ECUATORIAN JOURNAL OF PEDIATRICS
rev-sepp.ec

ORIGINAL RESEARCH

Prevalence of complicated appendicitis and associated factors in pediatric surgery at Vicente Corral Moscoso and José Carrasco Arteaga Hospitals.

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Received: July 2, 2020
Accepted: August 19, 2020
Published: January, 2021
Editor: Dr Paúl Astudillo Neira

Bibliographic letterhead:

Sisalima J, Córdova F. Prevalence of Complicated Appendicitis and Associated Factors, in the Pediatric Surgery Service of the Vicente Corral Moscoso and José Carrasco Arteaga Hospitals. May 2018 -April 2019. Rev. Ecuat. Pediatría 2020;21(3):Article 21:1-8. doi: 10.52011/0031

DOI:
https://doi.org/10.52011/0031

Abstract

Introduction: Acute appendicitis is the most frequent surgical emergency in children, and it constitutes a diagnostic challenge. Studies indicate that the determining factor for complications from appendicitis are factors attributable to the patient, such as waiting before seeking hospital care.

Methods: A quantitative, analytical cross-sectional study was carried out. The universe consisted of all patients admitted with a diagnosis of acute appendicitis at Vicente Corral Moscoso and José Carrasco Arteaga Hospitals, April 2018 to May 2019. The association between variables was determined by the Chi-square test and the intensity of association by prevalence ratios and 95% confidence intervals. The *P* value <0.05 was considered significant.

Results: A total of 267 patients admitted with a diagnosis of acute appendicitis were investigated, and the prevalence of complicated appendicitis was 38.2%. It was observed that the associated factors were initial misdiagnosis with a prevalence ratio (PR) of 1.57 (95%CI: 1.16 - 2.14; *P* = 0.01) and elapsed time between the onset of symptoms to arrival at the hospital of greater than 12 hours (PR 2.19; CI: 1.34 - 3.59 ; *P*<0.001). A protective factor was having had a previous medical evaluation (PR 1.48 95%CI: 1.07–2.04; *P* = 0.01) and medium to high socioeconomic condition (PR 0.71; 95%CI: 0.53 - 0.96; *P* = 0.03).

Conclusions: The prevalence of complicated appendicitis was high and is related to certain factors.

Keywords: Appendicitis; Postoperative Complications; Child; Procastination.

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Introduction

Acute appendicitis is the inflammation of the vermiform appendix. It constitutes the main cause of abdominal surgery in children and represents a diagnostic challenge due to the overlapping of symptoms with other diseases, particularly in younger patients in whom the clinical signs and others symptoms can be unreliable and nonspecific. The delay in its recognition is associated with increased morbidity, mortality, and medical costs. For a timely diagnosis, it is necessary to accurately evaluate the symptoms and signs, relying on the clinic, a complete physical examination of the child, medical observation in the emergency service, and, if possible, the Alvarado and PAS scales. In a few cases, the use of laboratory and imaging tests for children suspected of having acute appendicitis is beneficial. In this sense, it is necessary to know in detail the epidemiological and clinical characterization of this disease, as this will help to avoid delays in its diagnosis and subsequent surgical management, minimizing any risk of complications [1]. This disease represents a serious public health problem that puts patients at risk and could cause a fatal outcome if not treated in a timely manner.

The literature reports that up to 20% of appendectomies are carried out after the condition has already presented important complications. Several studies indicate that the determining factors for complicated appendicitis are attributable to the patient, such as self-medication, waiting before seeking medical attention, living in rural areas with limited access to health services, and being of low socioeconomic status. In addition, a misdiagnosis is a factor attributable to medical personnel, either due to ignorance of the variety of clinical presentations or due to a short time of evolution. It is also known that nonspecific clinical manifestations are related to the anatomical position of the vermiform appendix and the age of the child; children under five years of age have a higher rate of appendicular perforation [2].

Therefore, the objective of this study is to establish the prevalence and associated factors of complicated appendicitis in patients admitted with a diagnosis of acute appendicitis at José Carrasco Arteaga and Vicente Corral Moscoso Hospitals from May 2018 to April 2019. The hypothesis is that the prevalence is greater than 30% and presents a positive association with the variables of self-medication; initial misdiagnosis; elapsed time between the onset of symptoms and hospital arrival; elapsed time from hospital arrival to surgical resolution; negative association with urban residence; medium and high socioeconomic status; the person in charge of the child's care (parents); and prior medical evaluation.

