

Is Laparoscopic Appendectomy a Safe Procedure?

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Background: Laparoscopic appendectomy (LA) is a common procedure, considered to be a safe alternative to conventional open appendectomy (OA). LA is known to reduce parietal scarring, offers a shortened hospital stay and an earlier return to normal activities. Acute gangrenous and perforated appendicitis may be associated with an increased risk for postoperative complications following laparoscopic appendectomy.

Objective: To determine the complication rate following LA.

Material and methods: Between January 2000 and November 2003, 323 consecutive emergency appendectomies were performed (311 LA, 5 OA and 7 conversions). A retrospective analysis of LA was performed with evaluation of complication rate (fever, pain, intra-abdominal infection or abscess and abdominal wall infection), duration of preceding symptoms, interval between admission and operation, length of the operation, whether the performing surgeon was a resident or a senior surgeon, and the length of hospital stay (LOS).

Results: Two hundred patients (64.3%) were males and mean age was 35 years. Mean waiting time for surgery was 9.4 hours, mean operating time 48 minutes and conversion rate was 2.2%; mean LOS was 3.05 days. Histology showed acute inflammation in 81% (acute appendicitis in 54.34%, phlegmonous appendicitis - 17.36%, perforated or gangrenous appendicitis - 9.00%). There was a 10.6% overall incidence of infectious complications, 9.64% of readmissions and mortality was 0.

Conclusions: It appears that in the current study, the overall complication rate following LA is higher than expected, and tends to be even higher for complicated appendicitis. This needs further evaluation.

Keywords: laparoscopic appendectomy, complications

Introduction

The value of laparoscopic appendectomy (LA) is widely debated, although several trials have shown some advantages of LA over open appendectomy (OA). Since 1983, when laparoscopic appendectomy had been introduced by Kurt Semm [1], numerous retrospective studies, as well as several prospective-randomized studies published to date, have concluded that the laparoscopic technique is at least as good as OA, in adult as well as in pediatric populations. LA offers considerable advantages over OA, primarily because of the reduced rate of wound infections and shortened recovery times. The laparoscopic procedure has an important role in diagnosis and treatment of right lower quadrant pain in young women at child-bearing age or in overweight patients [2-5]. Other reports lead to skeptical conclusions showing longer operating time, more intraoperative injuries, more complications and higher total costs [6,7].

The indications for LA are ill-defined, particularly when looking at cases of complicated appendicitis [8]. On the other hand, it is already well established that OA has excellent results with a minimal morbidity rate (overall complication rate – 5.2%, wound infection – 2.5%, intra-abdominal abscess – 0.38% and mortality 0.08%) [9]. Nevertheless, there is a growing use of the laparoscopic approach in emergency situations for diagnosis and for definitive treatment of these conditions [10]. Complicated appendicitis, defined as acute appendicitis associated with perforation or intra-abdominal abscess (IAA) at time of in-

tervention, may affect a large proportion of the patients. Only a few retrospective studies have been published which analyzed the use of LA in complicated appendicitis [11]. In these studies there is a variable difference (from 1 to 24%) regarding the rate of intra-abdominal abscess as a function of severity of appendicitis [12-14].

Our department of surgery has an extensive experience in advanced laparoscopic procedures. Therefore we were at loss to explain the reason for the high rate of readmissions following LA. The current study was designed to retrospectively analyze the outcome of laparoscopic appendectomies performed during a 4-year period. The main purpose of the study was to establish the rate of complications following laparoscopic appendectomy.

Material and methods

The records of all patients who underwent emergency appendectomy (laparoscopic, laparoscopic converted to open or open) during a 4-year period (January 2000 to December 2003) were retrospectively analyzed.

Data collection

All patients' charts that underwent appendectomy during a four years period were retrospectively reviewed. The analyzed data included demographic details, patients' complaints and symptoms at the time of admission to the ER, length of symptoms before admission, body temperature and laboratory findings upon admission, length of hospital stay (LOS) and imaging studies (when used – CT/US).

Surgery-related data included waiting time to surgery, duration of surgery, the operating surgeon (whether a senior surgeon or a resident assisted by a senior surgeon), use of an endo-bag and/or an intraperitoneal drain, pathological diagnosis and characteristics of intraoperative (including anesthetic) and postoperative complications. Readmission after appendectomy due to objective findings or patients' complaints was considered as a postoperative complication. Minor complaints or signs, as mild pain or mild cellulitis, were treated on an ambulatory basis and were not included.

