with the LA technique and some authors have even suggested LA as the new "gold standard."

The interest of surgeons in laparoscopic procedures has grown remarkably in recent years, mainly due to the spectacular success of laparoscopic cholecystectomy. However, by virtue of its small incision, OA is already a type of minimal access surgery, and any advantage to LA is likely to be small and difficult to prove [3].

In a recently published paper [6], Johnson argues that any new surgical procedure must be shown to have one or more of the following advantages, especially when there is a tried and safe alternative. Possible advantages are its safety (fewer complications, reduced morbidity and mortality rates), ease in performance, and rapidity (operating time); it assures a speedier recovery with a shorter hospital stay, is cheaper, more cosmetic, and does not require general anesthetic. The results of a meta-analysis comparing LA and OA [3] suggested that LA results in significantly less postoperative pain, early resumption of solid foods, a shorter hospital stay and a faster return to normal activities. For the hospital, the costs of LA are significantly higher than of the conventional approach, but this expense could be offset, from the societal perspective, by an earlier return of patients to normal productive life.

The findings of our study could not show any significant advantages of the laparoscopic over the open approach. LA is not easier, quicker or safer, nor does it obviate general anesthesia. Furthermore, the operating room costs for LA are considerably higher than for OA. LA patients presented with a higher incidence of complications following surgery, and major differences were observed in the severity of complications between LA and OA patients. The most frequent complication in the OA group was wound infection, while LA patients suffered from intraabdominal abscesses. The higher severity of complications following LA resulted in a greater need for re-

admissions. Similar findings were reported in other studies. Golub et al. [3] found a higher incidence of complications excluding wound infections and intraabdominal abscesses in LA compared with OA patients (18% and 13% respectively), although these differences were not statistically significant.

The mean operating room time in our study was defined as the entire period the patient was in the operating room and not from the point of skin incision to closure. Somewhat surprisingly, our findings do not support those of most authors for operating room times (i.e., LA takes longer to perform). These findings could not be explained by differences in patient characteristics (i.e., age, gender, and appendix classification). Since the patients were assigned to open or laparoscopic appendectomy according to the surgical department on duty, different surgeons carried out each procedure. OA compared with LA is a relatively common and easy procedure and was frequently performed by surgical residents or physicians in their internship. Moreover, LA has been performed in our medical center since 1992. It is possible that all staff surgeons are well acquainted with laparoscopic surgery and have reached the top of their "learning curve," compared with the situation in other series where surgeons may be less familiar with this technique. Furthermore, the median operating room occupancy was similar in both groups, indicating that mean operating times for OA patients were affected by few relatively time-consuming procedures.

Almost all studies found that LA patients have less postoperative pain and discomfort. These randomized prospective studies usually used visual analog scales and other tabulated doses or days of narcotic use to record pain and pain control. Since our study was a retrospective one, we were not able to use visual analogue scales to assess the degree of pain and discomfort. However, our findings are in agreement with those of other studies that LA patients needed significantly less analgesia, suggesting that they suffered less pain and discomfort.

Most studies showed a shorter hospital stay following LA. Our study recorded a non-significant shorter stay for LA patients. However, differences in hospital stays to some extent reflect differences in healthcare systems. The Israeli hospital system cannot necessarily be compared with that of the U.S. or any other system, mainly because different patterns of medical practice and financial incentives are given to hospitals. For example, hospitals are reimbursed for cholecystectomy on a diagnosis-related group basis, as compared to a per diem basis for appendectomy.

A serious drawback of LA compared to OA is its relatively higher cost, mainly because of the longer operating room time and expensive disposables used. We found that from the hospital perspective, performing LA incurred about \$300 extra costs.

Conclusions

Laparoscopic surgery has proved to be an invaluable technical development for surgeons. Laparoscopic cholecystectomy has become an acceptable alternative to the open procedure and

the rate of its adoption by surgeons is almost 100%. However, other laparoscopic approaches for management of abdominal diseases have not proven easier, quicker, cheaper or safer, nor do they avoid general anesthesia. The procedure may lead to a slightly shorter initial hospital stay, but re-admissions for complications, their costs to the hospital and their effect on patients' quality of life must be added. Furthermore, the time that patients remain in hospital after open procedures is continuing to decline. While the laparoscopic approach is more cosmetic, the differences may not concern most patients. Moreover, the "laparoscopic revolution" has made surgeons more aware of the size, position and cosmetic closure even when they perform open surgery.

In general, our results support the concept that LA is feasible and safe for a routine acute appendicitis and perforated appendicitis. Minimally invasive surgery is one of the most important innovations that may reduce hospital stay. From an economic point of view, this is desirable because each procedure becomes cheaper, mainly due to a shorter hospital stay and an earlier return to normal activities. However, from the Israeli healthcare system's stance and the current system of hospital reimbursement, it would be an unwise decision to perform laparoscopic appendectomies. Hospitals are compensated on a per diem basis (currently about \$400); therefore, an earlier discharge and higher surgery cost in LA patients could negatively affect hospital revenues. From the societal point of view, the cost-effectiveness of laparoscopic procedures improves when they result in a quicker return to normal activity (household, work). However, the type of work and the employment conditions will determine whether a patient returns to work sooner or later. Further study controlling for patients' profession or type of work is needed to determine whether the laparoscopic approach is better.

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Correspondence: Dr. J.G. Peiser, Medical Management, Soroka University Medical Center, Beer Sheva 84101, Israel.

Phone: (972-8) 640-0688/3346

Fax: (972-8) 640-3335

email: jpeiser@bgumail.bgu.ac.il