

# Acute appendicitis: laparoscopic approach versus open surgery; costs and complications

## *Apendicitis aguda: abordaje laparoscópico versus cirugía abierta; costos y complicaciones*

Pablo Magaña-Mainero,\* Daniel De-Luna-Gallardo,\*\* Katia Picazo-Ferrera,\*\*\*,\*\*\*\*  
Juan Carlos Sainz-Hernández,\*\*\* Jorge Alejandro Ortiz de la Peña-Rodríguez\*\*\*\*\*

### Keywords:

Acute appendicitis,  
appendectomy,  
laparoscopic,  
laparoscopy,  
open surgery,  
complications.

### Palabras clave:

*Apendicitis aguda,  
apendicectomía,  
laparoscópica,  
laparoscopia,  
cirugía abierta,  
complicaciones.*

\* Fourth-year General  
Surgery Resident.

\*\* Second-year General  
Surgery Resident.

\*\*\* Attending Surgeon,  
Department of Surgery.

\*\*\*\* Resident in  
Endoscopy (INCan).

\*\*\*\*\* Head of the  
Postgraduate Course in  
General Surgery.

ABC Medical Center.

Received: 19/04/2018

Accepted: 25/10/2018



### ABSTRACT

**Introduction:** Acute appendicitis represents one of the most common surgical emergencies during daily surgical practice. The decision to perform open versus laparoscopic surgery continues to depend on the resources and training of the surgeon. **Objective:** The general objective of this study is to compare the surgical treatment of acute appendicitis, both laparoscopic and open, in a series of cases, analyzing the most common complications and costs generated for the patient. **Material and methods:** We conducted an observational, retrospective study with all cases operated for acute appendicitis in a period of 23 months. We performed an analysis taking as variables the demographics, transoperative findings, days of in-hospital stay or any postoperative complications. **Results:** With a total population of 713 patients, laparoscopic appendectomy was performed on 647 (90.74%) and appendectomy by open approach on 66; eight (1.24%) and four (6.06%) patients, respectively, presented postoperative complications during their treatment, which generated a considerable increase in costs, as well as in the average days of in-hospital stay. **Conclusions:** Laparoscopic management of acute appendicitis offers benefits such as a shorter hospital stay and a lower percentage of complications. Unlike open surgery, residual abscesses postoperative to laparoscopic surgery did not require reoperation, and there were no cases with wound dehiscence. Although laparoscopic surgery is more expensive on average, it offers less serious complications and its costs, when compared to those generated by open surgery, are lower.

### RESUMEN

**Introducción:** La apendicitis aguda representa una de las urgencias quirúrgicas más comunes durante la práctica quirúrgica diaria. La decisión de realizar una cirugía abierta versus laparoscópica sigue dependiendo de los recursos y entrenamiento del cirujano. **Objetivo:** El objetivo general del presente trabajo es comparar el tratamiento quirúrgico, tanto laparoscópico como abierto, de la apendicitis aguda en una serie de casos, analizando las complicaciones más comunes y costos que se generan para el paciente. **Material y métodos:** Realizamos un estudio observacional retrospectivo con todos los casos operados por apendicitis aguda en un periodo de 23 meses. Llevamos a cabo un análisis tomando como variables la demografía, hallazgos transoperatorios, días de estancia intrahospitalaria, complicaciones postquirúrgicas, estancia en la Unidad de Terapia Intensiva y costos totales. **Resultados:** En una población total de 713 pacientes, se realizó apendicectomía laparoscópica a 647 (90.74%) y apendicectomía por abordaje abierto a 66; ocho (1.24%) y cuatro (6.06%) pacientes, respectivamente, presentaron alguna complicación postoperatoria durante su tratamiento, lo que generó un incremento considerable en los costos, así como en el promedio de días de estancia intrahospitalaria. **Conclusiones:** El tratamiento laparoscópico de la apendicitis aguda ofrece beneficios, como menor tiempo de estancia intrahospitalaria y menor porcentaje de complicaciones. A diferencia de la cirugía abierta, los abscesos residuales postoperatorios a la cirugía laparoscópica no requirieron reintervención y no hubo casos con dehiscencia de la herida. A pesar de ser más costosa, en promedio, la cirugía laparoscópica ofrece dentro de sus beneficios menos complicaciones, y sus costos, al ser comparados con los generados por la cirugía abierta, son menores.

**How to cite:** Magaña-Mainero P, De-Luna-Gallardo D, Picazo-Ferrera K, Sainz-Hernández JC, Ortiz de la Peña-Rodríguez JA. Acute appendicitis: laparoscopic approach versus open surgery; costs and complications. Cir Gen. 2019; 41(1): 6-11.

