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Original research

Laparoscopic versus open approach in the management of appendicitis complicated exclusively with peritonitis: A single center experience[☆]



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HIGHLIGHTS

- Controversy exists regarding the use of laparoscopy in complicated appendicitis.
- This study compared laparoscopic versus open approach in appendicular peritonitis.
- There were no differences between groups in general and specific complications.
- Our results supports laparoscopy in cases of appendicular peritonitis.

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ABSTRACT

Background: Controversial evidence exists regarding the laparoscopic approach in patients with acute appendicitis complicated with peritonitis due to a higher rate of surgical complications. The aim of this study was to compare post-operative outcomes in patients with acute appendicitis complicated exclusively with peritonitis approached by laparoscopy versus open surgery. **Methods:** Single center retrospective analysis of clinical records of patients with appendicitis complicated with peritonitis operated from January 2003 until October 2013. Demographic data, intra-operative variables, length of stay, surgical complications, mortality, readmissions and reoperations were retrieved. **Results:** 227 patients were identified, 43% males, mean age 39 ± 17 years (range: 12–85 years). Ninety-seven patients (43%) underwent laparoscopic appendectomy, 13 of them were converted to open surgery (13%). Ninety-four patients presented with diffuse peritonitis (41.4%). Laparoscopic appendectomy showed longer operative time but shorter hospital stay ($p < 0.05$). There were no differences in post-operative complications (intra-abdominal abscess, surgical site infection and prolonged ileus). Laparoscopic appendectomy was associated with lower odds for developing any surgical complication in the multivariate analysis (OR 0.301, $p = 0.036$). **Conclusion:** Both approaches showed no differences in complications in the management of appendicitis complicated exclusively with peritonitis. In our experience, laparoscopic appendectomy is a safe approach in cases of appendicitis complicated exclusively with peritonitis.

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1. Introduction

Laparoscopy has been introduced in the treatment of many elective and emergency surgeries with comparable results to open approach.

Since the initial McBurney's description [1], open appendectomy (OA) has been considered the gold standard procedure for this disease. Nevertheless, in recent years laparoscopic appendectomy (LA) has demonstrated to be as safe as OA [2]. Moreover, LA has showed diminished post-operative pain, lower rates of wound

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infection, it has a clear diagnostic role in young women in reproductive ages and, in addition, it facilitates the management of obese patients [3].

Despite these benefits, there are controversial data regarding the use of LA in acute appendicitis complicated with peritonitis, since LA has been associated with higher rates of post-operative intra-abdominal abscesses [4] (POIAA). However, other series have shown the same rate of POIAA and lower rates of wound infection [5–7]. These results are supported by a systematic revision of retrospective series, which showed no differences in POIAA when comparing OA versus LA (Odds Ratio (OR) 1.24; IC 95% 0.84–1.84), and LA was associated with lower wound infection rate [8].

Therefore, the aim of this study is to compare LA versus OA in the management of appendicitis complicated exclusively with peritonitis (ACP) in the 10-year period of our institution in which both approaches were available, in terms of development of any surgical complication and also specific complications as POIAA.

2. Methods

2.1. Study design

Retrospective analysis of a single-center prospectively collected electronic database including 227 patients with the diagnosis of ACP from January 2003 until October 2013. Pre-operative demographic variables were retrieved as well as the presence of any comorbidity. Complete white blood cell (WBC) count and C-reactive protein (CRP) levels were registered before surgery.

2.2. Inclusion criteria

All patients with post-operative diagnose of ACP were included. Patients with absence of histological confirmation of appendicitis and pregnancy were excluded.

2.3. Surgical technique

All surgeries were performed by an attending member (Staff or Fellow) of the department of digestive surgery of our institution with a senior general surgery resident. The surgical approach was determined according to surgeon's preference and criteria. LA was performed using a Veress needle for abdominal insufflation and a 3-port technique was used (5- and 12-mm). A fourth additional port was used according to surgeon's preference. Mesoappendix was cauterized with bipolar laparoscopic forceps before cutting it. The appendix was ligated in the base with an external tied polydioxanone laparoscopic ligature and extraction was made using a plastic bag. Warm saline solution lavage and drainage were used according to surgeon preference.

2.4. Intraoperative data

Peritonitis was defined as the presence of pus in the abdominal cavity described in the surgical protocol and classified according to the extension as localized if pus was present only in one quadrant or the pelvis, or diffuse when 2 or more quadrants were involved. Conversion to open surgery was decided by each surgeon according to his own criteria. OA was done by a median infra-umbilical laparotomy, right paramedian laparotomy or wide extended McBurney's laparotomy.