Population and methods

Type of study

A prospective cohort study was carried out, since its purpose is to determine the relationship or possible non-causal association that occurs between two or more variables and to establish the possible causes of the phenomenon to be studied.

Study area

The study was carried out at José Carrasco Arteaga (Ecuadorian Institute of Social Security) and Vicente Corral Moscoso (Ministry of Public Health) hospitals in the pediatric surgery service. These are medical centers in the province of Azuay in Ecuador.

Variables

Dependent variables: complicated appendicitis. The independent variables include self-medication, initial misdiagnosis, previous medical evaluation, elapsed time between the onset of symptoms and hospital arrival, elapsed time between hospital arrival and surgical resolution, and socioeconomic conditions of the patient. Moderate variables: age, sex, place of residence, person in charge of the child's care (parents).

Universe and Sample

The universe corresponds to the total number of children hospitalized with a diagnosis of acute appendicitis in the pediatric surgery service between the period May 2018 to April 2019. The entire population was studied, a total of 267 cases. The determination of the sample size was made based on the calculation to estimate a proportion. The set criteria consisted of the following: the estimated population was 267; the level of confidence for 95% security was 1.96; and accuracy was 3%. The sample size estimated in the Epidat 3.1

program [Sergas, Santiago de Compostela, A Coruña, Spain] was 50 patients.

Inclusion criteria

-All patients admitted to the pediatric surgery service of the José Carrasco Arteaga and Vicente Corral Moscoso hospitals with a diagnosis of acute appendicitis during the study period.

-Patients whose parents had signed the informed consent and agreed to participate in the study; information provided to obtain socioeconomic status through the National Institute of Statistics and Censuses (INEC) form.

Exclusion criteria

-Patients with additional comorbidities, such as abdominal surgical history, self-medication in the last seven days due to symptoms other than abdominal, patients with neoplastic pathologies.

-Patients with incomplete records.

Information gathering procedures

-Informed consent was obtained by the guardian or representative of the patient, providing information to obtain socioeconomic status through the INEC form.

-The information was compiled in a form designed exclusively for the study. Information on the socioeconomic condition was provided by the tutor, while information related to the associated factors was taken from the clinical history. Subsequently, this was entered into a database with individual identification.

During the study period, all pediatric patients admitted with a diagnosis of acute appendicitis were identified. A review of the clinical records, the identification of cases, complicated and uncomplicated, and the data of the different variables under study were carried out. For the investigation of the information regarding the socioeconomic condition, an interview was used with a questionnaire of stratification of the socioeconomic level from the INEC.

Research technique: Survey, documentary review, interview with caregivers of patients, interview with patients, consultation of clinical history.

Analysis technique

All data were organized using the statistical program SPSS, version 15 [IBM, Armonk, NY, USA], for analysis and tabulation.

The prevalence of complicated appendicitis was obtained from the extraction of the proportion represented by gangrenous and perforated appendicitis, in relation to the total number of cases of appendicitis. The obtained value was amplified by one hundred.

The qualitative variables of sex, residence, socioeconomic status, caregiver, previous medical assessment, self-medication, initial misdiagnosis, anatomical location of the vermiform appendix, phase of acute appendicitis, were presented in absolute and relative frequencies. In the quantitative variables of age, elapsed time between the onset of symptoms to hospital arrival, elapsed time from hospital arrival to surgical resolution, the range was obtained and they were treated with measures of central tendency and dispersion. To determine the association between variables, cross tables were used, placing the appendicular complication in the columns and each of the analyzed factors in the rows.

To determine the association between variables, the Chi^2 square test was performed, considering a value of $P<0.05$ as statistically significant. The intensity of the statistical association was obtained through the prevalence ratio with a 95% confidence interval; they were considered conclusive or positive when the prevalence ratios were greater than a value of one, and negative with values less than one.

Results

Univariate Analysis

General characteristics of the patients in the sample

A total of 267 patients who were admitted with a diagnosis of acute appendicitis were investigated, determining a prevalence of 38.2% cases of complicated appendicitis. Of the total population studied, the highest percentage corresponded to the male sex, corresponding in the same way the population with the highest percentage of complications (53.92%) (see Table 1) The most representative age group were those between 10 and 15 years. A greater representation of inhabitants from urban areas was found. In addition, the patients were typically of average socioeconomic status, and that the person in charge of the child's care were the parents.

In the study, the most common appendicular phase found during surgery corresponds to the phlegmonous

phase (42.6%), and the most frequent location corresponds to the retrocecal. Of the total 102 complicated appendicitis cases, 85.29% were in a retrocecal location (see Table 2).

