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Practical classification of the severity and medical-surgical management of acute appendicitis

Clasificación práctica de la gravedad y manejo médico-quirúrgico de la apendicitis aguda

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Keywords:
Appendicitis, classification, surgical management, complications, cecal appendix.

Palabras clave:
Apendicitis, clasificación, manejo quirúrgico, complicaciones, apéndice cecal.

ABSTRACT

Objective: To determine whether restructuring the macroscopic classification of acute appendicitis, according to the findings, can guide surgical management, directly impacting hospital stay, prognosis, complication rate and reinterventions. **Setting:** A public general hospital in the State of Mexico. **Design:** A prospective, cross-sectional, comparative, observational and analytical study. **Statistical analysis:** Descriptive statistics of demographic data comparing the appendicitis groups based on the suggested classification were used. Student's t test for continuous variables with a 95% confidence interval was used, along with the Excel data analysis system. A probability value < 0.05 was accepted as statistically significant. **Material and methods:** 182 patients admitted to the Emergency Department of the General Hospital of Atizapán in a period from November 2016 to October 2017 with painful abdominal syndrome suggestive of acute appendicitis, were studied. The classification suggested in evolutionary stages was applied by the author, relating it to the suggested management and contrasting it with the traditional classification and the liberal management of the other surgeons, assessing the presence of complications, re-interventions and days of hospital stay. **Results:** Patients with suggested management according to the new classification presented lower rates of infection and reintervention, compared to patients without suggested management in the classification presenting a higher rate of infections (41.1%), reinterventions (10.5%) and days of hospital stay (200-300% longer stay). **Conclusions:** This research allows us to recommend the use of this classification, since in addition to being accurate to assess the severity of acute appendicitis and its relationship with peritoneal cavity contamination, it serves as a guide to surgical management according to the intraoperative findings, decreasing, on the other hand, not only the rate of complications and days of hospital stay, but also reinterventions.

RESUMEN

Objetivo: *Determinar si la reestructuración en la clasificación macroscópica de la apendicitis aguda, de acuerdo con los hallazgos, puede guiar el manejo quirúrgico, impactando directamente en la estancia hospitalaria, el pronóstico, la tasa de complicaciones y las reintervenciones.* ***Sede:*** *Hospital General de Atizapán, ISEM.* ***Diseño:*** *Estudio prospectivo, transversal, comparativo, observacional y analítico.* ***Análisis estadísticos:*** *Se realizó estadística descriptiva de los datos demográficos, comparando los grupos de apendicitis con base en la clasificación sugerida, utilizando la t de Student para variables continuas con un intervalo de confianza de 95%, y el sistema análisis de datos de Excel. La probabilidad de < 0.05 fue aceptada como estadísticamente significativa.* ***Material y métodos:*** *Se estudiaron 182 pacientes que ingresaron al Servicio de Urgencias del Hospital General de Atizapán en un periodo de noviembre de 2016 a octubre de 2017, con síndrome doloroso abdominal sugestivo de apendicitis aguda; se les aplicó la clasificación sugerida en estadios evolutivos, por parte de los autores, relacionándola con el manejo sugerido y contrastándola con la clasificación tradicional y el manejo liberal de los demás cirujanos, valorando la presencia de complicaciones, reintervenciones y días de estancia hospitalaria.* ***Resultados:*** *Los pacientes con manejo sugerido de acuerdo con la nueva clasificación presentaron menor tasa de infección y de reintervención, comparado con los pacientes sin el manejo sugerido en la clasificación presentando una mayor tasa de infecciones (41.1%), reintervenciones (10.5%) y días de estancia hospitalaria (200-300% más de estancia).* ***Conclusiones:*** *Esta investigación nos permite recomendar el uso de esta clasificación, ya que además de ser precisa en la gravedad de la apendicitis aguda y su relación con la contaminación de la cavidad peritoneal, da guía al manejo quirúrgico de acuerdo con los hallazgos transoperatorios, disminuyendo no sólo la tasa de complicaciones y días de estancia hospitalaria, sino también las reintervenciones.*

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INTRODUCTION

Traditionally, the classification of acute appendicitis has include four phases according to the macroscopic anatomopathological intraoperative findings; however, these do not clearly define the severity of the contamination of the peritoneal cavity, nor its systemic repercussion in the patient.[1,2]

