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Laparoscopic Appendectomy in Switzerland: A Prospective Audit of 2,179 Cases

Markus Schäfer[a,b] Lukas Krähenbühl[a,b] Edgar Frei[a]
Markus W. Büchler[a,b]

[a]Swiss Association for Laparoscopic and Thoracoscopic Surgery (SALTS), and [b]Department of Visceral and Transplantation Surgery, Inselspital, University of Bern, Switzerland

Key Words
Laparoscopy · Appendicitis · Laparoscopic appendectomy · Complications

Abstract
Background/Aims: Since its introduction in 1983, laparoscopic appendectomy (LA) has not replaced the conventional open procedure. The patient benefit seems limited to a decreased wound infection rate, and the overall morbidity and mortality rates remain equal to those of open appendectomy. ***Methods:*** The data (collected by the Swiss Association of Laparoscopic and Thoracoscopic Surgery) from 2,179 patients undergoing LA at 84 surgical institutions in Switzerland between January 1995 and December 1997 were retrospectively analyzed. ***Results:*** More than 90% of all patients had no intra- or postoperative complications. However, perforated appendicitis was associated with more complications, in particular a threefold increased wound infection rate (9.2 vs 3.5%). Furthermore, the conversion and reoperation rates of perforated appendicitis were significantly increased compared to 'simple' acute appendicitis (25.5 and 10.4% vs 4.8 and 2.1%, respectively). LA performed with a stapling device is superior to LA performed with loops, although the difference is not significant. ***Conclusion:*** Therefore, LA is a safe and effective procedure. The postoperative morbidity and mortality rates are comparable to those of open appendectomy, which is still the most commonly used procedure in Switzerland. The question of whether perforated appendicitis is better treated laparoscopically or by the open procedure cannot be answered with our data.

Introduction

Although the technique of laparoscopic appendectomy (LA) was already described by Semm [1] in 1983, it never became as widely accepted as laparoscopic cholecystectomy [2]. The benefits of LA are not as obvious and overwhelming as those of laparoscopic cholecystectomy. Traditional open appendectomy is already a minimally invasive procedure which can be performed through a small muscle-splitting incision. Nevertheless, at least some advantages of LA can be suggested. First, the diagnostic value of laparoscopy itself, and second, the improved postoperative recovery. Third, in two recently published meta-analyses, the wound infection rate was significantly lower

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Lukas Krähenbühl, MD
Department of Visceral and Transplantation Surgery
University of Zurich, Rämistrasse
CH–8091 Zurich (Switzerland)
Tel. +41 1 255 36 965, Fax +41 1 255 44 49, E-Mail lukas.kraehenbuehl@ch.usz.ch

Table 1. Characterization of patients and intraoperative findings

No. of patients	2,179
Males	823 (38%)
Females	1,356 (62%)
Sex ratio	0.6
LA as main operation	1,931
Mean age, years	33.6
Range, years	5–92
Incidental appendectomies	248
Mean age, years	42.3
Range, years	9–95
Intraoperative findings	
Acute appendicitis	1,289 (66.8%)
Perforated appendix	251 (13.0%)
Normal appendix	386 (20.0%)
Tumor	5 (0.2%)

in the laparoscopic group compared to the open technique [3, 4]. Finally, adhesion formation after LA is probably less compared to open appendectomy [5].

The aim of this prospective study is to present a 3-year review of LA performed in Switzerland. In addition, it is aimed to evaluate the two most popular techniques for LA, the first using preformed ligatures (Endo-loops®) and the second using an endoscopic stapling device (Endo-GIA®).

Patients and Methods

Since 1995, the Swiss Association for Laparoscopic and Thoracoscopic Surgery (SALTS) has prospectively collected data from patients undergoing LA at 84 surgical institutions (>60% of all laparoscopic procedures in Switzerland). More than 130 items (including personal data, indication for surgery, surgical technique, morbidity and mortality) were recorded for every patient.

After this, the data from 2,179 LAs performed between January 1995 and December 1997 (beyond the learning curve) were analyzed.

The choice of the selected open or laparoscopic approach for treating the patients with acute right iliac fossa pain was not limited by any selection criteria of the SALTS. The surgeons were completely free in their decision-making. Furthermore, there was no standardized preoperative investigation procedure (e.g. clinical examination, laboratory findings and ultrasonography).

