

Relevant aspects of acute appendicitis

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INTRODUCTION

Appendicitis is the most frequent abdominal surgical emergency. The risk of developing an appendiceal disorder during life is 7%, which represents 11 cases per 10,000 inhabitants per year. It may occur at any age, but it is generally found in patients aged from 15 to 30 years (23 cases/10,000 inhabitants/year)¹⁻⁴. The diversity of differential diagnoses makes the right-side acute abdominal pain more difficult to be elucidated, especially in women. Even when all symptoms and exams indicate appendicitis, the surgical procedure and the histopathological exam of the appendix may show a normal appendix, another diagnosis, or no abdominal disorder. Despite many thousands of published studies about appendicitis, the appendix is still a mysterious organ and its disorders are still not well known

RELEVANT ASPECTS

This critical literature review of acute appendicopathies, including appendicitis, emphasizes 10 pivotal topics, which are relevant to the diagnosis and treatment of appendiceal disorders. This systematic search of the literature was performed on PubMed and Medline according to the PRISMA.

ETIOPATHOGENESIS OF THE ACUTE APPENDICOPATHIES

The appendix is a misunderstood organ, considering the unidentified role it plays in the body. Despite the paracecal position, the appendiceal characteristics are different from all other digestive organs and do not seem to be linked to digestion^{1,2}. Its rich neuroendocrine and immune cell structure, as well as its disorders, have a closer relationship with neuroendocrine and immune systems. To reinforce this concept, it is important to highlight that the most frequent cancer of the digestive system is adenocarcinoma, but the most common appendiceal malignancy is the carcinoid tumor, which belongs to the neuroendocrine system².

There are many theories about the pathogenesis of appendicitis, most of which are associated with obstructive factors and intraluminal hypertension, but none of them has been proven to be true in experimental and clinical studies¹⁻⁴. Another theory describes the neuroimmunoendocrine appendicopathy, whose clinical picture is similar to that of acute appendicitis, but without inflammation⁴⁻⁹. This disease, known since the beginning of the past century, may clarify the morphologically normal appendices found in patients with clinical and radiological manifestations of acute appendicitis.

DIAGNOSIS OF ACUTE APPENDICITIS

The diagnosis of appendicitis is a challenge even for surgeons with great clinical experience. Migrating pain to the right flank associated with hyporexia, fever, and a painful mass in the right flank is the classic clinical manifestation of acute appendicitis. However, this medical condition, accompanied by leukocytosis ($>10,000/\text{mm}^3$), neutrophilia (70–95%), and toxic granulations in the leukocytes, is present in less than 60% of patients with acute appendicitis^{2,10}.

Abdominal radiography in the anteroposterior view presents disorders in up to 95% of the cases and discloses distension of the cecum and ascending colon with fecal accumulation in the cecum, due to an adynamic ileum, as a cecal response to the appendiceal inflammation¹¹⁻¹³. Other radiographic findings are appendiceal fecaliths, air within the appendix, loss of the cecal wall and psoas muscle boundaries, and a nonspecific mass in the right flank^{2,14,15}. The ultrasound exam shows a non-mobilized and enlarged ($>6\text{ mm}$) inflamed appendix^{2,15,16}. Computed tomography presents findings similar to those found in radiography and ultrasound^{2,15,16}.

WHEN TO OPERATE AN ACUTE APPENDICITIS

Acute appendicitis diagnosed in a critically ill patient with clinical instability must be immediately operated due to the risk of

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Conflicts of interest: the authors declare there is no conflicts of interest. Funding: none.

Received on December 19, 2021. Accepted on January 06, 2022.

serious complications that occur when appendicitis progresses to perforation, peritonitis, and sepsis^{2,4}. In contrast, if the suspicion of acute appendicitis occurs in a young patient, who is previously healthy and with uncharacteristic symptoms, the patient may be hospitalized for more exams and clinical observation. In these cases, if the option is for surgical treatment, it can be performed during the day under favorable conditions for the patient and the surgical team^{2,4}.

