

Predicting factors of postoperative complications in appendectomies.

Fatores preditores de complicações pós-operatórias em apendicectomias.

Luis Fernando Moreira, TCBC-RS^{1,2}; Henrique Iahnke Garbin³; Gabriella Richter Da-Natividade³; Bernardo Volkweis Silveira, ACBC-RS^{1,2}; Thais Vicentine Xavier⁴.

1. Federal University of Rio Grande do Sul, Postgraduate Program in Surgical Sciences, Faculty of Medicine, Porto Alegre, RS, Brazil.
2. Hospital de Clínicas de Porto Alegre, General Surgery Service, Porto Alegre, RS, Brazil.
3. Federal University of Rio Grande do Sul, Faculty of Medicine, Porto Alegre, RS, Brazil.
4. Federal University of Pelotas, Faculty of Medicine, Pelotas, RS, Brazil.

ABSTRACT

Objective: to evaluate the main risk factors for postoperative complications in patients undergoing appendectomy for acute appendicitis. **Methods:** we retrospectively analyzed 1241 patients undergoing open or laparoscopic appendectomy. Patients were allocated to four groups: Group 1, without postoperative complications, and Groups 2, 3, and 4, with postoperative complications defined according to their severity, following Clavien-Dindo classification (I, II, and \geq III, respectively). **Results:** patients aged \geq 38.5 years had more severe complications ($p < 0.0001$). Patients in Group 1, without postoperative complications, had, for the most part, a laparoscopic approach. Groups 2, 3, and 4 underwent, predominantly, to an open surgery ($p < 0.0001$). In cases of acute appendicitis, the *odds ratio* (OR) for complications was 3.09, 3.04, and 12.41 for Groups 2, 3, and 4, respectively ($p < 0.0001$). Anesthetic risk, duration of the procedure, and length of hospital stay were related to a higher risk and severity of complications. **Conclusion:** the main predicting factors of postoperative complications in patients operated for acute appendicitis were: age \geq 38.5

years, conventional or open surgical access, complicated appendicitis, ASA \geq 2, and surgical time >77 minutes.

Keywords: Appendicitis. Appendectomy. Risk Factors. Postoperative Complications.

INTRODUCTION

The morbidity rate of acute appendicitis is 10% and its mortality rates range from 0.24% to 4%. It is the most frequently diagnosed disease among emergency surgeons and it accounts for about 20% of all surgical interventions¹⁻³. Appendectomy is the gold standard treatment, recognized for more than a century, since its description by McBurney, in 1894⁴. The operation can be performed as an open or laparoscopic surgery, depending on the surgeon's experience, hospital characteristics, and factors related to the patient.

Recent studies suggest the efficacy of exclusive antibiotic therapy for the treatment of specific cases, especially for uncomplicated appendicitis, as an alternative to surgical treatment; however, such an indication remains controversial and debatable⁵⁻⁷. The current guideline of the Society of American Gastrointestinal and Endoscopic Surgeons and the consensus of The European Association for Endoscopic Surgery place surgery as the gold standard for the treatment of acute appendicitis^{8,9}. Postoperative complications should be considered when choosing the best management option, however, few studies describe the relevant risk factors for these complications^{10,11}. In addition, it is necessary to identify patients at higher risk for postoperative complications in order to maintain more frequent monitoring. Therefore, this study aims to identify the most common risk factors associated to postoperative complications after appendectomies.

METHODS

This study retrospectively analyzed 1241 classic or suspected cases of acute appendicitis admitted to the Emergency Department of *Hospital de Clinicas de Porto Alegre* (HCPA), Rio Grande do Sul, Brazil, and treated by conventional or laparoscopic appendectomy from 2009 to 2014. Pediatric patients, pregnant women, those operated in other services and referenced to HCPA due to complications, and also those with other diagnoses different from acute appendicitis were excluded from the study. This project was carried out by *Grupo de Pesquisa de Oncologia Cirúrgica do Sul* (SSORG) - a research group

on surgical oncology from the southern part of Brazil - and was approved by the Research Ethics Committee under number 496976157.0000.5327.