Surgical procedure

Before surgery all patients received broad-spectrum antibiotics based on each patient's renal function (ampicillin, metronidazole and gentamicin for creatinine < 1.5mg/dl or cefuroxime and metronidazole for creatinine >1.5mg/dl). This preoperative dose was followed by 2 more doses after surgery in non-complicated cases. In complicated cases (defined as gangrenous or perforated with or without abscess or peritonitis) the patients were treated with antibiotics for 5–10 days.

Laparoscopic appendectomy was performed by a standardized technique. Following establishment of pneumoperitoneum of 15 mm Hg, a 10 mm trocar was inserted at the umbilicus and two additional 5 mm ports (or one 5mm port and one 10 mm port) were introduced under vision at the left lower quadrant. Transection of the appendiceal mesentery and adhesions was performed using bipolar electrocautery. The appendix was transected at its base after ligation with an Endo-Loop® PDS II® (Ethicon, Inc. Somerville, NJ, USA). Trying to avoid contamination of the abdominal wall, according to the surgeon's decision, the appendix was extracted through one of the 10 mm trocars with or without an endo-bag (Trupharm medical supply LTD, Taipei, Taiwan). At the surgeon's discretion, the peritoneal cavity was irrigated following removal of the appendix and/or an intra-peritoneal 7 mm flat silicone drain was inserted.

A normal appendix was not resected whenever any other gross pathology was found during laparoscopy. These patients were not included in the current study.

Anesthesia was induced in a rapid sequence manner with propofol and succinylcholine and was maintained with sevoflurane, nitrous oxide in oxygen 60%–40% and aliquots of fentanyl. Muscle relaxation was achieved with rocuronium. Patients were ventilated in a volume control

mode with a tidal volume of 6–7 mL/Kg and a respiratory rate of 10–16 breaths/min, aiming to maintain an end-tidal CO₂ value of 30–40 mmHg.

Postoperative pain was prevented by intraoperative administration of tramadol and dipyrone and managed postoperatively by aliquots of IV morphine as required. Metochlopramide or ondansetron was given intraoperatively to prevent postoperative nausea and vomiting. A balanced lactated Ringer's solution was used for fluid replacement as dictated by the patient's hydration status.

Statistical analysis

The data were introduced into a database and analyzed with SPSS 10.0 for Windows (SPSS, Inc., Chicago IL). The categorical variables were compared by Fisher's exact test, continuous variables by t-test and ANOVA was used for analysis of categorical, non-continuous data of 3 or more groups.

Results

From January 2000 until December 2003, three hundred and twenty three consecutive emergency appendectomies were performed – 311 laparoscopic, 5 open and 7 conversions (most of them due to adhesions). Only patients who underwent LA were included for further analysis. There were 200 males (64.3%); the mean age was 36 years. (range 14–83; median – 30). Duration of symptoms before admission was 1 day (mean; range 0–7 days; median – 12 hours). (Additional data are shown in table I).

Whenever the clinical diagnosis was not obvious, imaging studies were used. In 39 cases (12.5%) a CT scan was performed that was normal in 2 cases (5.13%), showed a tubular structure in the right lower quadrant (RLQ) in 23 cases (58.97%), an abscess in the RLQ in 6 cases (15.4%), a small bowel obstruction (SBO) in 3 cases (2.7%) and a local infiltration of the cecal region in 4 cases (10.26%). In another 24 cases an US was performed that was normal in 12 cases (50%), presented a tubular structure in RLQ in 10 cases (41%), and in 2 cases (8.33%) a collection was discerned in the RLQ.

Waiting time for the surgery ranged from 20 min to 72 hours (mean – 9.4 hrs; median – 7 hrs). Surgery time itself ranged from 30 minutes to 2 hours (mean 40 mins; median – 50 mins). Following surgery all patients

Table I. Pre-operative, operative and post-operative details

	Min	Max	Mean (Median)	SD
Symptoms duration (days)	0	7	1.01 (0.5)	1.53
Temperature (°C)	35.7	39.6	37.176 (37.0)	0.797
WBC (x 10 ³ µl)	3.9	28.7	12.696 (12.200)	4.162
Time to surgery (hours)	0.30	72.00	9.4105 (7)	8.7819
OR time (hours)	0.30	2.00	0.8364 (0.833)	0.3106
Antibiotic treatment	1	18	3.05 (1)	3.49

