

# Outcomes of a Low-cost, Outpatient Laparoscopic Appendectomy Protocol Performed by First- and Second-year General Surgery Residents in Cases of Uncomplicated Appendicitis

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## ABSTRACT

**Introduction:** Appendicitis is one of the most frequent surgical diseases. In uncomplicated appendicitis, outpatient protocols have been shown to significantly reduce costs and can be replicated by residents. In Colombia, this type of protocol has never been evaluated. The aim of this study was to evaluate the outcomes of a low-cost, outpatient laparoscopic appendectomy protocol performed by first- and second-year general surgery residents in uncomplicated appendicitis.

**Materials and methods:** A prospective longitudinal study of outpatient management after laparoscopic appendectomy was conducted in Bogotá, Colombia. It included patients with uncomplicated acute appendicitis and excluded those with evidence of perforation, abscess, or gangrenous appendicitis. The frequency of complications, readmissions, and postoperative pain were evaluated as outcomes.

**Results:** 285 patients were included, with a median age of 28 years and 52.3% ( $n = 149$ ) were female. All patients had modulated pain and tolerance of the oral route during the postoperative period. There were only 10 (3.5%) readmissions and 12 (4.2%) complications, of which 80% ( $n = 8$ ) and 58.3% ( $n = 7$ ) corresponded to the laparoscopic group. On bivariate analysis, no association was found between the frequency of complications and the surgical approach (open vs laparoscopic surgery,  $p = 0.10$ ), the stage of appendicitis (edematous vs fibrinopurulent,  $p = 0.14$ ), or the American Society of Anesthesiologists classification (I vs II,  $p = 0.44$ ).

**Conclusions:** This study demonstrated that the low-cost outpatient management protocol for uncomplicated appendicitis by laparoscopic appendectomy performed by first- and second-year residents had a low frequency of complications and readmission, with no significant differences compared with open surgery or appendicular phase.

**Clinical significance:** The findings of this study have important implications for clinical practice. Outpatient postoperative management can reduce healthcare costs and improve patient satisfaction by reducing hospital stays and facilitating earlier recovery. This alternative should be considered for selected patients who meet the criteria for safe and effective care.

**Keywords:** Ambulatory surgical procedures, Appendicitis, Appendectomy, General surgery, Laparoscopy, Operative surgical procedures.

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## INTRODUCTION

Acute abdominal pain is the main cause of general surgery consultations in the emergency department (ED). Acute appendicitis stands out as the most prevalent gastrointestinal surgical emergency globally, affecting approximately 6–7% of the global population and comprising 1% of all surgical procedures.<sup>1,2</sup> Laparoscopic appendectomy represents the optimal surgical approach for treating acute appendicitis. It is linked to fewer perioperative complications in comparison to the open technique, offering advantages, such as reduced postoperative pain, lower incidence of surgical site infections (SSI), a shorter hospital stay, and a quicker resumption of normal daily activities.<sup>2,3</sup> Previously, an American surgical program (National Surgical Quality Improvement Program; NSQIP) reviewed 32,000 patients from 2008, showing that hospitalization for uncomplicated acute appendicitis ranged from 1.8 to 2.2 days.<sup>4,5</sup> Today, uncomplicated acute appendicitis treated with laparoscopic appendectomy requires minimal length of hospital stay, allowing for postoperative monitoring in an outpatient setting.<sup>4</sup>

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The treatment of acute appendicitis has evolved in the last 20 years with the introduction and development of minimally invasive surgery allowing many laparoscopic procedures to be performed on an outpatient setting.<sup>6</sup> In the US, a confirmed outpatient protocol for laparoscopic appendectomy in uncomplicated acute appendicitis has shown a relevant increase in the rate of outpatient management without raising the morbidity-mortality among patients.<sup>4</sup> The percentage of appendectomy procedures performed in outpatient settings, as reported in the literature, ranged from 20 to 88%.<sup>6</sup> This type of protocols allows a better flow of patients with a higher hospital bed availability, discharging those with favorable evolution and low risk of postoperative complications. In Colombia and Latin America, evidence on this topic is very scarce or non-existent. Considering the relevance of improving the dynamics of the care of one of the most frequent surgical diseases in our region, guaranteeing adequate outcomes as well as the establishment of a program that can be replicated by first-year residents, facilitating their early exposure to laparoscopy and improving their learning curve and surgical performance, the aim of this study was to evaluate the outcomes of a low-cost, outpatient laparoscopic appendectomy protocol performed by the first- and second-year general surgery residents in uncomplicated appendicitis.