Bivariate analysis

Once the analysis of the association between the possible associated factors and the symptoms of complicated appendicitis was conducted, it was determined that complicated appendicitis was positively associated with having a wrong initial diagnosis and an elapsed time between the onset of symptoms to hospital arrival of longer than 12 hours. Respectively, this presented a 1.57 and 2.19 times higher risk of presenting complicated issues. Furthermore, it was determined that having had a medical evaluation prior to arrival at the hospital, and having a medium and high socioeconomic condition were protective factors (see Table 3).

The self-medication variable did not show a statistically significant association; however, it should be noted that the most commonly used medications were analgesics: antispasmodics (31.68%) and NSAIDs (26.73%).

Discussion

In the present investigation, the prevalence of complicated appendicitis was high. A statistically significant association was determined with the variables of misdiagnosis and an elapsed time between the onset of symptoms to hospital arrival of greater than 12 hours. Having a prior medical assessment and a medium or high socioeconomic status acted as protectors.

The prevalence of complicated appendicitis obtained in a sample of 267 children in the present study was 38.2%. By comparison, a study conducted by Macías-Magadán et al. in Mexico [3] identified 33% of patients experienced complicated conditions. Similarly, research carried out in Peru by Jimmy et al. indicated 41%, and Cárdenas in Cuenca, Ecuador indicated 34.9% of complicated cases [4].

The prevalence of acute appendicitis varies according to the geographical location and characteristics of each population. However, in the studies carried out in Cuenca-Ecuador, results similar to those found in the present investigation are seen. As acute appendicitis is a frequent reason for attention, it is important to know the expected number of complicated cases to alert medical personnel to abdominal pain issues, thus avoiding possible complications.

Table 1 Sociodemographic characteristics

Variables		Frequency	%
Sex	Male	141	54.8
	Female	126	47.2
Age (Years)[1]	2 to 4	12	4.5
	5 to 9	85	31.8
	10 to 15	170	63.7
Socioeconomic condition	High	1	0.4
	Middle class (level A)	21	7.9
	Middle class (level B)	149	55.8
	Middle class (level C)	93	34.8
	Lower class	3	1.1
Place of residence	Urban	138	51.7
	Rural	129	48.3
Caretaker	Parents	259	93.6
	Siblings	6	2.2
	Close relative	10	3.7
	Others	1	0.4

[1] Median: 11 years

Table 2 Distribution according to appendicular phase and location of the Vermiform appendix

		Total	Complicated	%
Appendicular phase	Inflammatory	51	0	0
	Phlegmonous	114	0	0
	Gangrenous	30	30	11.23
	Perforated	72	72	26.96
	Pelvic	11	4	3.92
Location	Subcecal	24	10	9.81
	Retrocecal	229	87	85.29
	Retrocolic	2	1	0.98
	Pre-ileal	1	0	0

It was observed that there is a higher frequency of acute appendicitis in males, with 52.8%. Related data was evidenced in the investigation in Peru (61%) [5] and Colombia (56.50%) [6]. While in Ecuador, Tipan et al. [3], like Córdova et al. [7], found similar data to the present investigation with 56.5% and 54.1%, respectively.

Table 3 Distribution of Factors Associated with Complicated Appendicitis

Variables		Complicated apendicitis				*P*	PR	95% CI	
		Present		Absent					
		F	%	F	%				
Self-medication	Yes	44	44.40	55	55.60	0.11	1.29	0.95	1.74
	No	58	34.50	110	65.50				
Inicial misdiagnosis	Yes	31	53.45	27	33.97	0.01	1.57	1.16	2.14
	No	71	33.97	138	66.03				
Prior medical evaluation	Yes	64	44.76	79	55.24	0.01	1.48	1.07	2.04
	No	38	30.65	86	69.35				
Time onset of symptoms and arrival at the hospital[1]> 12 hours	Yes	88	44.44	110	55.56	0.0001	2.19	1.34	3.59
	No	14	20.29	55	79.71				
Time from admission to emergency until the time of surgical intervention[2]> 12 hours	Yes	22	41.50	31	58.50	0.58	1.11	0.77	1.60
	No	80	37.40	134	62.60				
Urban residence	Yes	46	33.33	92	66.67	0.09	0.77	0.56	1.04
	No	56	43.41	73	56.59				
Middle socioeconomic condition (level A)	Yes	57	33.33	114	66.67	0.03	0.71	0.53	0.96
	No	45	46.88	51	53.13				
Parents as caretakers	Yes	98	39.20	152	60.80	0.20	1.67	0.70	3.98
	No	4	23.53	13	76.47				