Table II. Patients' age, drainage and complications Vs pathology

Pathology					
Age					
< 25 (n = 114)	26	68	16	4	p = 0.003
25–45 (n = 111)	19	64	20	8	
> 45 (n = 86)	15	37	18	16	
Total (n = 311)	60	169	54	28	
Drainage					
Yes (n = 103)	8	46	29	20	p = 0.004
No (n = 208)	52	123	25	8	
Complications					
Yes (n = 33)	4	18	5	6	p = 0.003
No (n = 279)	56	151	49	22	

Table III. Pathological results

	311 patients
Normal	60 (19.29%)
Acute	169 (54.34%)
Phlegmonous	54 (17.36%)
Perforated/Gangrenous	28 (9.00%)
Carcinoid	3 (0.96%)
Diverticulitis	6 (1.93%)
Parasites	4 (1.28%)
Crohn's disease	1 (0.32%)

1 case with associated parasites, 1 case with associated diverticle. 1 case with associated carcinoid, 2 cases with associated parasites, 2 cases with associated diverticulitis. 1 case with associated carcinoid, 1 case with associated parasites, 1 case with associated diverticulitis. 1 case with associated carcinoid, 2 cases with associated diverticulitis, 1 case with associated Crohn's disease.

received broad spectrum antibiotics for a mean period of 3.05 days (range 1-18), based on the clinical judgment of the surgeon related to the severity of inflammation. This period includes the antibiotics that the patient received after discharge from hospital (Table 1). Patients were discharged if there were no complaints, for at least 24 hours, with normal body temperature, normal WBC and normal bowel movements. LOS ranged from 1 to 16 days (mean – 3.6; median – 3).

During the operation an endo-bag was used in 27 cases and a drain was introduced in 103 cases (31.89%). There were significantly more drainage insertions in advanced cases ($p = 0.004$), most of them in the perforated appendicitis group (Table II).

Most operations were done by residents (78.5%), with the assistance of a senior surgeon; all other cases were performed by the senior surgeon. It was impossible to evaluate precisely the rate of intra-operative irrigations, as this detail was missing from most operative reports.

The pathology of the appendix was described as acute inflammation in 169 cases (54.34 %), phlegmonous in 54 (17.36%), perforated or gangrenous appendicitis in 28 (9%) and normal appendix in 60 cases (19.3%). An additional pathology of the appendix was found in 14 cases (Table III).

Thirty-three patients had a complication (10.6%), 30 of them were readmitted. In 3 patients the complication was diagnosed during the first hospitalization and caused prolongation of the hospital stay. The symptoms and complications are shown in Table IV. A CT scan was performed in 25 cases, and in 10 cases peritoneal infiltration was described, an IAA was diagnosed in 7 and wound infiltration in 1 case.

Complications were more frequent in cases of complicated appendicitis ($p=0.003$) (Table 2), and in older patients, and affected 16.4% of patients older than 45 years ($p=0.005$). In addition there was a correlation with the length of antibiotic treatment ($p=0.001$) (Table 5). The complications had no correlation with the length of the first hospitalization, use of drains or the use of an endo-bag. There were no complications related to anesthesia and there were no third admissions.

Table IV. Characteristics of complications

	No. of patients (%)	% of total
Complications	33	10.6
Pain	17 (56.67)	5.4
Fever	18 (60)	5.8
Wound infection	5 (16.67)	1.6
Intra-abdominal abscess	7 (23.34)	2.3
Leak	1 (3.33)	0.3
SBO	1 (3.33)	0.3
CT Findings	25 patients	
Infiltration	10 (40)	
Abscess	7 (28)	
Intra-abdominal fluid	3 (12)	
Wound infiltration	1 (4)	
Leak	1 (4)	
SBOe	1 (4)	
No finding	2 (8)	
Time to readmission		
0-7 days	19	
8-14 days	8	
>15 days	6	
Treatment		
Antibiotics	29 (87.87)	
Reintervention	3 (9.09)	
Drainage	6 (18.18)	

Small Bowel Obstruction; 3 cases with associated intra-abdominal fluid; 1 case with associated wound infiltration and 1 case with prolonged first admission; Including 3 cases with prolonged first admission.

Twenty-nine patients with a complication were treated with antibiotics (87.87%). In 3 cases a reintervention was performed (for SBO, intestinal leak or intra-abdominal abscess); percutaneous - CT guided drainage was used in another 6 cases (Table V).

