

Laparoscopic appendectomy in complicated appendicitis with compromised appendix base: a retrospective cohort study

Apendicectomía laparoscópica en pacientes con apendicitis aguda complicada con base apendicular comprometida: estudio de cohorte retrospectivo

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Abstract

Background: Patients with compromised appendix base constitute a subgroup of patients with complicated appendicitis, and there is few available information. **Objective:** To study the frequency of stump leaks and fistulae in patients with complicated appendicitis with compromised stump. **Method:** This is an observational, retrospective study of patients that underwent laparoscopic appendectomy with compromised appendix stump. **Results:** From 2015 to 2019, 158 patients with complicated appendicitis were operated, of them 54 had compromised base or stump. There were 66.7% men, with a mean age of 38.7 years. For stump closure, a simple knot was employed in 57.4%, and in 42.6% an invaginated suture was employed. Regarding complications, 16.7% developed intraabdominal abscess, 7.4% ileus and 7.4% had wound infection. We found one stump leak and one stump fistula. The mean length of stay was 5.4 days (range: 1-20). There were 5 reoperations, 4 for abscess drainage and 1 for stump leak. **Conclusions:** Patients with acute complicated appendicitis with compromised appendicular base, laparoscopic surgery either with simple knot or with invaginated suture resulted in low frequency of stump leaks and fistula.

Keywords: Acute appendicitis. Laparoscopic appendectomy. Complicated appendicitis. Appendix stump closure.

Resumen

Antecedentes: Los pacientes con base apendicular comprometida constituyen un subgrupo de pacientes con apendicitis complicada y existe poca información al respecto. **Objetivo:** Conocer la frecuencia de fístulas y fugas fecales en pacientes con apendicitis complicada con base apendicular comprometida. **Método:** Se trata de un estudio observacional, retrospectivo y transversal de pacientes operados de apendicectomía laparoscópica con base apendicular comprometida. **Resultados:** De 2015 a 2019 se encontraron 158 casos de apendicitis complicada, de los cuales 54 tenían la base apendicular comprometida. Hubo predominio de varones (66.7%) y la edad media fue de 38.7 años. En el 57.4% de los casos se realizó un nudo simple y en el 42.6% un punto transfixivo con invaginación del muñón. En relación con las complicaciones, el 16.7% desarrollaron abscesos intraabdominales, el 7.4% íleo y el 7.4% infección de herida. Hubo un paciente con fuga del muñón y un paciente con fístula cecal. The mean length of stay was 5.4 days (range: 1-20). Se realizaron cinco

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reintervenciones: cuatro para drenaje de absceso intraabdominal y una por fuga del muñón. Conclusiones: En los pacientes con base apendicular comprometida, el manejo laparoscópico con ligadura simple o con punto transfixivo resulta en una baja frecuencia de fuga y fístula del muñón apendicular.

Palabras clave: *Apendicitis aguda. Apendicectomía laparoscópica. Apendicitis complicada. Cierre de muñón apendicular.*

Introduction

Acute appendicitis, described for the first time by Heber Fitz in 1886, is currently the most common cause of acute abdominal pain¹. The general incident of acute appendicitis varies between 76 and 227 cases per 100.000 inhabitants per year². The general risk of acute appendicitis has been reported to be between 6% and 16%. This condition affects every age group, with a higher incidence in the second decade of life³.

Acute complicated appendicitis diagnosis is performed using the macroscopic aspect during the transoperative period or by a histopathological study, and is defined as a perforated or with necrosis, or a pelvic abscess and generalized peritonitis²⁻⁶.

Standard treatment is still appendectomy, by open or laparoscopic approach. Laparoscopic appendectomy was described for the first time in 1983⁵. This is a well described surgical technique that has been widely accepted because it results in fewer surgical wound infections, less postoperative pain, a quick recovery, and an earlier return to work compared to open surgery⁶.