In most cases a 3-trocar technique was used. After exploring the abdominal cavity, the mesoappendix was dissected using bipolar current (preferred technique) and staples or using a stapling device. The appendix itself was then transected using either a linear stapling device (Endo-GIA®) or a preformed ligature (Endo-loop®). Removal of the appendix was performed through the 10- to 12-mm trocar in the left lower quadrant without wound protection or by using an endo-bag (when the diameter of the appendix was >12 mm or perforation occurred). All specimens removed were sent for histological examination.

The H+ statistics, which represents the largest database of the national health care system, prospectively collects the data from patients undergoing open appendectomy and LA at 522 surgical institutions (approximately 50% of all surgical institutions in Switzerland). However, for every patient only a few items such as diagnosis, operative therapy, age, length of hospital stay and mortality were recorded. In 1997, a new system of data collection was introduced in Switzerland, and therefore, the database since 1997 was excluded from further analysis.

The results are expressed as mean ± standard deviation and range values. Data were compared by chi square test with Yates correction. A p value of <0.05 was considered to be significant.

Results

Characterization of Patients and Intraoperative Findings

There were 823 male (38%) and 1,356 female (62%) patients. Whereas 1,931 patients underwent LA as the main procedure due to suspected acute appendicitis, in 248 patients incidental appendectomy was performed during laparoscopy for other indications (e.g. cholelithiasis, inguinal hernia repair or chronic abdominal pain). The mean age at the time of operation was 33.6 (range 5–92) and 42.3 (range 9–95) years for suspected appendicitis and incidental appendectomy, respectively. Nearly all patients (97%) presented in a very good, low-risk condition according to the ASA 1 and 2 classification. Patients with incidental appendectomy were excluded from further analysis.

LA was performed as emergency operations within 24 h of admission in 90% of all patients with right iliac fossa pain. Histological examination of the specimen revealed acute appendicitis in 66.8% (1,289 cases), normal appendix in 20.0% (386 cases) and perforated appendicitis in 13.0% (251 cases). Five patients (0.2%) were found to have an appendiceal tumor. Acute appendicitis and perforated appendicitis were both associated with localized peritonitis of the right lower quadrant in 58.2 and 55.0%, respectively. A generalized peritonitis of the whole abdominal cavity was found in 5.6% of perforated appendicitis compared to 1.0% of acute appendicitis.

The baseline data with the intraoperative findings are shown in table 1.

Table 2. Operating time and surgical technique

	Overall group (n = 1,931)	Acute appendicitis (n = 1,289)	Perforated appendicitis (n = 251)
Operating time, %			
<60 min.	65.0	69.0	38.8
60–120 min	32.5	29.5	52.9
>120 min	2.5	1.6	8.3
Surgical technique, %			
Stapling device	56.7	58.6	49.4
Loop	33.1	35.7	24.3
Others (e.g. additonal clips, sutures)	12.2	12.1	24.3
Laparoscopic assisted resection	2.7	2.2	6.0

Operating Time and Surgical Technique

As shown in table 2, two thirds of all LAs were performed within 60 min. The remaining third lasted up to 120 min. Only in 2.5% was the operating time >120 min. Whereas the operating time was not prolonged in acute appendicitis, in cases of perforation the operating time markedly increased. Thus, the percentages of LA with acute appendicitis and perforated appendicitis which lasted up to 60 min were 69.2 and 38.7%, respectively. The operating time was not influenced by the technique used for appendiceal dissection and stump closure.

An endoscopic linear stapling device was used to cut the appendix and to close the stump in 56.7% of all LAs. Less frequent (33.1%) was the use of preformed ligatures. No further information was available concerning the number of ligatures which were attached to the appendiceal stump. Whereas some surgical institutions only used stapling devices, others performed LA only with loops, mainly for financial considerations. Additional sutures or clips were used to close the stump in 12.2%. In a few cases the appendix was resected with laparoscopic assistance (2.7%). Acute inflammation of the appendix did not complicate the closure of the appendiceal stump. However, perforation of the appendix, especially at the appendiceal base, made closure more difficult. Therefore, the use of ligatures and stapling devices alone was limited to 73.7% (overall group 89.8%). Additional sutures or clips were needed in 24.3% of cases. Finally, perforated appendices were more often removed with laparoscopic assistance (6.0%).

