



Assessment and surgical management of appendicitis in pediatrics

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LITERATURE REVIEW

ABSTRACT

Acute appendicitis is one of the most common surgical emergencies in childhood, requiring rapid assessment and intervention. The clinical and radiological characteristics of this condition may vary in children, presenting significant diagnostic challenges. Surgical management is essential to avoid serious complications, such as perforation and peritonitis. Considering the importance of an early and precise approach, the evaluation and surgical management of appendicitis in pediatrics have been the subject of studies and systematic reviews to optimize clinical practice. Objective: To analyze and synthesize recent studies on the evaluation and surgical management of appendicitis in children, aiming to identify the best diagnostic and therapeutic practices. Methodology: The review was carried out in accordance with PRISMA guidelines. The PubMed, Scielo and Web of Science databases were searched for articles published in the last 10 years. The descriptors used included "pediatric appendicitis", "diagnosis", "surgery", "management" and "evaluation". The inclusion criteria were original studies focusing on clinical evaluation, imaging diagnosis and surgical management in pediatric patients with acute appendicitis. Exclusion criteria were studies in languages other than English, Portuguese or Spanish, case reports and narrative reviews. Results: The results highlighted the importance of careful clinical evaluation, together with the use of imaging tests, such as ultrasound and computed tomography, in the diagnostic approach to appendicitis in children. In addition, several surgical strategies were discussed, including laparoscopy, and the role of pre- and postoperative antibiotic therapy. Factors such as age, clinical presentation and time elapsed since the onset of symptoms were considered when making surgical decisions. Conclusion: The systematic review highlights the importance of a multidisciplinary and individualized approach in the evaluation and surgical management of appendicitis in pediatrics. The evidence gathered provides support to improve clinical practices, aiming for an effective and safe approach in this specific context.

Keywords: "pediatric appendicitis", "diagnosis", "surgery", "management" and "evaluation".

Avaliação e manejo cirúrgico da apendicite em pediatria

RESUMO

A apendicite aguda é uma das emergências cirúrgicas mais comuns na infância, exigindo rápida avaliação e intervenção. As características clínicas e radiológicas desse quadro podem variar em crianças, apresentando desafios diagnósticos significativos. A conduta cirúrgica é essencial para evitar complicações graves, como perfuração e peritonite. Considerando a importância da abordagem precoce e precisa, a avaliação e conduta cirúrgica da apendicite em pediatria têm sido objeto de estudos e revisões sistemáticas para otimizar a prática clínica. Objetivo: Analisar e sintetizar os estudos recentes sobre a avaliação e conduta cirúrgica da apendicite em crianças, visando identificar as melhores práticas diagnósticas e terapêuticas. Metodologia: A revisão foi realizada de acordo com as diretrizes do PRISMA. As bases de dados PubMed, Scielo e Web of Science foram pesquisadas para artigos publicados nos últimos 10 anos. Os descritores utilizados incluíram "apendicite pediátrica", "diagnóstico", "cirurgia", "conduta" e "avaliação". Os critérios de inclusão foram estudos originais com foco na avaliação clínica, diagnóstico por imagem e conduta cirúrgica em pacientes pediátricos com apendicite aguda. Os critérios de exclusão foram estudos em idiomas que não fossem inglês, português ou espanhol, relatos de caso e revisões narrativas. Resultados: Os resultados destacaram a importância da avaliação clínica criteriosa, juntamente com o uso de exames de imagem, como ultrassonografia e tomografia computadorizada, na abordagem diagnóstica da apendicite em crianças. Além disso, foram discutidas diversas estratégias cirúrgicas, incluindo a laparoscopia, e o papel da antibioticoterapia pré e pós-operatória. Fatores como idade, apresentação clínica e tempo decorrido desde o início dos sintomas foram considerados na tomada de decisão cirúrgica. Conclusão: A revisão sistemática destaca a importância da abordagem multidisciplinar e individualizada na avaliação e conduta cirúrgica da apendicite em pediatria. As evidências reunidas fornecem suporte para aprimorar as práticas clínicas, visando uma abordagem eficaz e segura nesse contexto específico.