Classifying, meaning arranging by classes or types, is the logical operation that facilitates the exposition of thought in any activity and, therefore, allows us to guide decision making. The current classification of acute appendicitis into non-perforated and perforated seems more a description of the findings than a classification since it does not guide us in decision making. For example, a sealed stage 4 appendicitis is not the same as a stage 4 with free purulent material throughout the cavity or fecaloid material, and even with lesion to neighboring organs. Then, why classify and manage acute appendicitis in the same way? Complications after the initial management entail the need for imaging studies, invasive procedures, longer antibiotic use, and prolongation of hospital stay with reports of up to 58% in the rate of complications when the initial presentation of the picture is that of a perforated appendicitis.[3]

Due to the importance of this pathology because of its high frequency, it is necessary to reassess if the classification of acute appendicitis reflects its severity, so it may guide us to adequately perform the surgical intervention, and if this surgical conduct in each case has an impact on complications, reinterventions, and hospital stay.

Therefor the paradigm of complicated acute appendicitis must change, since it is not only the appendix, but there are two entities: the appendix and a peritoneal cavity. This way, a secondary peritonitis with the consequences that it implies, both local and systemic, must be managed properly, without propitiating or waiting for tertiary peritonitis or hostile abdomen, which can lead to septic shock and death.

Classifications of acute appendicitis

Over the years, the classification of acute appendicitis has been the subject of debate. The most traditionally used by surgeons is based on macroscopic observation of the surgical findings and is divided into four stages: stage 1 erythematous or catarrhal, stage 2 suppurative or phlegmonous, stage 3 necrotic, and stage 4 perforated. However, as is evident, this classification does not clearly define the severity of the pathology nor its repercussion in the peritoneal or systemic cavity.[1,4] Moreover, this classification lacks bibliographic support, so some authors have used other classifications, such as complicated or non-complicated acute appendicitis, perforated or non-perforated acute appendicitis. This shows that there is not a unified consensus for its classification. Therefore, other classifications have then been used: clinical-etiological (non-obstructive perforated or non-perforated, obstructive perforated or non-perforated, and by vascular obstruction); evolutive (without perforation or with perforation, with local or diffuse peritonitis added); and topographic according to the anatomical variants of the appendicular tip.[5]

Maingot in 2008 clearly defines the extent of the disease, especially in complicated cases, opening a door to the management for each phase. The disease extension may be 1) non-perforated acute appendicitis and 2) Perforated; and a) with local abscess and b) generalized peritonitis. However, it is not the same an acute appendicitis with free fecaliths than without them, with free fecal matter or without it, and in how many quadrants is found or if it is generalized. Also, the state of adjacent tissues, which can be ileus or cecum; if it is necrotic or with wide perforations; and more importantly the systemic state of the patient, should be considered.[6]

In 2003, Dr. Gilberto Guzman classified appendicitis according to surgical findings in the following manner which is very similar to Maingot's classification: grade 0 without appendicitis; Ia edematous and ingurgitated appendix; Ib abscessed or phlegmonous appendix; Ic necrotic appendix without perforation; II perforated appendix with localized abscess; and III appendicitis complicated with generalized peritonitis. This classification is an adaptation of Maingot's and,

like him, focuses only on the appendix without emphasizing adjacent tissues involvement and the management in each case.[7]

Recently the classification proposed by the Mexican Association of General Surgery, which includes I) Acute appendicitis, divided into 1) Nonperforated, subdivided as a) edematous, hyperemic, b) abscessed, phlegmonous, c) necrotic; 2) Perforated, subdivided as a) abscessed with localized peritonitis and b) generalized peritonitis; and 3) Acute reactive appendicitis and II) Chronic appendicitis, defines the extent of cavity contamination. However, this classification does not define the extent of peri-appendicular tissues or the patient's systemic status. Neither does it guide us in the decision-making process of surgical and post-surgical management.[8]