A safe stump closure technique is key when dealing with an acute complicated appendicitis, as local inflammation and infection can result in complications, such as fecal leak, fecal fistulas, or organ-space surgical site infection (intraabdominal abscess). There are different appendiceal stump closure methods around the world, which can be divided in traditional ligations (such as intracorporeal or extracorporeal sutures or *endo-loops*), and ligations with mechanical devices (staplers, endoclips, or electrothermal devices)⁶⁻⁸. In our country, the availability of mechanical devices is limited, and for this reason, traditional ligation methods are a basic tool for appendiceal stump handling, and are a key part in the skills of a general surgeon. Traditional ligations are very cost effective methods, but they usually prolong surgery time compared to automatic techniques (staples)⁶⁻⁹. The formation of fecal fistulas following an appendectomy, although not a frequent complication, is associated with significant morbidity. Appendicular stump leaks

represent the primary cause for the development of fecal fistulas¹⁰. There are very few studies in medical literature, and none in our country, that describe the frequency of specific complication, such as fecal fistulas and leaks in patients with a compromised appendicular base.

Therefore, the purpose of this study is understanding the frequency of appendicular stump leaks and fecal fistulas in patients with acute complicated appendicitis with a compromise appendix base after laparoscopic surgery in our hospital.

Method

An observational, descriptive, retrospective, and transversal study was performed with patients with acute complicated appendicitis with a compromised appendix base who underwent laparoscopic surgery in Hospital General Dr. Manuel Gea González, in Mexico City. The study was conducted between January 2015 and December 2019 from the prospective database of laparoscopic appendectomies, as well as through the search of information in clinical records. Patient information was kept confidential.

This work was performed according to the STROBE recommendations (*STrengthening the Reporting of OBservational studies in Epidemiology*)¹¹ for the report of observational studies. The study was approved by the Committee of Biomedical Ethics and Research (record 04-82-2019).

All patients with acute complicated appendicitis with a compromised appendix base over the age of 18 underwent laparoscopic surgery during the aforementioned period, with no gender distinction. Patients whose records were not found or did not have complete information necessary for the study were excluded.

The primary objective was to understand the frequency of fecal leaks and fistulas in patients with acute appendicitis with a compromised appendicular base. As secondary objectives we describe the frequency of other postoperative complications related to complicated appendicitis, such as superficial or surgical site or organ/space (intraabdominal abscess) infection, postoperative ileus, reintervention, and death.

Acute complicated appendicitis is found in cases with necrosis (gangrene) or appendix perforation with or without local or generalized peritonitis during diagnostic laparoscopy¹². At the same time, the complicated appendicitis diagnosis was verified by reviewing the histopathology report, which confirmed the presence of necrosis or appendicular perforation on the appendix base. Regarding the definition of appendicular base, it is that initial anatomical portion of the appendix where it joins the cecum (proximal appendix third), at the point of confluence of the colon taenias, and it includes the transition between the final part of the cecum and the cecal appendix⁸. The appendicular base was considered to be compromised when ischemia, necrosis, or perforation were found in relation to acute complicated appendicitis, of that anatomical portion, described both on the postoperative notes of the surgeon and the histopathology report. Surgical reports that mention perforation or necrosis of the appendicular base, the proximal third of the appendix, the appendicular stump, and the transition portion between the cecum and the beginning of the appendix were included. Surgical findings of a compromised appendicular base and transoperative variables were obtained from postsurgical reports written after the laparoscopic appendectomy by the surgeon in charge of the case. Pathological findings were obtained from the pathology department reports, both macroscopic and microscopic.

A stump leak is defined as those cases, such as stump leak, in which the evacuation of intestinal or fecal material through the appendicular stump, resulting in a leak to the abdominal cavity or the formation of a collection, as well as abdominal sepsis. The leak diagnosis was performed using the waste in the drainage or a contrast tomography of the abdomen with contrast output through the stump when there is no drainage, during the early postoperative period.