## MATERIALS AND METHODS

### Study Design and Population

A prospective longitudinal study was executed in Bogotá, Colombia, spanning from January 2018 to January 2020, to assess the outpatient management following laparoscopic appendectomy. The procedure was executed by the first- and second-year general surgery residents under the supervision of a faculty surgeon, exclusively for cases of uncomplicated appendicitis. Inclusion criteria comprised individuals meeting the following conditions: (1) patients diagnosed with uncomplicated acute appendicitis (non-perforated edematous/fibrinopurulent) categorized as American Society of Anesthesiologists Physical Status Classification System<sup>7</sup> (ASA) 1 or 2; (2) Residing in the Bogotá metropolitan area or having the ability to travel to the hospital; (3) Exhibiting normal vital signs postoperatively; (4) Managing postoperative pain within a visual analogue scale of 4 or less; (5) Demonstrating the capacity to tolerate liquid intake, ambulate, and exhibit spontaneous urine output.<sup>6</sup>

Uncomplicated appendicitis was determined by the senior surgeon. Patients displaying signs of complications (perforation, abscess, or gangrenous appendicitis) were excluded.<sup>6</sup> Additionally, exclusion criteria encompassed pregnancy, conversion to open surgery, age below 15, intraoperative findings of perforation or abscess, and inadequate comprehension of postoperative care, warning signs, and indications for ED consultation.<sup>6</sup> The study assessed outcomes such as the frequency of complications, readmissions, postoperative pain, and mortality. Extensive preoperative counseling was administered to all patients regarding dismissal plans from the postoperative recovery unit after surgery.

### Surgical Technique

A standardized laparoscopic appendectomy technique utilizing three ports was employed across all patients. The procedure commenced with the introduction of a 10-mm steel reusable port at the umbilicus, employing a Hasson open technique to establish a

12 mm Hg pneumoperitoneum.<sup>8</sup> Subsequently, two additional steel reusable ports were inserted under direct laparoscopic visualization using a 30° laparoscope: A 12-mm port in the suprapubic region and a 5-mm port in the left iliac fossa. The mesoappendix underwent dissection and sectioning from the apex to the base, employing electrocoagulation with a monopolar laparoscopic hook device. The tip of the appendix was grasped and secured using two endoloops or Hem-o-lok clips, size XL. The appendix was transected between the two ligatures, leaving one loop or clip on the cecum end. Post-resection, a cost-effective specimen retrieval bag was introduced into the abdomen through the 12-mm suprapubic port, enclosing the excised appendix. At the conclusion of the surgery, it was administered Ropivacaine (40 mL, 200 mg) through infiltration at each port site.<sup>6</sup>

General anesthesia adhered to the recommendations of the Enhanced Recovery After Surgery Society.<sup>9</sup> During induction, a single intravenous dose of cefazolin (2 gm), along with intravenous injections of metoclopramide (10 mg) and dexamethasone (8 mg) was administered to enhance rehabilitation and prevent postoperative nausea and vomiting.<sup>6,9</sup> Multimodal analgesics were implemented from the initiation of surgery, encompassing an anti-hyperalgesic agent (ketamine 20 mg) and a step 1 analgesic (paracetamol plus non-steroidal anti-inflammatory drugs, unless contraindicated).<sup>6,10</sup>

Outpatient procedures in appendectomy studies are defined as surgeries with a hospital stay of less than 24 hours, with or without an overnight stay. In this investigation, the definition from the International Association for Ambulatory Surgery (IAAS) was adopted, characterizing ambulatory surgery as a procedure where the patient is discharged on the same working day.<sup>6</sup> Patients eligible for the cost-effective and outpatient laparoscopic protocol provided informed consent, incorporating comprehensive information about appendicitis, the surgical procedure, and their commitment to report any postoperative complications to the clinic. Monitoring persisted until full awakening, with patients retained until meeting clinical discharge criteria for outpatient procedures. Each patient was invited to a follow-up consultation at 8 days.