Although there was the same intraoperative complication rate, the conversion rate was slightly higher with loops (2.2 versus 1.8%). Postoperative wound infections were more frequent using loops compared to appendiceal stump closure with a stapling device (5.0 versus 2.9%). Loop appendectomy was associated with an increased reoperation rate compared to stapler appendectomy (4.2 versus 2.9%; table 3). Finally, the mean hospital stay was also prolonged after loop appendectomy compared to stapler appendectomy (7.0 versus 9.1 days).

Table 3. Surgical technique: stapling device versus loop

	Stapling device	Loop
Operating time	n.d.	n.d.
Conversion rate, %	1.8	2.2
Intraoperative complications	n.d.	n.d.
Wound infection rate, %	2.9	5.0*
Reoperation rate, %	2.9	4.2
Mean hospital stay, days	7.0	9.1*

n.d. = equal, no difference.
* $p < 0.05$ stapler versus loop.

Intraoperative Complications and Conversion Rate

The overall patient group and patients with acute appendicitis revealed in >90% no intraoperative complications. Bleeding problems (1.9%), inability to correctly visualize the appendix (1.8%) and perforation of the bowel (0.2%) were the main intraoperative complications. Some other minor complications, e.g. technical failure, are summarized in table 3, and they reached a level of 3.5%. However, perforated appendicitis was associated with more intraoperative complications, especially safe identification of the anatomical structures was hampered by the inflammatory tissue reaction. Limited view and bleeding complications occurred in 5.6 and 1.6%, respectively (table 3).

Table 4. Intraoperative and postoperative complications, conversion and reoperation rate, mortality and hospital stay

	Overall group (n = 1,931)	Acute appendicitis (n = 1,289)	Perforated appendicitis (n = 251)
Intraoperative complications, %			
Hematoma/bleeding	1.9	2.0	1.6
Bowel perforation	0.2	0.2	0.0
Limited view	1.8	1.6	5.6
Others (technical, anesthesia)	3.5	1.6	4.0
Postoperative complications, %			
Local			
Wound infection	3.3	3.2	9.2*
Hematoma/bleeding	1.7	1.3	4.0
Others (equipment, anesthesia)	1.0	3.4	3.6
Total	6.2	8.7	16.8*
Systemic			
Cardio-pulmonary	0.9	0.7	2.8
Lung embolism	0.5	0.2	2.8
Early bowel obstruction	0.8	0.6	3.6
Others	2.9	2.3	5.6
Total	5.1	3.8	14.8*
Conversion rate, %	6.8	4.8	25.5*
Reoperation rate, %	3.0	2.1	10.4*
Mortality, %	0.0	0.0	0.0
Mean hospital stay, days	7.6	8.0	9.2

* $p < 0.05$ acute versus perforated appendicitis.

Similarly, the conversion rate was related to the appendiceal pathology. The conversion rates were 6.8 and 25.5% for the overall and the perforated appendicitis groups, respectively ($p < 0.05$). Bleeding problems and intraoperative difficulty in visualizing the appendix were the main reasons for converting to an open procedure.

Postoperative Complications, Reoperation Rate and Hospital Stay

In the overall group, 94.4 and 95.9% of cases had no local or systemic postoperative complications, respectively. The wound infection rate was 3.3%. Bleeding complications and early bowel obstruction were noted in 1.9 and 0.8% of cases, respectively. Cardiopulmonary and thromboembolic complications were the most important systemic complications and occurred in 0.9 and 0.5%, respectively.

Whereas acute appendicitis revealed no increase in postoperative complications, perforated appendicitis was associated with a considerable number of local as well as systemic postoperative complications. In particular, the wound infection rate and early bowel obstruction rate were increased 3-fold to 9.2 and 3.6%, respectively. Cardiopulmonary and thromboembolic complications were also 2-fold increased to 2.8% each.