## INTRODUCTION

Acute appendicitis (AA) represents one of the most common surgical emergencies in daily surgical practice. About 6-8% of the population in western countries will have AA at some point in their life; a clear increase in its incidence is manifest between ages 10 and 30. However, the extremes of life are not exempt from this pathology, with a higher rate of complications derived from late diagnosis.<sup>1-4</sup>

Even with a thorough clinical examination, AA can be difficult to diagnose. Its global mortality is 0.3-11%, and is directly related to the time of evolution and the comorbidities present during the acute event.<sup>5-13</sup>

In general, it is accepted that laparoscopic appendectomy (LA) exceeds open surgery (OS), with better aesthetic results and fewer days of in-hospital stay in the postoperative period. On the other hand, the open approach shows a shorter intraoperative time and a lower rate of postoperative complications.<sup>14-17</sup>

Different studies demonstrate the effectiveness and the growing predilection for laparoscopic surgery in western countries.<sup>8-13</sup> Regarding national experience, we have the study by Cardenas,<sup>18</sup> whose five-year statistics reported an increase in the percentage of patients operated with laparoscopic technique, from 54% to little more than 70% over five years. In the said study costs and complications were compared.<sup>17</sup>

Demography in previous years showed a preponderance in females, largely attributed to the differential diagnosis of gynecological pathology. The mean age reported in these studies was 21 years,<sup>19,20</sup> with an average of 34-36 years in the fourth decade of life for both kinds of procedures. The number of in-hospital stay days was 2.5 for LA versus 3.3 for OS, and complications in laparoscopic surgery went from 1.5 to 6%, while for open surgery it went up to 10%. The costs of these complications were also statistically significant.<sup>21,22</sup>

The general objective of this study was to compare the surgical treatment –both laparoscopic and open– of acute appendicitis in a series of cases, analyzing the most common complications and costs generated for the

patient. This analysis compares the results from a private hospital in Mexico City.

## MATERIAL AND METHODS

A retrospective study was carried out of all the cases of acute appendicitis attended at the ABC Medical Center in the period from January 2014 to November 2015.

A search in the hospital database was performed, which included all patients diagnosed with AA in the period described. Both sexes and all ages of patients (from 2 to 88 years) were included. Patients with other diagnoses who underwent incidental appendectomy and those whose diagnosis of AA was not the cause of hospital admission were excluded. The sample was divided in two groups according to the type of surgical treatment: laparoscopic versus open, which were further divided in two subgroups: uncomplicated (phases 1-3) and complicated AA (phases 4-5, abscess or plastron, localized or generalized peritonitis).<sup>21</sup>

The variables evaluated were sex and age, intraoperative findings, the phase of appendicitis (1-5) and the occurrence of local or generalized peritonitis, as well as the presence of plastron and abscess, conversions of LA to OS, days of in-hospital stay, post-surgical complications and total costs. The Mannheim prognostic index was taken into account in cases with complicated appendicitis and in those with postoperative complications.

Postoperative complications were defined as the cases which during their stay had formation of an intra-abdominal abscess or residual collection, which needed reoperation or image-guided percutaneous drainage, infection of the operative site, wound dehiscence, as well as indirect infectious complications and days of stay in the Intensive Care Unit.

The costs, in accordance with the Privacy Law, could not be expressed in figures in pesos, so we expressed them in an increase factor (multiplying the lower cost [AA] by the increase factor expressed in x #; that is, "X" equals the lowest average cost multiplied by the increment factor). The total costs of in-hospital stay (in the ward or Intensive

Care Unit) were considered. These included hospitalization and operating room costs, medications administered, and medical fees of all the team members involved.

A statistical analysis was done, expressed in percentages, ranges and averages. Statistical analysis was carried out with a paired  $\chi^2$ .

## RESULTS

A total population of 713 patients diagnosed with acute appendicitis was studied; of these, 618 were adults and 95 pediatric, with an average age of 35 years, in a range of 2 to 88 years (Table 1). Based on sex, 334 men and 379 women were treated. A laparoscopic appendectomy was performed for 647 and open approach appendectomy for 66, which corresponded to 90.74 and 9.26%, respectively.

Of the group of patients treated with laparoscopic surgery (647), 41 (6.34%) presented with complicated disease, i.e., acute appendicitis phase 4 or 5, with a Mannheim index of 5-38. Eight cases (1.24%) presented with postoperative complications (Table 2) direct and indirect, and one conversion to OS. Among the direct ones, with a Mannheim index of 15-23, there were two residual abscesses (drained by interventional radiology) in two men, 54 and 81 years old. In the indirect complications group, with a Mannheim index of 5-16, there were three patients: two of them with hospital acquired

**Table 2: Percentage of patients with postoperative complications in cases of complicated disease (LA versus AA).**

	Postoperative complications/ complicated disease	%
LA	8/41	1.24
AA	4/6	6.06
p		< 0.05

pneumonia who required intensive care with ventilatory mechanical support (two women, aged 40 and 43, who completed seven and five days of in-hospital stay, with antibiotic therapy with moxifloxacin –400 mg intravenously every 12 hours for four days–, ceftriaxone –1 g intravenously every 12 hours for six days– and metronidazole –500 mg IV every eight hours for six days–) and one man with *Clostridium difficile* infection (managed with metronidazole –500 mg intravenously every eight hours for five days– and vancomycin –250 mg per os every eight hours for four days only–). The average in-hospital stay (Table 3) in the group with uncomplicated disease was 2.03 days (from 1 to 10 days) and the cost of the stay (Table 4) was equivalent to the baseline by a factor of increase of 2.20 (x 2.20). In the subgroup with complicated disease, the stay was 7.4 (from 5 to 15) days and the cost had an increase factor x 5.91.