Discussions

Published data regarding the incidence of post-operative infections following LA vs. OA are controversial. Several studies showed that LA, performed for complicated appendicitis, was associated with higher rates of postoperative intra-abdominal abscesses (IAA) in children [12,15–17] as well as in adults (5% vs. 1%, and 11% vs. 2.9%)[18,19], when compared to OA. Other authors found no such differences and LA was not associated with a higher complication rate, even with perforated appendicitis [20,21]

An analysis of twelve randomized, controlled trials failed to detect a clear difference between LA and OA in this regard. This was mainly due to different outcomes in positive trials or flaws in the negative ones [11]. A meta-analysis of 17 trials, published later, found that LA offered significant improvement in postoperative outcomes at the cost of a longer operation. LA was associated with a reduced wound infection rate, but seemingly a double rate of IAA [22]. A Cochrane systematic review included 54 studies, of which 45 compared LA to OA. The rate of wound infections was smaller after LA than after OA, but the incidence of IAA was 2.5 times higher after LA [23].

Other smaller studies found a high rate of IAA following LA in patients with perforated appendicitis, although this difference didn't always reach a statistical significance

Table V. Patients' age, drainage and antibiotics Vs complications

Complications	Yes	No	
Age (years) (n = 311)			
< 25	9	105	p = 0.05
25–45	10	101	
> 45	14	72	
Drainage (n = 103)			
Yes	12	91	p = 0.44
No	21	187	
Antibiotic treatment			
≤ 3 days	16	216	p = 0.001
≥ 4 days	17	62	

[24]. One study reported an overall complication rate of 9.3%, similar to our results [25]. The infectious complications were much more frequent in the LA, and reached 17.6%. Phillips et al analyzed their experience over ten years in children undergoing LA. They found an overall decrease in the incidence of IAA in children with perforated appendicitis; thus emphasizing the importance of experience, in performing LA [26].

Most recent studies found a similar rate of IAA following LA and OA, with a higher rate of wound infections following OA [27–38]. Despite these results, not all published studies concluded that LA should be recommended to every patient. This hesitation was mainly attributed to a tendency towards longer operative time and higher costs. One group that found similar rates of IAA concluded that LA does not offer significant advantages over OA. On the other hand, the same group came to a different conclusion in a subsequent study, stating that LA should be considered as the first-line approach for all patients with acute appendicitis, from a hospital utilization point of view [39,40].

Antibiotics are considered beneficial in reducing post-operative infections after appendectomy [41]. In the current study there is a strong correlation between duration of antibiotic treatment and complication rate, most of the cases being treated for less than 3 days or over a week. This may be related to the fact that we did not follow a strict protocol for the proper combination and duration of antibiotic treatment.

In our study older age was associated with a higher complication rate (age over 45). A similar correlation was found regarding the distribution of the pathology over age. Most of the complicated cases (gangrenous, perforated or with abscess) were in the 45–83 years group. This may be related to a delayed admission of these patients to the hospital. Therefore the higher complication rate in this age group may be related to a more advanced pathology at presentation. There were more insertions of drains in advanced cases, mainly in patients with perforated or gangrenous appendicitis, but this didn't have an effect on the complication rate. It is important to emphasize that there was a high complication rate in the appendixes described as normal (6.66%).

No statistical difference was found analyzing the correlation between the complication rate and duration of symptoms before admission, fever, WBC, surgery time,

waiting time to surgery, use of an endo-bag or drainage and the pathology. There was no difference in the complication rate in respect to the surgeon that performed the operation (specialist or resident).

We think that the high rate of IAA, similar to some other studies, may be related to the fact that the entire procedure is performed intra-peritoneally (transection of the appendix) with potential soiling of the abdominal cavity. This reason along with pneumo-peritoneum, which may impair the metabolic and immune response of the peritoneum, may predispose to a higher complication rate [42]. On the other hand, LA has been shown to cause less surgical trauma than OA, less wound infections and offers a more rapid recovery [30].

In our study we found a high rate of intra-abdominal complications following LA, which are not usually seen following OA. So far it appears that this problem is related to the procedure itself (LA) rather than the pathology. This finding is supported by the occurrence of infection even with normal appendix or uncomplicated appendix infections.

Conclusions

Our study has several limitations, as it is retrospective and most procedures were performed by the laparoscopic route, therefore no statistical comparison could be undertaken between open vs. laparoscopic procedures. In our study there was a 10.6% rate of complications, higher than expected even for OA. We may have missed several patients who had a complication but preferred to refer to another hospital, and then the complication rate would be even higher. It is reasonable to conclude that the complication rate is not related to a learning curve, as it was similar both in seniors and in residents supervised by a senior. We have no explanation for the high rate of complications. We believe that further evaluation should be done concerning the use of an endo-bag; strict protocols should be used to improve antibiotic treatment and possible avoidance of intra-abdominal drains.

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