The overall reoperation rate was 3.0% (57 patients). Whereas 30 patients were reoperated laparoscopically, the remaining 27 patients underwent an open reoperation. The majority of reoperations took place between 2 and 5 days after LA. The most frequent reason being local or generalized peritonitis which needed further treatment with lavage and debridement. However, LA for perforated appendicitis was associated with the higher reoperation rate of 10.4%.

Nevertheless, there were no intraoperative or postoperative deaths after LA for acute right iliac fossa pain (table 4).

The mean hospital stay in the overall group was 7.6 days with a range between 1 and 52 days. Patients with perforated appendicitis revealed a prolonged mean hospital stay of 9.2 (range 1–52) days.

H+ Statistics

The members of the H+ statistics performed 8,175 appendectomies in 1995 and 1996, but only 914 (11.1%) were performed laparoscopically. There were 4,113 male

Table 5. H+ statistics for 1995 and 1996

	<16 years	16–65 years	>65 years	Total
No of patients				
1995	1,307	3,066	486	4,859
1996	906	2,066	344	3,316
Laparoscopic appendectomy				
1995				518 (10.7%)
1996				396 (11.9%)
Mortality rate, %				
1995	0.2	0.0	2.6	0.2
1996	0.0	0.1	1.1	0.1
Mean hospital stay, days				
1995	6.2	6.7	12.4*	6.9
1996	6.3	6.8	12.2*	7.0

* $p < 0.05$ patients >65 years versus patients <16 and 16–65 years, respectively.

and 4,062 female patients. The mean hospital stay was 7.0 days, whereby patients >65 years revealed a markedly prolonged hospital stay of 12 days. Furthermore, mortality was increased in elderly patients. The data of the H+ statistics are summarized in table 5.

Discussion

The purpose of the current series was to investigate the clinical relevance of LA in Switzerland. To this end, the data of 2,171 LAs performed by the members of the SALTS within a 3-year period were retrospectively analyzed.

Although LA has been performed in many Swiss surgical institutions since the late 1980s, it has never replaced the conventional open procedure. According to the data of the largest hospital statistics of Switzerland, it is estimated that only 11% of all appendectomies are performed laparoscopically [6]. This low rate of LA is in comparison to the literature which reports similar rates of LA in several European countries (1.2–20.0%) [2, 7]. Different explanations can be assumed for this low rate of LA. The lack of experience with laparoscopy handicaps its application under emergency conditions and at night. Furthermore, the costs of LA are higher due to the technical devices used and the longer operating time, whereas the length of the hospital stay is not shorter with LA (7.6 versus 6.9 days) [6]. Finally, no standardized criteria concerning the technical approach for appendectomy in Switzerland are available. Whereas some surgeons and surgical institutions always perform LA, some others restrict the indication for LA to female patients of child-bearing age with unclear right iliac fossa pain. Thus, the choice of technical approach is rather influenced by the surgeon's personal preferences and the availability of technical equipment and experienced operating staff than by scientifically based selection criteria.

Generally, the available data show no clear evidence of patient benefit after LA [8–16]. Most of the published studies revealed a lower wound infection rate after LA which is in fact the sole advantage [3, 4, 7]. In our study, we found a wound infection rate of 3.5%, which is rather low and within the range of the data from other studies [7–16].

The overall negative appendectomy rate remained at 20.0%, which is similar to that of open appendectomy [2, 17]. The negative appendectomy rate could not be specifically evaluated for young women of child-bearing age.

Overall, appendiceal perforation was not only associated with longer operating times, but also increased intraoperative and postoperative complication rates, especially the wound infection rate. Perforated appendicitis is closely associated with an increased inflammatory tissue reaction of the cecum as well as of the peritoneal cavity. To this end, identification and handling of the inflamed anatomical structures may be more difficult. These circumstances are at least partly responsible for the extended operating time, the difficulty in achieving safe stump closure and the increased complication rates. In addition, perforated appendicitis led to increased conversion and reoperation rates, although some of the re-laparoscopies

were planned (second-look operations) for further lavage of the peritoneal cavity. Due to the methodological limitations, we were unable to determine the influence of appendiceal perforation and the extent of peritonitis on the length of the hospital stay.