SURGICAL ACCESS TO APPENDECTOMY

The current preference is for laparoscopy through three ports (umbilical and suprapubic of 10 mm and another in the right flank of 5 mm). This procedure initially allows for diagnostic confirmation of appendiceal inflammation. Even if the appendix looks normal, most surgeons opt for appendectomy. However, according to the surgeon's decision, laparoscopy may only be propaedeutic, without removing a morphologically normal appendix. In this case, the patient must be controlled and informed that he/she still has an appendix and should be kept in the hospital until the clinical manifestations disappear. If there is a worsening of the clinical manifestations without evidence of another disorder, the removal of the appendix is indicated through a second laparoscopy during the same hospitalization^{1,4,17,18}. The main advantages of laparoscopy are as follows:

- more accurate diagnosis of the appendicopathy;
- access to the entire abdomen for diagnosis and treatment of another disorder, if the appendiceal inflammation is not confirmed;
- removal of the appendix inside the trocar, without contamination of the abdominal wall and, consequently, less risk of surgical infection;
- the possibility of other procedures in the same surgical act, such as aspiration of liquids, including pus, in generalized peritonitis, and drainage of abscesses;
- lower incidence of incisional hernias;
- less postoperative pain;
- faster return to normal activities.

Single-port appendectomy is performed by surgeons who have experience in laparoscopy and have adequate devices. Appendectomy using robotic arms associated with single port access will gain space in surgical procedures in the near future¹⁹⁻²¹.

Laparoscopy may be contraindicated or converted to laparotomy in the presence of the following:

- cardiovascular collapse and pulmonary failure exacerbated by pneumoperitoneum;

- multiple abdominal adhesions resulting from previous surgical procedures or other abdominal disorders that prevent safe access to the appendix;
- a woman in the last trimester of pregnancy, due to difficulty in accessing the appendix, mainly by surgeons with less practice;
- difficulty to control a surgical complication.

Specific transverse incision over the McBurney's point is indicated if there is no possibility of laparoscopy or if the surgeon has no experience with this method. When performing a laparotomy, even with a specific incision, the appendix must always be removed, regardless of whether it is inflamed or not^{1,4,18}.

MANAGEMENT OF THE APPENDICEAL STUMP AND DRAINAGE

Before the laparoscopic appendectomy, the management of the appendiceal stump after the removal of the appendix was a controversial issue. Stump ligation with or without its invagination, and even leaving the stump without ligation but only with local drainage have been published^{1,4,18}. However, experience has shown that there is no difference between the results of the different managements. In laparoscopy, the stump is only clipped or ligated without invagination or coverage and no relevant complication has been registered when the surgical procedure is adequate^{1,4,18-21}. Therefore, the management of the appendiceal stump is up to the surgeons to use their own best judgment.

Another controversial issue is regarding the drainage of the operated region. Some surgeons routinely leave local drains; however, most of them prefer to drain when there is no conviction in the perfect closure of the appendiceal stump or cecum. The lack of consensus also refers to the type of drain to be used. Some opt for the rubber Penrose drain, others for a silicone tubular, multitubular, covered tubular, or even the combination of several drains. This difference in options is due to uncertain and unpredictable drainage efficacy. Even in the presence of multiple local drains, a cecal fistula may be externalized far from its origin without any drain path. In fact, fistulas remain a difficult challenge to be understood and prevented. The drain should be maintained only if the drainage volume is above 30 ml/day. The patient in good health can be discharged from the hospital and change the drain dressings at home or at a medical service. After the drain is removed, a new abdominal imaging study must be performed to confirm that there is no longer any collection to be drained.

CARE WITH THE SURGICAL ACCESS

Skin antisepsis before all surgical procedures, including appendectomies, should use soapy antiseptics and alcoholic solutions, preferably iodinated, for a sufficient time to achieve an adequate and effective cleaning. All studies show that care and well-done skin antisepsis is the most effective method of reducing surgical infection. Antibiotic prophylaxis may be recommended, although its results ARE NOT certain, and there is no uniformity regarding the drug and its period of use^{1,4,18,19,22}. Protectors of the abdominal wall in appendectomies did not prove their efficacy.

At the end of laparoscopy operations, it is useless to clean the port, as the trocars protect it. In contrast, after appendectomy through laparotomy, the abdominal wall must be cleaned after closing the peritoneum. There is no consensus on the solution to be used, and comparative studies have shown no difference among them. Most surgeons use 0.9% saline solution at room temperature with good results; however, other solutions may be suitable as long as they do not harm the tissues^{2,4}.

POSTOPERATIVE ABDOMINAL COMPLICATIONS

Most of the appendectomy postoperative follow-ups are uneventful with progressive improvement of the patients, who may be discharged from the hospital on the first postoperative day. However, in the presence of fever, sickness, and abdominal pain, the patient must not be discharged from the hospital, and laboratory and imaging exams are mandatory. The most frequent complications include infection of the abdominal wall, pericecal abscess, and right subphrenic abscess. Appendiceal stump or cecal fistula may also occur, and the diagnosis can be confirmed by ultrasound or computed tomography. Immediate adequate drainage is required either for an intra-abdominal abscess or fistula, and the drain may be introduced using an imaging method. If the complication cannot be cured by conservative drainage, a new surgical treatment may be required. Using laparoscopy, most complications, including general peritonitis, are adequately treated. Surgical difficulties and complications indicate conversion to laparotomy^{1,4,18-22}.