Patients were allocated to four different groups depending on the presence or absence of postoperative complication and on the degree of severity of the complication. We used Clavien-Dindo classification, proposed by Clavien *et al.*, in 1992, redefined by Dindo *et al.*, in 2004, and validated by Moreira *et al.* to the Portuguese language in 2016, to compare and report postoperative complications¹²⁻¹⁴. Group 1 was composed by operated patients who did not present postoperative complications; Groups 2, 3, and 4 were composed by patients with postoperative complications classified as Clavien-Dindo I, II, or \geq III, respectively (Table 1).

Table 1. Groups of the study

Group	Clavien-Dindo classification ¹³	Definition
1	-	Absence of postoperative complication
2	I	Any deviation from the ideal postoperative course without the need of pharmacological treatment or surgical, endoscopic, and radiological interventions.*
3	II	Requires pharmacological treatment with drugs other than those permitted for grade I complications.**
4	III	Requires surgical, endoscopic, or radiological intervention.
	IV	Life-threatening complication. Need for UTI treatment.
	V	Death of the patient.

*Therapeutic regimens allowed: analgesics, antipyretics, antiemetics, diuretics, electrolyte replacement, and physiotherapy. This category also includes operative wounds drained at bedside; **Blood transfusion and total parenteral nutrition are also included.

For each patient, the following epidemiological characteristics were determined: gender and age, type of access performed (open, laparoscopic, or converted), type of appendicitis (complicated or non-complicated), risk stratification (American Society of Anesthesiology - ASA), surgical time in minutes, length of hospital stay in days, and occurrence or non-occurrence of postoperative complication, classified according to Clavien-Dindo. Cases in which the appendix was only hyperemic and edematous or with fibrinous exudate were considered as uncomplicated appendicitis, whereas those with necrotic and abscessed or perforated appendix were considered as complicated appendicitis. Patients undergoing contaminated surgeries (uncomplicated appendicitis) received only antibiotic prophylaxis, and patients undergoing infected surgeries (complicated appendicitis), antibiotic therapy. In laparoscopic surgeries, three incisions to the abdominal cavity were made in a

triangular position: infraumbilical, left iliac fossa, and suprapubic. A three-month postoperative follow-up was performed to evaluate the presence of complications.

As for the statistical analysis, a significance level ≤ 0.05 was established for all tests. Data were analyzed using PASW Statistics for Windows, version 18.0, Chicago: SPSS Inc. For quantitative variables, data were expressed as mean and standard deviation or median; on the other hand, the qualitative variables were expressed in frequency tables. The Pearson's chi-square test was used for comparisons between categorical variables. The level of statistical significance for surgical and hospitalization time was calculated using the Kruskal-Wallis test of independent samples. *Odds ratio* (OR) was calculated using Group 1 as the control.

RESULTS

Age was associated with the severity of the complications. Patients older than 38.5 years had more severe complications [age determined as cutoff point by ROC Curve ($p < 0.0001$)]. Group 1 presented the lowest percentage of patients older than 38.5 years (25.2%), as shown in table 2. Gender was not a significant predictive factor for postoperative complications. The type of surgical access showed correlation among the groups ($p < 0.0001$). Group 1, without complications, had the majority of patients undergoing laparoscopic surgery, whereas in Groups 2, 3, and 4 most of patients were submitted to conventional surgery. Among the groups with complications, there was a higher frequency of laparoscopic surgery in Group 4. Uncomplicated appendicitis was associated with Group 1, whereas Groups 2, 3, and 4 were inversely associated with uncomplicated appendicitis ($p < 0.0001$). Complicated appendicitis presented OR of 12.41 (6.33-27.39; 95% confidence interval - CI) for Group 4. ASA score was associated with the severity of the postoperative complications ($p < 0.0001$). Group 1 was correlated to ASA score 1, Group 2 to ASA score 2, and Groups 3 and 4 to ASA scores ≥ 3 .

Table 2. Association among predicting variables of postoperative complications and the study groups.