Appendicular stump or cecum fistulas generally require more time to develop (late postoperative period) and must have epithelization between the cecum and the skin. Fecal waste is presented through the drainage, or once this has been removed, through the orifice where it was placed. They were diagnosed with oral contrast tomography or tomography fistulography.

The surgical procedure involved laparoscopic surgery with standard technique in our academic center. The procedure is performed with three ports (one optical and two work ports). Surgery begins with a diagnostic laparoscopy and the identification of the appendix. Then, the mesoappendix is dissected and

a simple ligation is made with monofilament suture, and the appendicular base with simple ligation or a transfixive and invaginating stitch. Afterwards, purulent collections are suctioned. The placement of a drain (in general Jackson-Pratt type) is at the discretion of the treating surgeon. All surgeries are performed or supervised by an attending certified surgeon.

For the description of the cohort of patients included socio-demographic variables were taken into account, such as age, gender, BMO, comorbidity, and anesthetic risk, according to the ASA (American Society of Anesthesiology). At the same time, transoperative and postoperative results were included: surgical time, transoperative bleeding, type of appendicular stump approach (suture, endo-*loop*), conversion to open surgery, and impatient hospital stay. The frequency of postoperative complications was also analyzed, including appendicular stump leak and the formation of cecal fistula, as well as the rest of complications (secondary objective), which were classified according to the Clavien-Dindo classification¹³.

The period of collection and follow up of information included up to 6 months after surgery for the primary objective of the study (stump leaks and fistulas), and 90 days after surgery for secondary variables.

Data obtained were integrated into a predefine Excel database (Microsoft, Inc). This study reports results with central trend measurements (mean, average) and their respective dispersion measurements (standard deviation or range). For nominal variables the total number of patients and percentages were used. The statistical analysis program SPSS version 18.0 was used (SPSS Inc. Chicago, IL, USA).

Results

From January 2015 to December 2019, 158 cases of patients who underwent acute complicated appendicitis through laparoscopic surgery in our center were found, and 54 (34.2%) of them were reported with a compromised appendicular base. These 54 cases included for analysis were predominantly male (66.7%) and the mean age was 38.7% (range: 18-74). Regarding the rest of demographic variables an average BMI of 27.4 kg/m² was found, 21.2% of patients had some comorbidity, and 55.5% were classified as ASA II. The remaining information is presented in Table 1.

Out of the 54 patient with acute complicated appendicitis, 37 (68.5%) had a necrotic and friable

Table 1. Sociodemographical data (n = 54)

Variable	
Mean age (min-max)	38.7 (18-74)
Gender n (%)	
Female	18 (33.3)
Male	36 (66.7)
Mean BMI (min-max)	27.4 (14.5-38.6)
Comorbidity, n (%)	
None	43 (79.6)
DM2 + SAH	1 (1.9)
DM2	4 (7.4)
SAH	6 (11.1)
ASA, n (%)	
I-II	52 (96.3)
III-IV	2 (3.7)

ASA: American Society of Anesthesiology; DM2: type 2 diabetes mellitus; SAH: systemic arterial hypertension.

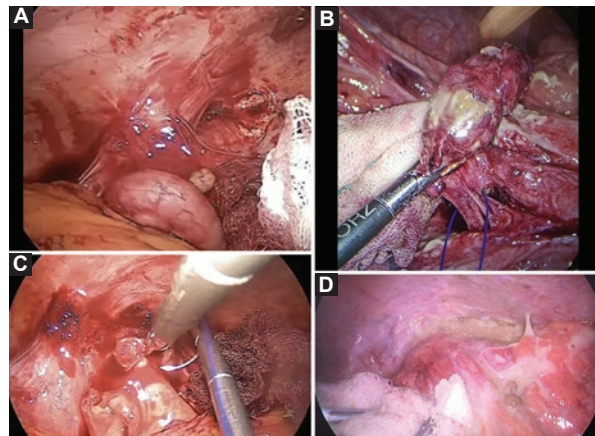


Figure 1. Complicated appendicitis with compromised appendicular base. **A:** appendicitis with free fecalith and adhesions. **B:** perforation of appendicular base with mesoappendix. **C:** transfixive stitch to the base of the perforated appendix, with affected cecum. **D:** appendicitis with free fecalith and generalized purulent peritonitis.