In 2012, Gomes proposed a classification according to laparoscopic findings into: grade 0 (normal appearing appendix); grade 1 (appendix with hyperemia and edema); grade 2 (fibrinous exudate); grade 3A (segmental necrosis); grade 3B (basal necrosis); grade 4A (abscess); grade 4B (regional peritonitis); and grade 5 (diffuse peritonitis).[9] The goal of this new system was to provide a standardized classification to allow a more uniform patient stratification for appendicitis investigation and to help determine the optimal management according to the grade assigned. In 2015, the same author Gomes gave a proposal for a new acute appendicitis classification system based on clinical, and imaging and laparoscopic findings. He classified appendicitis into 1) uncomplicated acute appendicitis, subdivided into grade 0, normal appearing appendix (endo-appendicitis/peri-appendicitis); grade 1 inflamed appendix (hyperemia, fibrin edema with no or very little pericholecystic fluid). 2) complicated acute appendicitis subdivided into grade 2 necrosis, A - segmental necrosis, (without or little pericolic fluid), B - base necrosis, (without or little pericolic fluid); grade 3 - inflammatory tumor. A - A phlegmon. B - Abscess less than 5 cm in diameter without peritoneal free air. C - Abscess greater than 5 cm in diameter without peritoneal free air, and grade 4 - perforated - diffuse peritonitis with or without peritoneal free air. This classification was born out of the author's observation that a new comprehensive classification system for acute appendicitis was needed because treatment options for complicated cases of acute appendicitis now include non-surgical modalities.[10]

The percentage of complications increases according to the type of acute appendicitis and its degree of evolution. Most frequent complications are infectious, wall abscesses, and intraperitoneal abscesses, but tertiary peritonitis and hostile abdomen may also be observed, which can lead to abdominal sepsis and septic shock.[11,12]

MATERIAL AND METHODS

A prospective, cross-sectional, observational, and analytical study was conducted in 182 patients admitted to the General Hospital of Atizapán in the period between November 2016 and October 2017 with the diagnosis of probable acute appendicitis.

The study protocol was approved by the Research and Ethics Committees of the *Hospital General de Atizapán, Estado de México*. Attached is the authorization sheet by the head of teaching and research, dated September 29, 2016. The confidentiality of the information obtained was always respected with strict respect for human dignity.

The present study did not imply any risk for the patients, since only the classification proposed by the author was applied, correlating it with the surgical finding in relation to the stage, surgical management, and rate of complications, as well as days of hospital stay without influencing the decision of the Surgeon assigned to the Emergency Department regarding medical decision or surgical intervention. The management performed was compared with that suggested, and contrasted according to evolution, complications, and days of hospital stay.

The aim of this new system was to provide a standardized classification to allow a more uniform patient stratification for the investigation of appendicitis, and to help determine the optimal management according to stage. To this end, surgical management was suggested according to the stage of the classification and to be able to compare whether it leads to a surgical procedure.

Descriptive statistics of demographic data were done, and analytical statistics were performed to compare the appendicitis groups using the Student's t test on continuous variables to assess the suggested classification, with a 95% confidence interval, using the Excel data analysis system. A probability value < 0.05 was accepted as statistically significant.

Suggested classification

The importance of a classification is to provide guidelines for surgical management, homogenize treatment, predict complications according to surgical findings and facilitate the healing process in the evolution of the patient, and to contribute to the teaching and learning process of surgical residents. In this way, management can be decided, reducing unnecessary prolonged in-hospital stay.

The logical operation that facilitates the exposition of thought in any activity to guide decision making is to group the elements following some criteria and then classify them.[13] In acute appendicitis the ideal classification system should be designed to meet the following conditions:

1. To provide an accurate description of the state of the lesion of the cecal appendix, surrounding tissues, and the degree of contamination of the peritoneal cavity.
2. To determine the most appropriate surgical treatment according to the degree of injury.
3. It should be useful in the calculation of the prognosis in the event of a possible complication.
4. That it complies with the recommendations for the surgical management of complicated acute appendicitis.
5. To establish norms for the prevention of surgical site infection, tertiary peritonitis, or hostile abdomen.

Therefore, the following classification of acute appendicitis is suggested, correlating

Table 1: Comprehensive classification of severity and suggested management of acute appendicitis.