2.5. Post operative variables

The primary end point was the development of any surgical complication (SC), defined as any deviation of the expected post-operative course and categorized according to the Clavien–Dindo Classification [9]. Specific SC such as POIAA, surgical site infection (SSI) and prolonged ileus (PI) were analyzed separately.

Secondary end points analyzed were operative time, length of hospitalization and 30-days mortality.

2.6. Long term follow up

All patients were followed by revision of our clinical records and a telephone interview was attempted with all the patients. Mortality was confirmed using the National Database of Death. Readmissions and reoperations were registered and specific long term SC such as incisional hernia and mechanical bowel obstruction episodes were also retrieved.

2.7. Statistical analysis

Analysis was done by intention to treat. Categorical variables were analyzed with Chi-square and Fisher exact test. For variables with a normal distribution a t-student was used. For variables with a non-normal distribution a non-parametric test was used (Mann-Whitney). Logistic regression was made for the presence of SC using the variables described above.

3. Results

Two hundred and twenty seven patients with ACP were identified, 97 of them were operated by laparoscopic approach. There were no differences in mean age, comorbidities, ASA classification and WBC count between groups. Pre-operative CRP was lower in the LA group (Table 1).

There were no differences in the ratio of diffuse peritonitis between groups, being 48 out of 130 for OA (36.9%) versus 46 out of 97 for LA (47.4%, $p = 0.13$). There were 13 conversions in the LA group (13/97; 13.4%) all due to the presence of intra-abdominal adhesions and inflammatory cecum, which did not allow a safe ligation of the appendix base (Table 1).

There were no differences in complications between groups when categorized according to Clavien–Dindo classification. Nevertheless, there was a tendency to lower global SC, lower SSI,

Table 1
Demographic variables and perioperative variables.

Variables	OA (n = 130)	LA (n = 97)	p
Age (median ± SD)	38 ± 17.5	39 ± 17.1	0.91
Male (%)	49 (37.7)	49 (50.5)	0.06
Comorbidities (%)	45 (34.6)	33 (34)	NS
ASA (%)			
I	80 (61.5)	62 (63.9)	0.07
II	37 (28.4)	29 (29.9)	
III	7 (5.4)	0	
IV	0	0	
V	0	0	
WBC (U/dl) (mean ± SD)	15,672 ± 6492	14,736 ± 4737	0.26
CRP (mg/dl) (mean ± SD)	17 ± 13.5	11 ± 10.4	0.002
Diffuse peritonitis (%)	48 (36.9)	46 (47.4)	0.13
<i>Surgical approach</i>			
Complete laparoscopic		84 (86.6)	
Conversion		13 (13.4)	
McBurney	56 (43.1)	4 (4.1)	
Median	70 (53.8)	8 (8.2)	
Other	4 (3.1)	1 (0.4)	

shorter PI and lower mechanical bowel obstruction episodes in favor of LA (Table 2).

Open appendectomy showed a shorter operative time ($p < 0.001$) but a longer hospital stay ($p = 0.02$) as compared to LA (Table 2). Readmissions were significantly higher in the OA group (5.4% OA vs 0% LA, $p = 0.02$). There were two deaths in the OA group, both by refractory septic shock. No mortality was registered in the LA group (Table 2).

When multivariate analysis was performed to identify factors that could increase the risk of any surgical complications, higher CRP levels, WBC count, longer operative time and younger age showed to be significant (Table 3). LA approach was the single variable associated with a lower probability to develop any SC (OR 0.3, CI 95% 0.099–0.922).

4. Discussion

Laparoscopic appendectomy has been proven to be a safe procedure in the management of non-complicated acute appendicitis, but there is controversial data regarding its indication in the management of ACP, since there are reports that show higher and lower rates of POIAA [4,10–13]. In most publications reported so far, there is no clear consensus to categorize complicated appendicitis, including cases with peritonitis but also the necrotic or perforated appendicitis with no evidence of pus in the abdominal cavity [14,15]. It is reasonable to think that the presence and extension of peritonitis could be a risk factor for POIAA, and therefore, necrotic or perforated appendicitis without pus in the cavity, could have a lower risk of POIAA as compared to those complicated with peritonitis.

Particularly, our series included exclusively patients who had localized or diffuse peritonitis. Our results showed no differences between OA versus LA in the primary end-point, namely the presence of any SC, and even more, we did not find differences in POIAA, SSI nor PI. A multivariate analysis was made in order to determine factors that could increase the risk of SC: younger age, higher CRP, higher WBC levels and longer operative time were associated with higher odds of SC. On the contrary, LA approach was the only variable associated with lower odds for developing any SC. We believed that this is explained in part by the advantage that has the LA group to inspect the entire abdominal cavity, a

Table 3

Multivariate analysis for any surgical complications.