F: Frequency. PR: prevalence ratio. 95% CI: 95% confidence interval, [1]: 48 hours average. [2]: 8 hour average

The highest frequency of appendicitis cases was identified in the age group between 10 and 15 years (63.76%). Park in his study conducted in Peru [8], found that the highest percentage was the age group between 11 and 16 years. Tipan et al. [3], in their research in Cuenca-Ecuador, found that the most frequent age group was between 13 and 15 years, while Córdova et al. [7] determined that the highest frequency of appendicitis cases was in the age group of 6 to 11 years (54.1%).

The present study demonstrated that having a wrong initial diagnosis increases the risk of developing complicated appendicitis 1.57 times. Similar data was found by Cárdenas in his study in Cuenca (PR 1.6; *P* = 0.01) [4]. Several studies, such as those of Sanabria and collaborators in Colombia [9], García and collaborators in Azogues [10], Valderrama in Peru [11], and Macías–Magadan in Mexico [3] investigated this relationship without finding a statistically significant association. Therefore, subsequent studies with a similar methodology should be carried out to confirm this association.

Elapsed time from the onset of symptoms to hospital arrival of greater than 12 hours increases the risk of presenting complicated appendicitis 2.19 times. The study carried out by Cruz-Díaz, et al. (*P*<0.001; OR 5.72; CI: 3.16 -10.37) [12]; and Rodríguez Campos (PR 2.44 IC: 1.23 - 4.83; *P*= 0.009) [12] in Peru, found similar data, as did Cárdenas in Ecuador (PR 1.8; CI: 0.9 - 3.3; *P*= 0.03) [4]. This could be explained that when symptoms persist, people seek other professional opinion with the consequent prolongation of the diagnosis time and the increased risk of complications.

If we consider that complicated appendicitis is a problem that must be solved by surgical intervention, the opportunity to access surgical treatment will largely depend on the behavior of the population facing the problem. In other words, having a better socioeconomic level would allow a greater perception of risk. Therefore, the timely search for care is a protective factor. Corroborated data in the present investigation proves this to be a protective factor (PR 0.71; CI: 0.53 - 0.96; *P*= 0.03). This concurs with the study conducted in Mexico by Cortés [13], which indicates that having middle socioeconomic status is a protective factor (*P*= 0.04). However, this has certain limitations, as it corresponds to a population with different characteristics and different stratification of the variable. No other investigations in this regard required additional studies to corroborate this information.

A previous medical evaluation also acted as a protective factor in our research (PR 1.48; CI: 1.07 - 2.04; *P*= 0.01). Cárdenas' study, in the city of Cuenca-Ecuador, also investigated this variable without finding a

statistical association; however, although there are no other studies in the pediatric population that determine this condition, our results may be an approximation for future research in this regard.

Conclusion

The prevalence of complicated appendicitis was 38.2%. An initial erroneous diagnosis, and a time between the onset of symptoms to hospital arrival of greater than 12 hours proved to be the two factors associated with complications of acute appendicitis. Previous medical assessment and a medium to high socioeconomic status were associated with protective factors.

Abbreviations

PR: Prevalence ratio; NSAIDs: Non-steroidal anti-inflammatory drugs

Acknowledgments

We want to thank the operating room staff of the Cuenca Public Hospitals, places where the surgeries were performed.

Authors' contributions

JLSO: Research idea, data collection, article writing, statistical analysis, editorial corrections.
FMCN: Research idea, study design, critical analysis, research direction.
All authors read and approved the final version of the manuscript.

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Funding

The authors financed the expenses incurred in the production of this article.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due participant confidentiality but are available from the corresponding author on reasonable request.

Ethical statements

The protocol of this study was approved by the Institutional Teaching Committee and by the Bioethics Committee of the Faculty of Medicine of the Universidad de Cuenca.

Protection of persons

The authors declare that the procedures followed were in accordance with the ethical standards of the responsible human experimentation committee and in accordance with the World Medical Association and the Declaration of Helsinki.

Confidentiality of the data

The authors declare that they have followed the protocols of their work center on the publication of patient data.

Consent for publication

The authors have obtained the informed consent from the caretakers of the patients referred to in the article. This document is in the possession of the corresponding author. The parents have signed the authorization for publication of this article.

Competing interests

The authors have no competing interests to declare.

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SU: Short URL

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