	Group 1		Group 2		Group 3		Group 4		p
	n	%	n	%	n	%	n	%	
Gender									
Female	462	77.4	65	10.9	45	7.5	25	4.2	0.505
Male	478	51.9	77	54.2	52	53.6	37	59.7	
Age									
Up to 38.5 years	703	74.8	85	59.9	53	54.6	33	53.2	<0.0001
Above 38.5 years	237	25.2	57	40.1	44	45.4	29	46.8	
Type of surgery									
Open	442	47.0	93	65.5	66	68.0	39	62.9	<0.0001
Laparoscopic	467	49.7	40	28.2	26	26.8	19	30.6	
Converted	31	3.3	9	6.3	5	5.2	4	6.5	
Type of appendicitis									
Uncomplicated	641	68.2	58	40.8	40	41.2	9	14.5	<0.0001
Complicated	229	31.8	84	59.2	57	58.8	53	85.5	
ASA									
1	641	68.2	80	56.3	50	51.5	28	45.2	<0.0001
2	265	28.2	54	38.0	36	37.1	25	40.3	
≥3	34	3.6	8	5.6	11	11.3	9	14.5	

Significance level calculated by chi-square test.

Group 2 presented OR of 1.98, which increased according to the severity of the complications, reaching 2.60 in Group 3 (Table 3).

Table 3. Odds ratio of the groups that presented postoperative complications (Groups 2, 3, and 4) compared to the group of patients without postoperative complications (Group 1).

	Group 2		Group 3		Group 4		p
	OR	CI	OR	CI	OR	CI	
Female	0.873	0.61-1.12	0.895	0.58-1.36	0.7	0.40-1.17	0.505
Appendicitis Complicated	3.098	2.16-4.46	3.047	1.99-4.70	12.412	6.33-27.39	<0.0001
Above 38.5 years	1.989	1.37-2.86	2.461	1.60-3.76	2.605	1.53-4.39	<0.0001

Confidence interval of 95%. Significance level calculated by chi-square test; OR= odds ratio; CI= confidence interval.

Surgical duration and length of hospital stay were related to the severity of complications: the higher the mean and median of the variables, the greater the severity ($p < 0.0001$) (Table 4 and Figure 1).

Table 4. Mean and median of surgical duration and length of hospital stay in each group.

	Group 1		Group 2		Group 3		Group 4		
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	p
Surgical duration	67.77	60	77.43	70	77.68	70	88.47	85	<0.0001
Length of hospital stay	3.33	2.39	4.48	3.97	5.7	3.98	13.06	9.87	<0.0001

Surgical duration in minutes, length of hospital stay in days. Significance level calculated using Kruskal-Wallis test of independent samples.

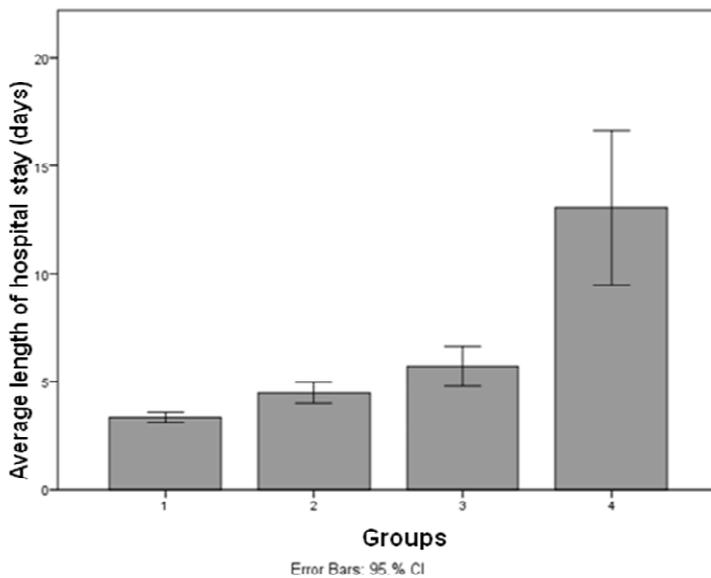


Figure 1. Average length of hospital stay in each group with its respective confidence interval. Confidence intervals: Group 1: 3.11-3.56; Group 2: 4.01-4.96; Group 3: 4.78-6.62; Group 4: 9.48-16.63. Significance level <0.0001 calculated using the Kruskal-Wallis test of independent samples.