Variables	Odds ratio (IC 95%)	p
Age	0.974 (0.946–0.999)	0.048
Operative time	1.012 (1.001–1.022)	0.032
Laparoscopic approach	0.301 (0.099–0.922)	0.036
C-reactive protein	1.047 (1.012–1.082)	0.008
White blood cell count	0.99 (0.9998–0.99999)	0.023

direct visualization at the time of the lavage and less inflammatory repercussion secondary to the minimally invasive approach.

In our group, LA took longer operative time than other reported by large series of complicated appendicitis [16], probably related to the time taken to perform a laparoscopic lavage and to the fact that almost all the procedures were performed by general surgery residents. Despite this observation, patients were discharged earlier than those who had OA, probably due to less post-operative pain and earlier return to solid food intake, although these parameters were not measured in this study.

It is well known that laparoscopy is associated with lower post-operative adhesions and therefore lower rates of mechanical bowel obstructions [17,18]. Thus, it is expected to have a tendency of lower rate of mechanical bowel obstruction in the LA group, as shown in our series.

The principal strength of our study lies on the fact that all the patients included were complicated exclusively with peritonitis. To our knowledge, there is only one large series recently published that evaluated only this type of clinical presentation [19]. Thereaux et al. included 141 patients with a laparoscopic approach in cases of appendicitis complicated with diffuse peritonitis, with lower rates on POIAA and a low rate of conversion to open surgery. In our series, we analyzed both localized and diffuse peritonitis with no differences between groups. Therefore, the initial extension of peritonitis had no influence on the development of POIAA. By the other hand, our rate of conversion to open surgery in the laparoscopic group was 13.4%, which is comparable with data reported by other series [20].

Limitations in our study include a possible bias in follow-up since it is restricted to the clinical records of our own institution and to the fact that we were able to contact only 74 patients (32.6%) by telephone. However, primary end points tend to present in the first 30-days post surgery and therefore, short-term SC are more precisely followed than long-term complications such as mechanical bowel obstruction episodes and incisional hernias, which could be underestimated. Also, this study is not a standardized protocol established to treat ACP patients, therefore there could be a selection bias determined by each surgeon preference regarding to offer a laparoscopic or open approach.

5. Conclusion

Considering the results and limitations of our study, it seems reasonable to continue performing LA in the setting of ACP in our center since we have not observed higher rates of POIAA.

Laparoscopic approach in cases of appendicitis complicated with peritonitis is a safe procedure and it is comparable to the open approach.

Ethical approval

None required.

Table 2
Short and long term end points.

Variables	OA (n = 130)	LA (n = 97)	p
<i>Short term – primary end points</i>			
SC, any (%)	29 (22.3)	14 (14.4)	0.17
Clavien–Dindo classification (%SC)			
I	19 (65.5)	11 (78.6)	
II	1 (3.5)	0	
IIIA	0	0	
IIIB	2 (6.9)	0	
IVA	2 (6.9)	2 (14.3)	
IVB	3 (10.3)	1 (7.1)	
V	2 (6.9)	0	
Surgical site infection (%)	8 (6.2)	3 (3.1)	0.36
Intra-abdominal abscess (%)	2 (1.5)	4 (4.1)	0.4
Prolonged ileus (%)	9 (6.9)	2 (2.1)	0.12
<i>Short term – secondary end points</i>			
30-day mortality (%)	2 (1.5)	0	0.5
Readmissions (%)	7 (5.4)	0	0.04
Operative time (median min ± SD)	115 ± 38	150 ± 45	<0.001
Length of hospitalization (median days ± SD)	6.1 ± 6	4.5 ± 2.4	0.02
<i>Long term end points</i>			
Incisional hernia (%)	2 (1.5)	2 (2.1)	0.6
Mechanical bowel obstruction (%)	3 (2.3)	0	0.28

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Author contribution

Felipe Quezada: Study design, data collection and analysis, and manuscript writing.

Nicolas Quezada: Study design, data collection and analysis, and manuscript writing.

Ricardo Mejia: Study design, data collection and manuscript writing.

Alejandro Brañes: Data collection and manuscript revision.

Oslando Padilla: Data analysis and manuscript revision.

Fernando Pimentel: Study design and manuscript revision.

Nicolas Jarufe: Study design and manuscript revision.

Conflicts of interest

None.

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