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
• Acute appendicitis without perforation a. Erythematous, edematous b. Absceded c. Necrotic	• Acute perforated appendicitis with localized abscess	• Perforated acute appendicitis with generalized purulent peritonitis	• Perforated acute appendicitis with generalized purulent peritonitis + free fecaliths	• Acute perforated appendicitis with generalized peritonitis and ileal or cecal necrosis
Suggested handling	**Suggested handling**	**Suggested handling**	**Suggested handling**	**Suggested handling**
• Appendectomy and drying	• Appendectomy, drying and drainage	• Appendectomy, cavity lavage (without drainage)	• Appendectomy + exhaustive lavage and new systematic laparotomy within 48 hours according to the intervention criteria	• Appendectomy + right hemicolectomy with and/or ileal de-functionalization + exhaustive lavage and new systematic laparotomy within 48 hours according to reintervention criteria
1	2	3	4	5

Source: Study data.

it with surgical management *(Table 1)*. The findings are determined by the surgeon intraoperatively and will be described according to the classification used.

Support for suggested management

Use of antimicrobials: Antibiotic treatment should be started as soon as the indication for surgery is given and in case of severe sepsis or septic shock.[2,14] In the first hours of treatment, the aim of antibiotic therapy is to limit bacteremia and reduce the frequency of residual abscesses.[2,15] Antibiotic management should ideally cover aerobic and anaerobic microorganisms. Then, according to the guidelines, cultures should be taken to direct therapy. The use of antimicrobials should be continued with intravenous management until a minimum of 24 hours if there is no fever nor leukocytosis, besides an adequate general condition of the patient with a reestablished intestinal function.[4]

Surgical treatment: Antibiotic therapy contributes to improve the prognosis,[15] but it is not enough to achieve cure. An adequate surgical procedure is essential to control the origin of the infection. The fundamental objective in the surgical treatment of acute appendicitis complicated with secondary peritonitis is to control the cause of peritoneal contamination and the prevention of residual sepsis.

Drainage of the surgical site: Drains should be left in place to evacuate an undrained or insufficiently drained abscess or to establish a controlled fistula. Other than these indications, the placement of drains is ineffective in generalized peritonitis, as fibrin rapidly surrounds the drains along their intraperitoneal course and effectively block their outflow effect.[1] It is usually not necessary to leave drains in place if adequate cleansing of the abdominal cavity has been performed.[8]

Intraoperative peritoneal lavage for generalized peritonitis: The reduction of the bacterial inoculum in the abdominal cavity may be attained by aspiration of purulent material and by exploring the cul-de-sac and parieto-colic slides, as well as the subphrenic and subhepatic spaces. Intraoperative lavage with warm saline is a procedure generally performed during laparotomy for diffuse peritonitis. The addition of antibiotics to the lavage fluid does not seem to influence the evolution of the intraabdominal contamination.[16]

Lavage of the entire abdominal cavity should be performed until the fluid is clear, which results in excellent survival and minimal residual sepsis in patients with generalized peritonitis. The amount of peritoneal lavage fluid required varies from patient to patient. In some cases, it may be as much as 10 to 15 liters in severe postoperative stercoraceous peritonitis.[17,18]

Currently, not as much washing solutions are used. Today, only 3 to 5 liters are used according to some studies that, although they were performed on animals, have been taken as guidelines. They mention that it must be considered that peritoneal lavage alters the abdominal cavity local defense mechanisms. Saline solution acts as a co-adjuvant to alter phagocytosis and leukocyte migration in the abdominal cavity[19] so the addition of antibiotics or antiseptics to the lavage fluid alters neutrophil chemotaxis, inhibits their microbicidal activity[20] and increases the formation of postoperative adhesions.[21]

Once the abdominal lavage is completed, strict drying of the abdominal cavity is important because the residual saline solution dilutes the bacterial opsonins, leaves the bacteria in suspension in a liquid medium, reduces phagocytosis, and allows bacterial proliferation.

The use of an ion selectivity electrolyzed solution for intraoperative peritoneal lavage has recently been reported. Between 6 to 10 liters of the corresponding solution were used. They were previously heated at 37 ºC until macroscopic contamination was completely eliminated.[22] At our hospital we do not have any experience with the use of these type of solutions.