DISCUSSION

Appendectomy is one of the most frequently performed surgical procedures in the world. There has been a growing increase in the incidence of acute appendicitis in recently industrialized countries, such as Brazil¹⁵. In addition to this, risk factors for postoperative complications of appendectomy have not been fully elucidated yet. The Clavien-Dindo classification proved to be effective in assessing the degree of surgical complication in several countries, being a simple, objective, and reproducible method, based on the therapeutic consequences of the complications^{13,14,16}. Our study demonstrated that the age over 38.5 years is predictive of postoperative complication, expected ratio due to the greater

number of comorbidities in older patients. The studies that specifically analyzed postoperative complications found a correlation with the increase of age, such as Kotaluoto *et al.*, who identified an average age of 39 years in those who developed severe complications¹¹. Advanced age range was correlated with a longer evolution of the disease in several analyzes, mainly due to its atypical presentation, which leads to a late diagnosis possibly influencing the type of appendicitis at surgery, with an increase in complicated appendicitis¹⁷⁻²⁰. In contrast to other studies, our work did not show statistical difference in the rate of complications when related to gender²⁰⁻²².

The type of surgical access was highly related to the risk of postoperative complications. The absence of complications was significantly associated with laparoscopic surgery, a treatment of choice for uncomplicated acute appendicitis, in previous studies related to a lower number of postoperative complications, shorter hospitalization time, less postoperative pain, and faster convalescence²². Studies also suggest a reduction of long-term costs with laparoscopic surgery²³⁻²⁵. However, among the groups with complications, the laparoscopic surgery was more associated with Clavien-Dindo \geq III Group, suggesting that, despite the lower number of complications with this approach, these tend to be more severe. Thus, our study ratifies the comparison studies between laparoscopic and open surgeries, in which conventional surgery is associated with greater number of complications.

Complicated appendicitis proved to be an important predictor of risk for postoperative complications. This finding confirms other analyzes that have demonstrated association of complications with the evolutionary phase of appendicitis, although these studies do not show increase in chance as high as presented here²⁶⁻²⁹. Complicated appendicitis increases the risk of postoperative complications, particularly in Clavien-Dindo \geq III Group, leading to an odds ratio of 12.41. Therefore, patients diagnosed with this type of appendicitis deserve more postoperative care for the early management of possible complications.

ASA classification proved to be a predictor of postoperative complications. As expected, since ASA evaluates the preoperative condition of the patient, with a score that predicts morbimortality and is one of the risk factors for surgical site infections³⁰. Likewise, surgical time and length of hospital stay after surgery were significantly associated with the degree of complications. Studies show that the longer hospitalization time is related to the evolutionary phase of appendicitis, which results in more severe complications^{19,28}.

Our results allow us to determine patients at greater risk for postoperative complications. Factors such as age \geq 38.5 years, open surgery, complicated appendicitis,

ASA \geq 2, and surgical time >77 minutes should be taken into account for the early diagnosis and treatment of such complications, aiming at reducing postoperative morbimortality.