Although the operating time and the number of intraoperative complications were similar, LA performed with a linear stapling device was superior to LA perfomed with loops, presumably due to safer stump closure and less manipulation of the inflamed appendix. In particular, the wound infection, conversion and reoperation rates were reduced. Ortega et al. [11], who performed the largest prospective randomized trial comparing stapling device versus loop appendectomy, also found that LA performed by stapling devices was superior to loop and even open appendectomy. Therefore, although linear stapling devices are more expensive than loops, the overall costs may be decreased due to less postoperative complication and reoperation rates. However, this has not been confirmed by our data, since cost analysis was not routinely performed by the SALTS data sheet.

In conclusion, LA is a safe and effective procedure. The postoperative morbidity and mortality rates are comparable to those of the conventional open procedure. However, most of the patients with right iliac fossa pain due to acute appendicitis still undergo an open appendectomy in Switzerland. The main advantage of LA may be the decreased wound infection rate (3.5%). The question of how perforated appendicitis should be treated cannot be answered with these data. However, it seems that due to increased morbidity and operating time, LA may not be considered as the procedure of first choice to treat perforated appendicitis. Finally, our study revealed that LA performed with a linear stapling device is superior to loop appendectomy.

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References

1 Semm K: Endoscopic appendectomy. Endoscopy 1983;15:59–64.
2 Baigrie RJ, Dehn TCB, Fowler SM, Dunn DC: Analysis of 8,651 appendectomies in England and Wales during 1992. Br J Surg 1995;82:933.
3 McCall JL, Sharples K, Jadallah F: Systematic review of randomized controlled trials comparing laparoscopic with open appendicectomy. Br J Surg 1997;84:1045–1050.
4 Chung RS, Rowland DY, Li P, Diaz J: A meta-analysis of randomized controlled trials of laparoscopic versus open appendectomy. Am J Surg 1999;177:250–256.
5 De Wilde RL: Goodbye to late bowel obstruction after appendicectomy. Lancet 1991;338:1012.
6 H+ Spitalstatistiken: Medizinische Gesamtstatistik der Schweizer Spitäler 1995. 1996;26:103.
7 Fingerhut A, Millat B, Borrie F: Laparoscopic versus open appendectomy: Time to decide. World J Surg 1999;23:835–845.
8 Kum CK, Ngoi SS, Goh PMY, Tekant Y, Isaac JR: Randomized controlled trial comparing laparoscopic and open appendicectomy. Br J Surg 1993;80:1599–1600.
9 Tate JJT, Chung SCS, Dawson JW, Lelong HT, Chand A, Lau WY, Li AKC: Conventional versus laparoscopic surgery for acute appendicitis. Br J Surg 1993;80:761–764.
10 Mompean JAL, Robles Campos R, Parilla Paricio P, Soria Aledo V, Garcia Ayllon J: Laparoscopic versus open appendicectomy: A prospective assessment. Br J Surg 1994;81:133–135.
11 Ortega AE, Hunter JG, Peters JH, Swanstrom LL, Schirmer B: A prospective comparison of laparoscopic with open appendectomy. Am J Surg 1995;169:208–213.
12 Martin LC, Puenta I, Sosa JL, Bassin A, Breslaw R, McKenney MG, Ginzburg E, Sleeman D: Open versus laparoscopic appendicectomy: A prospective randomized trial. Ann Surg 1995;222:256–262.
13 Mutter D, Vix M, Bui A, Evrard S, Tassetti V, Breton JF, Marescaux J: Laparoscopy not recommended for routine appendectomy in men: Results of a prospective randomized study. Surgery 1996;120:71–74.
14 Hansen JB, Smithers BM, Schache D, Wall DR, Miller BJ, Menzies BL: Laparoscopic versus open appendectomy: Prospective randomized trial. World J Surg 1996;20:17–21.
15 Kazemier G, de Zeeuw GR, Lange JF, Hop WCJ, Bonjer HJ: Laparoscopic vs open appendectomy. A randomized clinical trial. Surg Endosc 1997;11:336–340.
16 Reietsen O, Larsen S, Trondsen E, Edwin B, Faerden AE, Rosselan AR: Randomized controlled trial with sequential design of laparoscopic versus conventional appendicectomy. Br J Surg 1997;84:842–847.
17 Berry J Jr, Malt RA: Appendicitis near its centenary. Ann Surg 1984;200:567–575.