Reinterventions: In the most severe infections, particularly postoperative infections, there is no means to effectively drain the entire peritoneal cavity.[23] Two approaches have been proposed: on-demand re-interventions, which do not provide complete satisfaction due to the delay in revision sometimes observed in complex critical patients, and systematic re-

interventions scheduled every 24-48 hours until a macroscopically clean peritoneal cavity is achieved.[24] The criteria for reintervention are conditional *(Table 2)*. Strict compliance with the formal criteria for reintervention makes it possible before cardiocirculatory accidents secondary to toxic-infectious shock occur. The first manifestations of peritoneal infection, secondary to the loss of hermeticity of the appendicular stump closure or an incidental lesion, as in tertiary peritonitis occur very early, almost always within three days after the operation. Most often, the first manifestation is fever, followed by diarrhea, gastric hypersecretion and stasis, hiccups, isolated tachycardia, significant decrease in diuresis and, finally, lack of resumption of intestinal transit or secondary interruption.[17]

Management of the causative lesion: Occasionally, adjacent cecal necrosis, a lesion of the last portion of the small bowel, or both, is discovered; in either case, treatment consists of an ileocolic resection with ileostomy and terminal colostomy. In a patient in shock, tissue perfusion, including intestinal perfusion, is altered. In these circumstances, the risk of dehiscence of a new suture is high. The same risk of suture dehiscence exists after performing a digestive anastomosis in a septic environment. Therefore, in such situations, it seems prudent to forego immediate digestive continuity in favor of ostomies.[15]

Prevention of residual sepsis and surgical site infection: To prevent residual sepsis in a patient operated on for appendicitis complicated by generalized peritonitis, especially with the formation of residual abscesses, the fundamental objective must be to help the defense mechanisms of the peritoneum to recover their normal function. From the initial intervention, a very careful cleaning and debridement of all the fibrinopurulent material found should be carried out.

On the other hand, removal of abdominal hair has been mentioned as a general measure to prevent surgical site infection (SSI), which

Table 2: Criteria for reintervention in peritonitis.

Criteria for conservative behaviour	Criteria for conservative behavior	Criteria for rapid reintervention	Criteria for rapid reintervention
• Diuresis preserved (+ 40 ml/hour) • Stable cardiocirculatory state without the need for vasopressor amines and, above all, without having to progressively increase the doses • Lack of general toxic and infectious signs • Lack of abdominal signs of diffusion; intestinal transit preserved or restored and decreased nasogastric tube fluid output	• Rapid disappearance of the alarm sign that led to a suspected diagnosis of postoperative peritonitis • Slightly elevated neutrophil polymorphonuclear count or, if clearly elevated, a marked drop in values compared to the previous figure • Easily correctable functional renal failure • Lack of indication for assisted ventilation or prolongation of ventilation in a patient without preoperative respiratory failure	• Oligo-anuria • Insufficient cardiocirculatory status with increasing deterioration • Insufficient cardiocirculatory status with increasing deterioration • Lack of satisfactory clinical and laboratory response to intensive medical treatment • Abdominal signs of propagation; lack of resumption of intestinal transit or secondary arrest	• Elevated rate of leukocytosis • Persistence of renal failure despite intensive medical treatment or worsening of renal failure • Need for assisted ventilation

Source: Study data.
Adapted from: Parc Y, et al.[17]

should be done immediately before the operation.[25] Proper skin preparation at the time of the operative procedure with an antiseptic agent is a well-established preventive measure.[26] Gentle tissue handling, protection of wound edges with compresses, thorough contamination cleansing, complete removal of necrotic or devitalized tissues, and avoidance of dead spaces are important to prevent infection. Finally, avoiding hypothermia, maintaining high tissue oxygen concentrations, and avoiding hyperglycemia have been mentioned in relation to the prevention of SSI.[27,28]

Application of the suggested management according to stage

A. Stage 1: There is scarce presence of bacteria in the peri-appendicular fluid, so the suggested treatment is appendectomy, drying of the cavity, and antimicrobial management for two days with intravenous (IV) antibiotics. In our hospital we use in the first instance metronidazole 500 mg IV every eight hours or clindamycin 600 mg IV every eight hours in conjunction with ceftriaxone or cefotaxime 1 g IV every 12 hours. In children, the dose of each antibiotic is calculated according to their weight. The use of antimicrobials should be continued with intravenous management until a minimum of 24 hours if there is no fever nor leukocytosis, the patient is in general good conditions and his/her intestinal function is restablished.[4]
B. Stage 2: Perforated appendix with localized abscess. The suggested treatment is appendectomy, drying, and drainage in the cruciate area and IV antimicrobials for three to four days.
C. Stage 3: Perforated appendicitis with generalized purulent peritonitis. The suggested treatment is appendectomy and lavage of the peritoneal cavity without drains left in place, and IV antimicrobials for five to seven days (see surgical site drainage in management rationale).
D. Stage 4: Perforated appendix with generalized purulent peritonitis and free fecaliths. The treatment consists of appendectomy with exhaustive lavage of the peritoneal cavity without drains left in place, reoperation after 48 hours for a new abdominal cavity lavage according to the criteria for reoperation and clinical evolution (see drainage of the surgical area).
E. Stage 5: Perforated appendix stage 4 plus necrosis of ileum or cecum. The treatment includes a right hemicolectomy with abdominal cavity lavage and ileostomy or ileocolonic anastomosis (based on cavity contamination and whether septic shock is present), and a peritoneal cavity lavage without drainage, with reoperation after 48 hours for a new abdominal cavity lavage according to the criteria for reoperation and clinical evolution (see surgical site drainage).