Data collected for each patient encompassed age, gender, length of stay, operating time, complications within 30 days of discharge, unexpected return consultations, unexpected readmissions, and unexpected reoperations. Complications were categorized using the modified Clavien system.<sup>11</sup> Information was gathered during routine postoperative follow-up, with all patients granting informed consent for the research use of their data.

### Outpatient Management Protocol

Once the patients were selected, education was provided to them and their families during the immediate postoperative period. An instruction manual with simple, patient-friendly, and standardized graphical instructions for postoperative care was designed. The manual included general care (position, rest, exercise, and feeding), wound and dressing management, use of painkillers (acetaminophen-naproxen scheme, except in cases of hypersensitivity), and warning signs and indications for ED readmission. A week after discharge, patients were required to attend an outpatient check-up to rule out postoperative complications and review the histopathology report. Finally, after 30 days, a telephone communication was made with all patients to complete the postoperative follow-up.

**Statistical Analysis**

It was assessed the normality of quantitative variables using the Kolmogorov–Smirnov test. Skewed variables were expressed as the median (interquartile range, IQR, or range). Qualitative variables were concisely presented as frequency and percentages. Comparative analysis utilized Pearson’s Chi-square test or Fisher’s exact test for categorical variables, and Student *t*-test or Mann–Whitney test for quantitative variables. Statistical significance was established at a *p*-value < 0.05. We conducted all analyses using the Statistical Package for the Social Sciences (SPSS) version 28.0 software.

**Ethical Statements**

Approval for this study was granted by the ethics review board of the institution. The protocol adhered to the principles outlined in the Declaration of Helsinki and the guidelines of Good Clinical Practice.<sup>12,13</sup>

**RESULTS**

A total of 285 patients, with a median age of 28 years, participated in the study, and 52.3% (*n* = 149) were female. Among them, 237 (83.1%) were classified as ASA type I, while 16.9% (*n* = 48) fell into type II. Regarding the appendicular phase, 45.6% (*n* = 130) were in the edematous phase, and 54.4% (*n* = 155) were in the fibrinopurulent phase. The laparoscopic group exhibited a median operative time of 50 (17–120) minutes, slightly longer than the 47.5 (15–90) minutes observed in the open surgery group (Table 1).

The rate of readmission to the ED for this cohort was 3.5% (*n* = 10/285). The primary cause for readmission in 5 patients was uncontrolled postoperative pain, occurring between the third and eighth postoperative day, and was managed through in-hospital analgesic treatment. Additionally, one patient was readmitted due to postoperative vomiting, treated with in-hospital symptomatic management. The remaining four readmissions were attributed to superficial SSI in one patient requiring wound management, and organ/space SSI in three patients necessitating percutaneous drainage and intravenous antibiotics (Table 1).

The overall frequency of complications in the study was 4.2% (*n* = 12/285), slightly exceeding the rate of readmissions (3.5%). This discrepancy was attributed to complications being identified not only through readmissions but also through postoperative control consultations and a 30-day postoperative telephone follow-up. The range of complications included four cases of seroma, three cases of organ/space SSI, three cases of superficial SSI, one case of surgical wound dehiscence, and one case of perilesional ecchymosis.

Bivariate analyses revealed no significant association between unexpected readmissions and complications with any of the preoperative or perioperative variables (Table 2). Out of the 285 patients meeting the criteria for outpatient postoperative management, 95.7% (*n* = 273) completed the follow-up without associated morbidity, and 96.5% (*n* = 275) completed the follow-up without requiring readmission to the ED.