RESUMO

Objetivo: avaliar os principais fatores de risco para complicações pós-operatórias em pacientes submetidos à apendicectomia por apendicite aguda. **Métodos:** foram analisados retrospectivamente 1241 pacientes submetidos à apendicectomia aberta ou laparoscópica. Os pacientes foram alocados em quatro grupos: Grupo 1, sem complicações pós-operatórias, e Grupos 2, 3 e 4, com complicações pós-operatórias, definidas de acordo com sua gravidade, conforme classificação de Clavien-Dindo I, II e \geq III, respectivamente. **Resultados:** pacientes com idade \geq 38,5 anos tiveram complicações mais graves ($p < 0,0001$). Os pacientes do Grupo 1, sem complicações pós-operatórias, foram predominantemente operados por via laparoscópica. Os Grupos 2, 3 e 4 foram, em sua maior parte, operados por via convencional ($p < 0,0001$). Razão de chances de complicações para apendicite complicada foi de 3,09, 3,04 e 12,41 para os Grupos 2, 3 e 4, respectivamente ($p < 0,0001$). Risco anestésico, duração do procedimento e tempo de internação hospitalar estiveram relacionados com maior risco e gravidade de complicações ($p < 0,0001$). **Conclusão:** os principais fatores preditores de complicações pós-operatórias em pacientes operados por apendicite aguda foram: idade \geq 38,5 anos, acesso cirúrgico convencional ou aberto, apendicite complicada, ASA \geq 2 e tempo cirúrgico >77 minutos.

Descritores: Apendicite. Apendicectomia. Fatores de Risco. Complicações Pós-Operatórias.

REFERENCES

1. Bhangu A, Søreide K, Di Saverio S, Hansson Assarsson J, Thurston Drake F. Acute appendicitis: modern understanding of pathogenesis, diagnosis, and management. *Lancet*. 2015;386(10000):1278-87.
2. Rebollar González RC, García Álvarez J, Trejo Téllez R. Apendicitis aguda: revisión de la literatura. *Rev Hosp Jua Mex*. 2009;76(4):210-6.
3. Shogilev DJ, Duus N, Odom SR, Shapiro NI. Diagnosing appendicitis: evidence-based review of the diagnostic approach in 2014. *West J Emerg Med*. 2014;15(7):859-71.
4. McBurney C. IV. The incision made in the abdominal wall in cases of appendicitis, with a description of a new method of operating. *Ann Surg*. 1894;20(1):38-43.

5. Flum DR. Clinical practice. Acute appendicitis--appendectomy or the "antibiotics first" strategy. *N Engl J Med.* 2015;372(20):1937-43. Erratum in: *N Engl J Med.* 2015;372(23):2274.
6. Harnoss JC, Zelenka I, Probst P, Grummich K, Müller-Lantzsch C, Harnoss JM, et al. Antibiotics versus surgical therapy for uncomplicated appendicitis: systematic review and meta-analysis of controlled trials (PROSPERO 2015: CRD42015016882). *Ann Surg.* 2017;265(5):889-900.
7. Wilms IM, de Hoog DE, de Visser DC, Janzing HM. Appendectomy versus antibiotic treatment for acute appendicitis. *Cochrane Database Syst Rev.* 2011;(11):CD008359.
8. Gorter RR, Eker HH, Gorter-Stam MA, Abis GS, Acharya A, Ankersmit M, et al. Diagnosis and management of acute appendicitis. EAES consensus development conference 2015. *Surg Endosc.* 2016;30(11):4668-90.
9. Korndorffer JR Jr, Fellingner E, Reed W. SAGES guideline for laparoscopic appendectomy. *Surg Endosc.* 2010;24(4):757-61.
10. Bliss LA, Yang CJ, Kent TS, Ng SC, Critchlow JF, Tseng JF. Appendicitis in the modern era: universal problem and variable treatment. *Surg Endosc.* 2015;29(7):1897-902.
11. Kotaluoto S, Pauniah SL, Helminen MT, Sand JA, Rantanen TK. Severe complications of laparoscopic and conventional appendectomy reported to the Finnish Patient Insurance Centre. *World J Surg.* 2016;40(2):277-83.
12. Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. *Surgery.* 1992;111(5):518-26.
13. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240(2):205-13.
14. Moreira LF, Pessôa MC, Mattana DS, Schmitz FF, Volkweis BS, Antoniazzi JL, et al. Adaptação cultural e teste da escala de complicações cirúrgicas de Clavien-Dindo traduzida para o Português do Brasil. *Rev Col Bras Cir.* 2016;43(3):141-8.
15. Ferris M, Quan S, Kaplan BS, Molodecky N, Ball CG, Chernoff GW, et al. The global incidence of appendicitis: a systematic review of population-based studies. *Ann Surg.* 2017;266(2):237-41.
16. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg.* 2009;250(2):187-96.