appendicular base, 15 (27.8%) had an inflamed and friable cecum and a necrotic appendicular base, and 2 (3.7%) had a perforated appendicular base in continuity with the transition with the cecum (Fig. 1).

Regarding the treatment use, in 31 patients (57.4%) a simple knot with non-absorbable monofilament (polypropylene) was used with a sliding knot according to the extracorporeal technique. In the rest of patients (42.6%) a transfixive stitch was used (non-absorbable monofilament suture) with subsequent invagination of the appendicular stump (with absorbable monofilament suture). In 45 patients (83.3%) a closed drainage was placed.

Table 2. Surgical results (n = 54)

Variable	
Surgical time (min), mean (min-max)	113 (55-195)
Transoperative bleeding (ml), mean (min-max)	89 (10-360)
Conversion to open surgery, n (%)	1 (1.9)
Postoperative complications, n (%)	
Stump leak	1 (1.9)
Cecal fistula	1 (1.9)
Clavien-Dindo complications, n (%)	
Degree I	
Superficial surgical site infection	4 (7.4)
Ileus	3 (5.6)
Degree II	
Prolonged ileus	1 (1.9)
Abscess, required antibiotic	3 (5.6)
Cecal fistula	1 (1.9)
Degree III-a	
Abscess, required puncture	2 (3.7)
Degree III-b	
Abscess, required reoperation	4 (7.4)
Reoperation by leak	1 (1.9)

The average surgical time was 113 minutes (range: 55-195) and the average transoperative bleeding was reported at 89 ml (range: 10-360) (Table 2). Only one patient (1.9%) required conversion to open surgery (explored laparoscopic approach).

Regarding postoperative complications, nine patients developed an intraabdominal abscess, and two of them were resolved using a guided percutaneous drainage using tomography plus antibiotics, three only required wide spectrum antibiotic treatment, and four required surgical drainage using laparoscopic surgery with peritoneal washing and placement of drainage. Lastly, four patients presented postoperative ileus, which was resolved with medical treatment (fasting and nasogastric probe).

Regarding the number of appendicular stump leaks, as well as cecal fistulas, we found that, out of 54 patients, 1 (1.9%) presented output of fecal matter through the drainage 6 days after surgery. This patient responded to conservative outpatient treatment with antibiotics, diet (high protein) and percutaneous drainage to bypass. As soon as the waste from drainage was clear, a colotomography was performed, and when the lack of leak and collection was reported, the drainage was removed.

One patient (1.9%) with necrotic appendicular base and friable cecum (not perforated) developed an appendicular stump leak 3 days after surgery. The diagnosis was performed due to the presence of fecal matter

through the drainage and wounds. The patient required reintervention through exploratory laparotomy, and due to the findings and the condition of the patient, it was necessary to perform a right hemicolectomy with terminal ileostomy.

Regarding the postoperative variables, oral diet began on average after 42.4 hours (range: 24-168). The mean length of stay was 5.4 days (range: 1-20). There were 5 reoperations, 4 for intraabdominal abscess drainage and 1 for stump leak. During the 90 day follow up no casualties were reported.

Discussion

This retrospective study reported that, in patients with complicated appendicitis with compromised appendicular base and treatment with simple ligation or invaginating stitch, the number of appendicular stump leaks and fistulas is very low (< 2%), and the rest of postoperative complication have similar frequencies to those reports by other international series. Our work's contribution is that we only analyzed the patient subgroup with an affected appendicular base. It is worth noting that the majority of international series analyze complicated appendicitis without discerning the anatomical location of the perforation^{6,8,14,15}.