NONOPERATIVE TREATMENT

Antibiotics and clinical control are the most widely recommended treatments in the presence of uncomplicated abdominal inflammatory diseases, such as diverticulitis, salpingitis, enterocolitis, and cholecystitis. Acute appendicitis has also been conservatively treated on special occasions over the past 70 years, with good immediate results in 60% of the cases²³⁻²⁵. The other 40% of the patients worsen their health condition or experience recurrence

of symptoms during the early post-treatment period. All of these cases must be immediately submitted to appendectomy²³⁻²⁵.

The conservative treatment started in the early years of the twentieth century for patients in adverse conditions, such as the absence of surgeons or an adequate surgical environment. The clinical results were considerably improved after the introduction of antibiotics. The conservative treatment starts with parenteral large-spectrum antibiotics against gram-negative bacteria. If the patients are in a good healthy condition, they may be discharged from the hospital and are advised to take the prescribed oral antibiotics for 2 weeks²³⁻²⁵.

FOOD INTAKE

Until half a century ago, the food intake was progressively released from restricted liquid only after patients had efficacious peristalsis for fear of colonic stasis and consequent cecal fistula. However, all studies have shown that regular food intake can be released since the first postoperative day. Fistulas and abscesses are not related to food intake^{17,22}. Major complications, such as peritonitis, or postoperative nausea and vomiting, usually due to the side effects of anesthetics, hinder the onset of food intake until the reduction of the patient's symptoms. During this short time, parenteral hydration is recommended^{17,22}.

RETURN TO USUAL ACTIVITIES AFTER TREATMENT

The patient should be discharged from the hospital as soon as he/she is able to walk and eat, and has a normal autonomy, even on the same day of the surgical procedure^{2,14}. To avoid the risk of incisional hernia, regardless of the size of the operation and surgical access, abdominal efforts should be avoided for at least 60 days^{17,22}.

FINAL CONSIDERATIONS

Despite being studied in many thousands of published works, the appendix is still an unknown organ in terms of its characteristics and functions. The pathophysiology of appendicopathies, including acute appendicitis, has not yet been established. Surgical progress has made the treatment safer, with better results and a faster recovery of patients to their normal life.

AUTHORS' CONTRIBUTIONS

AP: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, original draft writing, review and editing.