17. Augustin T, Cagir B, Vandermeer TJ. Characteristics of perforated appendicitis: effect of delay is confounded by age and gender. *J Gastrointest Surg.* 2011;15(7):1223-31.
18. Brenner AS, Santin J, Virmond Neto F, Boursheid T, Valarini R, Rydygier R. Apendicectomia em pacientes com idade superior a 40 anos - análise dos resultados de 217 casos. *Rev Bras Coloproct.* 2006;26(2):128-32.
19. Fischer CA, Pinho MSL, Ferreira S, Milani CAC, van Santen CR, Marquardt RA. Apendicite aguda: existe relação entre o grau evolutivo, idade e tempo de internação? *Rev Col Bras Cir.* 2005;32(3):136-8.
20. Nutels DBA, Andrade ACG, Rocha AC. Perfil das complicações após apendicectomia em um hospital de emergência. *ABCD Arq Bras Cir Dig.* 2007;20(3):146-9.
21. Silva SM, Almeida SB, Lima OAT, Guimarães GMN, Silva ACC, Soares AF. Fatores de risco para as complicações após apendicectomias em adultos. *Rev Bras Coloproct.* 2007;27(1):31-6.
22. Werkgartner G, Cerwenka H, El Shabrawi A, Bacher H, Hauser H, Mischinger HJ, et al. Laparoscopic versus open appendectomy for complicated appendicitis in high risk patients. *Int J Colorectal Dis.* 2015;30(3):397-401.
23. Di Saverio S, Mandrioli M, Sibilio A, Smerieri N, Lombardi R, Catena F, et al. A cost-effective technique for laparoscopic appendectomy: outcomes and costs of a case-control prospective single-operator study of 112 unselected consecutive cases of complicated acute appendicitis. *J Am Coll Surg.* 2014;218(3):51-65.
24. Long KH, Bannon MP, Zietlow SP, Helgeson ER, Harmsen WS, Smith CD, Ilstrup DM, Baerga-Varela Y, Sarr MG; Laparoscopic Appendectomy Interest Group. A prospective randomized comparison of laparoscopic appendectomy with open appendectomy: clinical and economic analyses. *Surgery.* 2001;129(4):390-400.
25. Santos FD, Cavasana GF, Campos T. Perfil das apendicectomias realizadas no Sistema Público de Saúde do Brasil. *Rev Col Bras Cir.* 2017;44(1):4-8.
26. Iamarino APM, Juliano Y, Rosa OM, Novo NF, Favaro ML, Ribeiro MAF Jr. Fatores de risco associados às complicações de apendicite aguda. *Rev Col Bras Cir.* 2017;44(6):560-6.
27. Li Z, Zhao L, Cheng Y, Cheng N, Deng Y. Abdominal drainage to prevent intra-peritoneal abscess after open appendectomy for complicated appendicitis. *Cochrane Database Syst Rev.* 2018;5:CD010168.

28. Lima AP, Vieira FJ, Oliveira GPM, Ramos PS, Avelino ME, Prado FG, et al. Perfil clínico-epidemiológico da apendicite aguda: análise retrospectiva de 638 casos. Rev Col Bras Cir. 2016;43(4):248-53.
29. St Peter SD, Sharp SW, Holcomb GW 3rd, Ostlie DJ. An evidence-based definition for perforated appendicitis derived from a prospective randomized trial. J Pediatr Surg. 2008;43(12):2242-5.
30. Wolters U, Wolf T, Stützer H, Schröder T. ASA Classification and perioperative variables as predictors of postoperative outcome. Br J Anesth. 1996;77(2):217-22.

Received in: 07/07/2018

Accepted for publication: 09/21/2018

Conflict of interest: none.

Source of funding: none.

Mailing address:

Luis Fernando Moreira

E-mail: lufmoreira@hcpa.edu.br / hgarbin@hcpa.edu.br