Frazee and Bohannon¹⁴ were the first to conclude that laparoscopic appendectomy is safe and effective. The superiority of a laparoscopic technique over others has not been clearly shown (for example, suture, endo-loop, stapler), regarding the approach to the necrotic or perforated appendicular base in acute complicated appendicitis. Currently, there is no global agreement on any reference method^{15,16}.

Complicated appendicitis has a higher rate of postoperative complications with an incidence that varies between 3.0% and 28.7%. These include surgical site infection (1.2-12.0%), bowel obstruction (0-1.9%), intraabdominal abscesses (1.6-8.0%), appendicular stump leak (< 1%), and stercoraceous fistulas (< 1%), among others¹⁷⁻¹⁹.

In 2014, Gomes et al.²⁰ evaluated the safety and effectiveness of laparoscopy in the treatment of acute complicated appendicitis. Out of 154 patients with acute complicated appendicitis, 14 (9.1%) presented a necrotic appendicular base, and 2 of them has a surgical site infection. Conversion to open surgery was necessary in eight of 154 patients (5.19%), and five of them had a necrotic appendicular base (3.24%). The authors concluded that a necrotic base was the most

significant factor associated with conversion to open surgery. In our study, all patients underwent laparoscopic surgery, and only one case required conversion to open surgery, and we found 16.7% of organ/space surgical site infection.

In a metaanalysis of the optimal approach to the stump in laparoscopic appendectomy conducted by Antoniou, et al.⁸ in 2017, it was not possible to analyze subgroups according to the degree of appendicitis and the involvement of the appendicular base, as it was not reported separately in studies. However, it is suggested that acute appendicitis with inflammation of the appendicular base can be better treated with a stapler or open surgery.

In terms of our main purpose, there is no information regarding the frequency of appendicular stump leak or fistula in laparoscopic appendectomy with a compromised base in adults. Lintula, et al.¹⁹ reported a frequency of 1% after a laparoscopic appendectomy in children with complicated appendicitis, and this percentage is similar to what we found in our series (1.9%).

Our study has some limitations, and we will cover the main ones. Firstly, the fact that it is a retrospective study in only one center means that the results have a bias risk in the selection and information. It may seem that the number of patients is not enough to validate the results, but we must consider that patients with complicated appendicitis where the affected segment was the appendix base were included (34.2% in our study). This is important because the middle third of the appendix is the most frequently affected site, or it can be perforated in case of an acute complicated appendicitis, and this is why the affected appendicular base is usually not analyzed separately in studies. Another important limitation is that we only evaluated the technique with appendicular stump suture, without considering other techniques, such as the use of intestinal staplers. The use of intestinal staplers is not immediately possible in our hospital. Despite this, we consider that the lack of availability in our medium of intestinal staplers to perform appendectomies makes it so that our results with the use of ligation with suture are more representative and general for the conditions of our country.

We believe that the results of this study may be of interest for all general surgeons that perform laparoscopic appendectomies, providing certainty that the use of appendicular stump suture or ligation during a laparoscopic procedure is not associated with an increase in the frequency of fecal leaks or fistulas compared to the data reported by international medical literature.

Conclusions

In accordance with the results of this study, in patients with acute complicated patients with compromised appendicular base, a laparoscopic approach with simple ligation or transfixative and invaginating stitch results in a low frequency of appendicular stump fecal leak and cecal fistulas.

Ethical disclosures

Protection of People and Animals. The authors state that no experiments have been conducted in humans or animals for this research.

Data Confidentiality. The authors state that the protocols of their work center regarding the publication of patient data have been followed.

Right to privacy and informed consent. The authors have obtained informed consent from the patients and/or subjects mentioned in the article. This document is owned by the corresponding author.

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Conflicts of interest

The authors state that there are no conflicts of interest for the performance of this study.

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