REFERENCES

1. Evans SRT. Appendicitis 2006. *Ann Surg.* 2006;244(5):661-2. <https://doi.org/10.1097/01.sla.0000243591.65502.02>
2. Snyder MJ, Guthrie M, Cagle S. Acute appendicitis: efficient diagnosis and management. *Am Fam Physician.* 2018;98(1):25-33. PMID: 30215950
3. Petroianu A, Oliveira Neto JE, Alberti LR. Incidência comparativa da apendicite aguda em população miscigenada, de acordo com a cor da pele. *Arq Gastroenterol.* 2004;41:24-6. <https://doi.org/10.1590/S0004-28032004000100005>
4. Bhangu A, Søreide K, Di Saverio S, Assarsson JH, Drake FT. Acute appendicitis: modern understanding of pathogenesis, diagnosis, and management. *Lancet.* 2015;386(10000):1278-87. [https://doi.org/10.1016/S0140-6736\(15\)00275-5](https://doi.org/10.1016/S0140-6736(15)00275-5)
5. Ferris M, Quan S, Kaplan BS, Molodecky N, Ball CG, Chernoff GW, et al. Global incidence of appendicitis: a systematic review of population-based studies. *Ann Surg.* 2017; 266(2):237-41. <https://doi.org/10.1097/SLA.0000000000002188>
6. Gutierrez M, Artioli T, Lopes FI, Monteiro FR, Boratto SDF. Appendectomy: prognostic factors in the Brazilian unified health system. *Rev Assoc Med Bras.* 2020;66(11):1493-7. <https://doi.org/10.1590/1806-9282.66.11.1493>
7. Petroianu A, Barroso TVV. Pathophysiology of acute appendicitis. *JSM Gastroenterol Hepatol.* 2016;4(3):1-4.
8. Villar Barroso TV, Petroianu A. Neuroimmunoendocrine peptides on inflamed and morphologically normal appendices removed due to clinical acute appendicitis. *Int J Surg.* 2019;67:76-8. <https://doi.org/10.1016/j.ijsu.2019.05.017>
9. Barroso TVV, Sales PGO, Petroianu A. Assessment of the vasoactive intestinal polypeptide in morphologically normal appendices removed from patients with clinical diagnosis of acute appendicitis. *Emerg Med.* 2015;5(1):1-4.
10. Petroianu A, Barroso TVV, Buzelin MA, Theobaldo BM, Tafuri LSA. Neuroendocrine apendicopathy in morphologically normal appendices of patients with diagnosis of acute appendicitis: diagnostic study. *Ann Med Surg.* 2020;60:344-51. <https://doi.org/10.1016/j.amsu.2020.10.044>
11. Howell JM, Eddy OL, Lukens TW, Thiessen MEW, Weingart SD, Decker WW. Clinical policy: critical issues in the evaluation and management of emergency department patients with suspected appendicitis. *Ann Emerg Med.* 2010;55(1):71-116. <https://doi.org/10.1016/j.annemergmed.2009.10.004>
12. Petroianu A. Faecal loading in the caecum as a new radiological sign of acute appendicitis. *Radiography.* 2005;11(3):198-200.
13. Petroianu A, Alberti LR, Zac RI. Faecal loading in the caecum as a new radiological sign of acute appendicitis. *World J Gastroenterol.* 2005;11(27):4230-2. <https://doi.org/10.3748/wjg.v11.i27.4230>
14. Petroianu A, Alberti LR, Zac RI. Assessment of the persistence of faecal loading in the caecum in presence of acute appendicitis. *Int J Surg.* 2007;5(1):11-6. <https://doi.org/10.1016/j.ijsu.2006.01.012>
15. Hawkins JD, Thirlby RC. The accuracy and role of cross-sectional imaging in the diagnosis of acute appendicitis. *Adv Surg.* 2009;43:13-22. <https://doi.org/10.1016/j.yasu.2009.02.010>
16. Rybkin AV, Thoeni RF. Current concepts in imaging of appendicitis. *Radiol Clin North Am.* 2007;45(3):411-22. <https://doi.org/10.1016/j.rcl.2007.04.003>
17. Nakhamiyayev V, Galldin L, Chiarello M, Lumba A, Gorecki PJ. Laparoscopic appendectomy is the preferred approach for appendicitis: a retrospective review of two practice patterns. *Surg Endosc.* 2010;24(4):859-64. <https://doi.org/10.1007/s00464-009-0678-x>
18. Jen HC, Shew SB. Laparoscopic versus open appendectomy in children: outcomes comparison based on a statewide analysis. *J Surg Res.* 2010;161(1):13-7. <https://doi.org/10.1016/j.jss.2009.06.033>
19. Mason RJ. Surgery for appendicitis: is it necessary? *Surg Infect.* 2008;9(4):481-8. <https://doi.org/10.1089/sur.2007.079>
20. Lee J, Baek J, Kim W. Laparoscopic transumbilical single-port appendectomy: initial experience and comparison with three-port appendectomy. *Surg Laparosc Endosc Percut Tech.* 2010;20(2):100-3. <https://doi.org/10.1097/SLE.0b013e3181d84922>
21. Saber AA, Elgamel MH, Ghazaly TH, Dewoolkar AV, Akl A. Simple technique for single incision transumbilical laparoscopic appendectomy. *Int J Surg.* 2010;8(2):128-30. <https://doi.org/10.1016/j.ijsu.2009.12.001>
22. Vidal O, Valentini M, Ginestà C, Martí J, Espert JJ, Benarroch G, et al. Laparoendoscopic single-site surgery appendectomy. *Surg Endosc.* 2010;24(3):686-91. <https://doi.org/10.1007/s00464-009-0661-6>
23. Gutierrez M, Artioli T, Lopes FI, Monteiro FR, Boratto SDF. Appendectomy. *Rev Assoc Med Bras.* 2020;66:1493-7.
24. Campbell MR, Johnston SL, Marshburn T, Kane J, Lugg D. Nonoperative treatment of suspected appendicitis in remote medical care environments: implications for future spaceflight medical care. *J Am Coll Surg.* 2004;198(5):822-30. <https://doi.org/10.1016/j.jamcollsurg.2004.01.009>
25. Podda M, Gerardi C, Cillara N, Fearnhead N, Gomes CA, Birindelli A, et al. Antibiotic treatment and appendectomy for uncomplicated acute appendicitis in adults and children: a systematic review and meta-analysis. *Ann Surg.* 2019;270(6):1028-40. <https://doi.org/10.1097/SLA.0000000000003225>