**DISCUSSION**

In the U.S. alone, 357,000 appendectomies are performed each year. Specific data regarding this issue in Latin America is unavailable.

**Table 1:** Sociodemographic, clinical, and surgical characteristics, and postoperative outcomes of the studied population, according to the surgical approach

Variable	N	Open	Laparoscopic
		n (%)	
Age			
Years, median (range)		24.5 (15–73)	29 (15–77)
Gender			
Female	149	3 (2%)	146 (98%)
Male	136	61 (44.9%)	75 (55.1%)
ASA			
I	237	56 (23.6%)	181 (76.4%)
II	48	8 (16.7%)	40 (83.3%)
Appendicitis phase			
Edematous	130	22 (16.9%)	108 (83.1%)
Fibrinopurulent	155	42 (27.1%)	113 (72.9%)
Surgical time			
Minutes, median (range)		47.5 (15–90)	50 (17–120)
Modulated pain			
Yes	285	64 (22.5%)	221 (77.5%)
Tolerates the oral route			
Yes	285	64 (22.5%)	221 (77.5%)
Readmission			
Yes	10	2 (20%)	8 (80%)
No	275	62 (22.5%)	213 (77.5%)
Complication			
Yes	12	5 (41.7%)	7 (58.3%)
No	273	59 (21.7%)	214 (78.3%)

\*ASA, American society of anesthesiologists physical status classification system

**Table 2:** Association between gender, clinical variables and type of surgical approach with the frequency of complications

Variable	N	Complication	Non-complication	<i>p</i> -value
		n (%)		
Gender				
Male	136	7 (5.1%)	129 (94.9%)	0.452
Female	149	5 (3.4%)	144 (96.6%)	
ASA				
I	237	9 (3.8%)	228 (96.2%)	0.440
II	48	3 (6.2%)	45 (93.8%)	
Appendicitis phase				
Edematous	130	3 (2.3%)	127 (97.7%)	0.143
Fibrinopurulent	155	9 (5.8%)	146 (94.2%)	
Surgical approach				
Open	64	5 (7.8%)	59 (92.2%)	0.103
Laparoscopic	221	7 (3.2%)	214 (96.8%)	

\*ASA, American society of anesthesiologists physical status classification system

However, the implementation of an outpatient laparoscopic appendectomy protocol could potentially eliminate the need for an average of 485,000 inpatient days annually, resulting in healthcare savings of almost \$1,000,000,000.<sup>4</sup> This study indicates that the protocol for outpatient laparoscopic appendectomy performed by first and second-year general surgery residents for uncomplicated appendicitis is safe and feasible with a very low postoperative morbidity and no need for surgical reinterventions.

The Jerusalem guidelines for diagnosing and treating acute appendicitis indicates that laparoscopic appendectomy is now the gold standard technique to treat acute appendicitis.<sup>14</sup> An analysis of NSQIP data by Page et al.,<sup>15</sup> shows that over 80% of appendectomies in the US are performed using a laparoscopic approach.<sup>4,15</sup> Our cohort showed that 77.54% of patients underwent a laparoscopic procedure. Although laparoscopic appendectomy has advantages, such as less pain, quicker return to work, better cosmetic result and shorter length of hospital stay. Many studies comparing open vs laparoscopic appendectomy have not shown significant differences in length of Hospital stay. Guller et al.<sup>16</sup> found that hospital stay was 2.06 days for laparoscopic vs 2.88 days for open appendectomy in 43,757 patients.<sup>16</sup> Our results show no differences in the length of hospital stay (<24 hours) for outpatient open vs laparoscopic appendectomy in uncomplicated cases performed by first and second-year general surgery residents. Our results also showed no difference in readmission rates (2 vs 8 patients) for open vs laparoscopic appendectomy, nor significant differences in the rate of postoperative complications (5 vs 7 patients). Our results are similar to those shown by Cash et al.,<sup>4</sup> but we reported a lower postoperative complications rate (4.2 vs 5.2%).