RESULTS

All the descriptive statistical results were presented in the article, since it was a double study including both the diagnostic scale and the classification at the same time.[29]

Of the 182 cases reviewed, 110 were male and 72 were female, with a male/female ratio of 1.5/1. The most frequent age range was between 10 and 25 years.

The time of evolution of the clinical picture before admission to the hospital was two to three days on average, except in complicated cases, which took an average of 15 days.

The most common symptom was right iliac fossa pain, pain migration (90%), nausea or vomiting (90%). The least common symptom was anorexia (18%). The most detected signs were McBurney's (98.6%) and Von Blumberg's (90%).

The following post-surgical complications occurred: 19% with surgical site infection, reoperation in nine cases due to organ-space type surgical site infection (an already established classification of surgical site infection that divides it into superficial, deep and organ-space with presence of abscess, either in superficial fasciae, deep or in cavity). Appendicitis certified with ultrasound (USG) with evidence of residual abscess, plus clinical condition of fever, bloating and explosive diarrhea. Two cases required hemicolectomy and stoma; they had an evolution time of 15-20 days and presence of necrosis and perforation of the cecum.

Of the patients, 8.7% of appendicitis were not diagnosed by pathology and the most complicated conditions with the longest evolution time due to early diagnosis were 26.37%, being more frequent in cases of children, women and the elderly, which led to more days of hospital stay, surgical and postsurgical complications, as well as higher hospital costs.

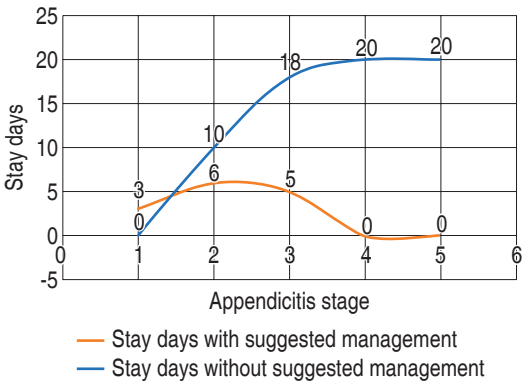
Of the 182 cases reviewed in relation to the appendicular stage corroborated by histopathological study, we observed a higher frequency of stage 4 (stage 2). The following post-surgical complications occurred: 34 cases (19%) with surgical site infection, reoperation in nine cases (4.9%) due to organ-space type surgical site infection (already established classification of surgical site infection that divides it into superficial, deep and organ-space with presence of abscess, either in superficial fasciae, deep or in cavity).[30] Two cases (1.09%) with prolonged evolution time of 15-20 days, which led to necrosis and perforation of the cecum, required hemicolectomy and stoma.

In relation to the proposed classification and its direct relationship with the suggested surgical management, data are shown in *Table 3* and *Figures 1 to 3*, from which we first deduce that of the 81 cases in stage one, the complication and reoperation rate is very low or nil. For stage two, the rate of infections is very low with the suggested management with only one case of surgical site infection that required wound healing procedures and six days of stay; compared to the 24 cases, where the management is not the suggested one. Two cases required reintervention due to organ space infection, with findings of intestinal inter-loop, pelvic and right subphrenic abscesses. In this stage, 47.8% of the 71 cases were complicated, and 13% of the total of 182 cases. This 47.8% of complicated cases occurred more frequently

Table 3: Relation of cases of acute appendicitis by stage, complications and days of hospital stay based on the suggested classification and management.