Of the group treated with OS (66 patients), six (9.09%) presented complicated disease (phase 4-5), with a Mannheim index of 10-26, four (6.06%) had direct postoperative complications (Table 2), with a Mannheim index of 16-26: three with a residual abscess and one with infection and wound dehiscence. All required reintervention. The in-hospital stay (Table 3) in the group with uncomplicated disease was 2.42 days (from 1 to 7 days), and the average cost of stay (Table 4), equivalent to the baseline was without an increase factor, x 1.00. In the subgroup with complicated disease, the stay was 15.5 (from 12 to 22) days and the average cost was equivalent to the baseline times 7.70 (x 7.70).

**Table 1: Sample of the study.**

	Non com- plicated	Compli- cated	Total	%	Age (years)
Number of patients	671	42	713	100	35 (2-88)
Men	352	22	334	52	33.6 (2-83)
Women	319	20	379	48	35.1 (3-88)
Age group					
Pediatric patients	136	6	95	20	9.2 (3-15)
Adults	535	36	618	80	33 (19-81)
Technique					
Open	60	6	66	9.3	21.9 (2-79)
Laparoscopic	606	41	647	90.7	35.8 (3-83)

**Table 3: Days of in-hospital stay (DIHS) by group, expressed in average and ranges (LA versus AA).**

DIHS	Non complicated		IF x	Complicated		IF x
	Average	Range		Average	Range	
LA	2.03	1-10	0.84	7.4	5-15	3.06
AA	2.42	1-7	1.00	15.5	12-22	6.40
p	< 0.3		< 0.05			

**Table 4: Costs expressed in baseline (1.00) and increment factor.**

\$	Increment factor	
	Non complicated	Complicated
LA	2.22	5.91
AA	1.00	7.70
p	< 0.05	< 0.05

**DISCUSSION**

Appendectomy is the most frequent emergency surgical intervention. More than 20 years have passed since the introduction of laparoscopic appendectomy by Semm. Several studies have shown that it is a promising and safe tool for definitive treatment, able to reduce the risk of complications and days of hospital stay.<sup>17,23</sup> However, there are still publications in which no significant differences have been observed between both approaches and, in addition, demonstrated an exponential increase in laparoscopic appendectomy.<sup>24-27</sup>

One of the arguments that repeatedly support laparoscopic versus open appendectomy,<sup>28-32</sup> also evidenced in our study, is the decrease in the length of hospital stay. In our series, an average stay of 2.03 days was observed with OS versus 2.42 days with LA in uncomplicated appendicitis, with a significant increase in complicated cases, where it rose to 7.4 versus 15.5 days, with a statistically significant increase for the group with AA in both cases (p < 0.05).

Regarding postoperative complications, a statistically significant increase (p < 0.05) was demonstrated in the OS group versus LA, with 6.06% versus 1.24%, respectively, in agreement with published literature by various authors.<sup>18,20,23,25,26,29,30</sup>

The costs of LA exceeded those of OS, with an increase factor of x 2.22, similar to what was published by Chu.<sup>31</sup> This is undoubtedly associated to factors such as greater use of supplies and longer surgical time. However, unlike reports in the literature, it was shown that in cases of complicated AA (or when presenting some complication), the cost of OS exceeded that of AL with an increase factor of x 7.70 versus x 5.91, in the same way as published by Cardenas.<sup>18,32-36</sup>

In our series, what has been reported in the literature so far was not reproduced: complications are less common in patients operated on by laparoscopy. Residual abscesses and surgical wound infections are more common in open appendectomies, and complications are usually more severe and costly, in addition to having a longer hospital stay.

**CONCLUSIONS**

Acute appendicitis is a common disease worldwide and is one of the surgeon’s most frequent reasons for emergencies. The gold standard for treatment continues to be surgery. Minimally invasive surgery has been positioned as the best therapeutic option due to the clear benefits it offers: it reduces days of hospital stay, the percentage of complications and their severity, it has a lower overall total cost for the patient and for the hospital where it is treated.

In our hospital, the predominance of laparoscopic surgery for the treatment of acute appendicitis is evident, in a first instance, by choice of the surgeon, by request of the patient, and because, according to our experience, it continues to be the best therapeutic option.

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*Correspondence:*

**Dr. Pablo Magaña Mainero**

Av. Carlos Graef Fernández Núm. 154,  
Alcaldía Cuajimalpa de Morelos,  
Ciudad de México.

Cell: 55-2909-8266

**E-mail:** [maganapm@gmail.com](mailto:maganapm@gmail.com)

[www.medigraphic.org.mx](http://www.medigraphic.org.mx)