Previous studies<sup>4,17,18</sup> have demonstrated that discharging patients with uncomplicated acute appendicitis within 24 hours of surgery resulted in an outpatient rate ranging from 65 to 88%, in contrast to the 100% observed in our study. No readmissions occurred in the outpatient group, leading to the conclusion that performing it safely for acute non-perforated appendicitis is feasible. Nevertheless, studies by various authors,<sup>19–21</sup> involving mixed populations of patients with complicated and uncomplicated appendicitis, reported outpatient surgery rates of only 18, 20, and 32, respectively.<sup>19–21</sup>

No national data regarding appendectomy procedures and their outpatient rates in Colombia are available. In comparison to France, only 1.3% of appendectomy procedures were conducted in outpatient settings in 2015.<sup>22</sup> Most surgeons in our country view conventional hospitalization as the standard of postoperative care for laparoscopic appendectomy. As Gignoux et al.,<sup>6</sup> we consider all patients with uncomplicated appendicitis to be eligible for outpatient postoperative care, unless they have severe comorbidities that require monitoring, who do not meet early discharge criteria or have severe infections or intraoperative complications. Dubois et al.<sup>23</sup> estimated a cost savings of \$323 per every outpatient laparoscopic appendectomy. These data support the implementation of protocols for low-cost and outpatient laparoscopic appendectomy for patients with uncomplicated appendicitis in low- to middle-income countries such as Colombia.

A scoring system to select patients with acute appendicitis for outpatient surgery was developed by Lefrancois et al.,<sup>21</sup> based on five preoperative criteria: body mass index (BMI) < 28 kg/m<sup>2</sup>, preoperative C-reactive protein (CRP) levels < 30 mg/dL, preoperative white blood cell (WBC) counts < 15,000/mm<sup>3</sup>, diameters of the appendix ≤ 10 mm, and no radiological signs of perforation.<sup>6,21</sup> In our analysis, no associated factors with failure

in the outpatient protocol for patients with uncomplicated appendicitis were identified.

In 2017, a cohort study involving 1,649 emergency appendectomies<sup>24</sup> revealed that outcomes of appendectomies executed by senior surgeons were compared with those performed by general surgery residents. The study showed no significant differences in postoperative complication rates, length of hospital stay, and overall duration of antibiotic treatment. Nevertheless, the surgery duration in the senior surgeon's group was significantly shorter compared with the resident's group (39.9 vs 48.6 minutes;  $p < 0.001$ ). This study demonstrates that laparoscopic appendectomies can be safely performed by surgical residents, as evidenced in our series.

Also, our analysis showed that none of the variables were significantly associated with postoperative complications or readmission. A previous study<sup>4</sup> showed no increase in the incidence of complications/readmissions for the outpatient group, but 72 patients required a 24-hour hospitalization postoperatively, and the authors could not identify a clinical indication for the postoperative admission.<sup>4</sup> These findings drive us to continue to apply our outpatient treatment protocol to improve the success of discharge in less than 24 hours after laparoscopic appendectomy for uncomplicated appendicitis and become the norm rather than the exception. However, it should be clarified that the protocol should not be used as a substitute for clinical judgment in the treatment of acute appendicitis patients.

As limitations, this was a single-center, non-randomized study, and complicated acute appendicitis patients were not included. Then, our results should be interpreted within the context of its design. However, it is necessary to recognize as a strength that this is the first study in Colombia and probably in Latin America that evaluates this type of protocol, demonstrating that it can be applied by residents, guaranteeing favorable and cost-effective outcomes, due to the low rate of complications and readmissions.

## CONCLUSIONS

This study demonstrated that the low-cost outpatient management protocol for uncomplicated appendicitis by laparoscopic appendectomy performed by the first- and second-year residents had a low frequency of complications and readmission, with no significant differences compared with open surgery or appendicular phase.

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