	Stage/ patients	Complica-tions	Reinter-ventions	Days of stay
Patients with suggested management	1/81	0	0	3
	2/46	1	0	6
	3/3	0	0	5
	4/0	0	0	0
	5/0	0	0	0
Patients without suggested management	1/0	0	0	0
	2/25	25	2	7-10
	3/5	5	3	12-18
	4/4	2	2	15-20
	5/2	2	2	15-20
p-value		0.22664	0.021312	0.044950

Source: Study data.



Days of stay in acute appendicitis (two-sample t-tests)

	With suggested management	No suggested management
Mean	2.8	13.6
Variance	7.7	74.8
Remarks	5	5
Hypothetical difference of means	0	
Degrees of freedom	5	
t-test	-2.65877621	
p-value (test) one-tailed	0.02247496	
Critical value of t-test (one-tailed)	2.01504837	
p (two-tailed test)	0.044950	
Critical value of t (two-tailed)	2.57058184	

Figure 1: *Days of stay of patients with stage 1, 2, 3, 3, 4 and 5 acute appendicitis with suggested management and without suggested management according to the proposed classification.*
Source: Study data.

in patients without the suggested management according to the stage and required a longer hospital stay, from seven to 10 days, for wound healing procedures and longer antibiotic administration. On the other hand, although we only had two reinterventions, they occurred in those who did not undergo the suggested management and the hospital stay increased to 12-15 days with the consequent hospital expense in all items: two surgeries, more days in bed, longer antibiotic use, intravenous solutions, man-hours, etc.

In stage 3, the five cases without suggested management presented complications of superficial and deep surgical site infection, and in three cases reoperation was required due to residual abscess and systemic inflammatory response, with a longer hospital stay of 12-18 days and higher overall hospital costs.

In stage 4 and 5, where the suggested management was not performed, four cases were found that required reintervention due to organ space infection, hospital stay of 15 to 20 days with a higher cost and the risk of greater morbidity and mortality for the patient.

In summary, we had 85 cases in stage 2-5 (corresponding to stage IV), of which 35 cases (41.1%) presented complications, were not staged as peritonitis secondary to complicated acute appendicitis and were not managed as suggested. Nine cases (10.5%) required reoperation, with an increase in hospital costs specially with a higher risk of morbidity and mortality. The hospital stay for these cases was 15 to 20 days, which is 200-300% more than in uncomplicated cases (three to five days). Not to mention the pending reconnection of intestinal transit, which will take more days of hospital stay.

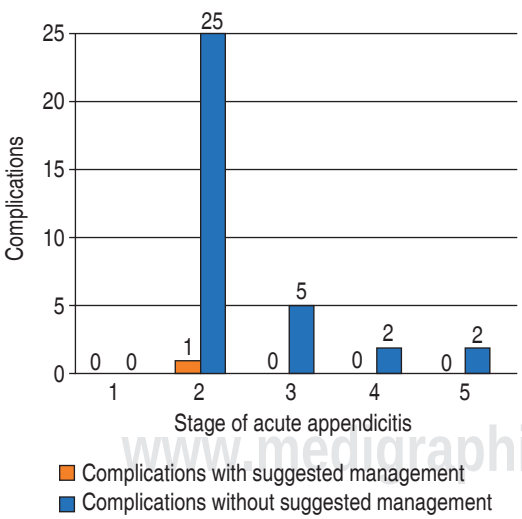
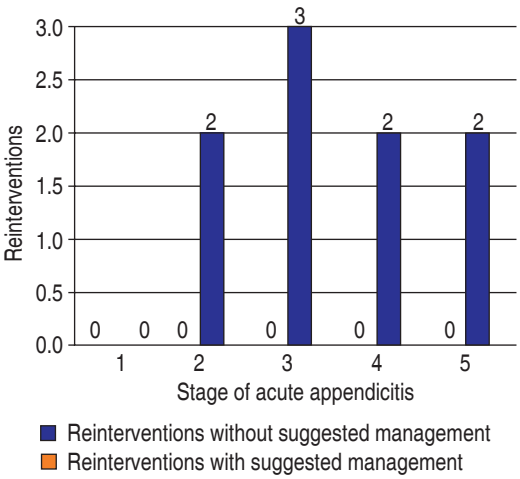


Figure 2: *Complication rate of patients with stage 1, 2, 3, 3, 4 and 5 acute appendicitis with suggested management and without suggested management according to the proposed classification.*
Source: Study data.



T-tests for two samples. Reinterventions of patients with acute appendicitis.

	With suggested management	Without suggested management
Mean	0	1.8
Variance	0	1.2
Observations	5	5
Hypothetical difference of means	0	
Grades of freedom	4	
t-test	-3.67423461	
p-value (one-tail)	0.01065582	
Critical t-test (one-tail)	2.13184679	
p-value (two-tails)	0.021312	
Critical t-test (two-tails)	2.77644511	

Figure 3: *Rate of re-interventions of patients with stage 1, 2, 3, 4 and 5 acute appendicitis with suggested management and without suggested management according to the proposed classification.*
Source: study data.

DISCUSSION

In relation to the suggested classification, we did not find much literature, only four articles suggesting a new classification, already contemplating that macroscopic classification is not adequate if it does not relate to severity to surgical management.

Gilberto Guzmán-Valdivia in 2003[7] suggested a useful classification in acute appendicitis dividing it into 3 grades from non-perforated appendicitis to perforated appendicitis with generalized peritonitis, mentioning at the same time surgical management with important results in the rate of complications and hospital stay. However, it does not consider or does not define whether the peritoneal contamination was purulent or fecaloid and whether the cecum or ileum were injured, so we consider our classification more specific and complete.

On the other hand, in 2015, Sergio David Castañeda[3] suggested changing the macroscopic classification of acute appendicitis, assessing whether it has any influence on the length of hospital stay and complication rate given the change in postoperative antibiotic management. He observed a decrease in the number of hospital days/year and in the number of antibiotic doses/year and reduction in the number of complications. He concluded that the change in the macroscopic classification and the new definition of perforated appendicitis has led to reduce the hospital stay and the number of antibiotics used without a significant impact on the rate of complications, giving greater emphasis on the use of antibiotics. In our classification, we go beyond the use of antibiotics with prevention of surgical site infection, tertiary peritonitis, and hostile abdomen.

In 2012, Gomes[9] proposed a classification according to laparoscopic findings; however, it was limited by its exclusive focus on intraoperative aspects, i.e., it continues with macroscopic description only seen during the laparoscopy procedure. In 2015, this same author[10] gave a new proposal for a new classification system for acute appendicitis based on clinical, imaging, and laparoscopic findings without any mention regarding the degree of peritoneal cavity contamination and its management, focusing on antibiotic management in early stages, with three days of management and in advanced or complicated up to 10 days of antimicrobials. But they did not mention the peritoneal cavity management, which in this proposal we do consider.

The suggested classification presented in this study indicates that it is possible to homogenize the characteristics of the surgical findings, to stage them, and gives us a guideline to decide an adequate surgical management considering the stage of the appendix, the peritoneal cavity, and the general condition of the patient. As can be seen in the graphs, the Student's t test showed a significant statistical p value < 0.05, which gives us the guideline to suggest this classification. In *Figure 1* we can observe that the mean number of days of stay in patients with suggested management was 2.8 days compared to 13.6 days in cases without the suggested management and p value = 0.04, barely significant. In *Figure 2* we found a higher rate of complications in stage 2 patients without suggested management with a mean of 6.8 compared to 0.2 in patients with suggested management. And in *Figure 3* we observed a higher rate of reinterventions in stages 2, 3, 4 and 5 without the suggested management with mean of 1.8 compared to 0 in patients with the suggested management, with a p value = 0.02.

CONCLUSIONS

The objective of this new classification system was to provide a standardized form to allow a more uniform patient stratification to guide the optimal management according to the stage, which was achieved by obtaining statistically significant results. Therefore, this publication allows us to recommend the use of this classification which, in addition to being clear in defining the severity of acute appendicitis, is directly related to the degree of contamination of the peritoneal cavity and damage of adjacent tissues and guides surgical management according to the interoperative findings. It helps to reduce hospital stay days, and therefore costs, by preventing complications, guiding us with the general and specific criteria of cavity management to avoid complications, reinterventions, and higher risk of mortality. It facilitates the healing process in the evolution of the patient, as well as the teaching-learning process of surgical residents.

It is left for the consideration of all surgeons, with the sole intention of favoring our work, the care of our patients and the teaching-learning process of all residents, by providing clarity on the severity to guide the surgical management based on the findings.

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