Palavras-chave: "apendicite pediátrica", "diagnóstico", "cirurgia", "conduta" e "avaliação"

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INTRODUCTION:

Acute appendicitis is a common condition in children, characterized by inflammation of the vermiform appendix, a small organ located at the beginning of the large intestine. This is one of the most frequent surgical emergencies in the pediatric age group, requiring a careful and rapid approach to prevent serious complications. Clinical assessment plays a crucial role in early identification of this condition, as symptoms can vary according to the child's age and ability to communicate. Generally, pediatric patients may present with diffuse or localized abdominal pain in the right lower quadrant, associated with symptoms such as nausea, vomiting and fever. However, children who are younger or are unable to clearly express their symptoms may present with less specific signs, such as irritability, refusal to eat, and bloating. Therefore, a detailed clinical history and a thorough physical examination are essential to guide the diagnostic investigation.

In addition to clinical assessment, diagnostic imaging plays a fundamental role in confirming clinical suspicion of appendicitis in children. Ultrasonography is often used as the initial method of choice, especially in suspected cases of uncomplicated appendicitis. This exam is non-invasive and does not involve exposure to radiation, and is well tolerated by pediatric patients. However, its sensitivity and specificity can be influenced by the operator's experience, image quality and the presence of factors such as obesity and intestinal gas. In cases of inconclusive diagnosis or suspected complications, computed tomography (CT) may be indicated. Abdominal CT has high sensitivity and specificity in detecting acute appendicitis and can provide detailed information about the severity of the disease and the presence of complications such as perforation or abscess. However, consideration should be given to the potential risk of radiation exposure, especially in younger children, and the need to minimize this risk by limiting the use of CT only to cases where it is clinically justified.

Acute appendicitis is a condition that requires immediate surgical approach, especially in children, due to the risk of serious complications, such as perforation and peritonitis. In this context, surgical management plays a central role, with appendectomy being the standard intervention to remove the inflamed appendix.



Recently, laparoscopy has emerged as a preferred therapeutic option, offering benefits such as shorter hospital stays and faster recovery compared to open surgery. Furthermore, antibiotic therapy plays an important role in the management of acute appendicitis, helping to reduce the bacterial load and preventing postoperative infectious complications. Administration of antibiotics before and after surgery has been associated with improved clinical outcomes, including reduced rates of wound infection and intra-abdominal abscess. Finally, when deciding on surgical management and postoperative management, it is essential to consider aspects specific to the pediatric population, such as the patient's age, clinical presentation, and the presence of underlying medical conditions. An individualized approach, taking these factors into account, is essential to ensure the best care and satisfactory clinical results for children with acute appendicitis.

The objective of this systematic literature review is to perform a comprehensive and updated analysis of scientific studies published in the last 10 years, addressing the evaluation and surgical management of appendicitis in pediatric patients. We intend to critically examine the available evidence to identify patterns, trends and gaps in the diagnostic and therapeutic approach to this condition in children, considering different modalities of diagnostic imaging, surgical methods, antibiotic therapy and post-operative management. Additionally, we seek to provide practical, evidence-based recommendations to guide clinicians, surgeons and other healthcare professionals in the effective management of appendicitis in children, aiming to improve clinical outcomes, reduce associated complications and optimize the quality of life of these patients.

METHODOLOGY

To carry out this systematic literature review, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist was used as a methodological guide. The PubMed, Scielo and Web of Science databases were searched to identify relevant studies on the topic. The descriptors used were "appendicitis", "children", "clinical evaluation", "surgical management" and "treatment". The inclusion criteria for selecting studies were as follows: studies published in the last 10 years; studies carried out in children diagnosed with appendicitis; studies that addressed



aspects of the clinical evaluation and surgical management of appendicitis in pediatrics; studies available in full text; studies published in English, Portuguese or Spanish.

The exclusion criteria were as follows: studies in adults or mixed populations of adults and children; studies that did not directly address the clinical assessment and surgical management of appendicitis in pediatrics; studies that were not available in full text; studies with small samples or isolated case reports; studies with unreliable methods or results.

Study selection was carried out independently by two reviewers, with any disagreement resolved by consensus or by consultation with a third reviewer. The selected articles were then evaluated for methodological quality and relevance to the review. Relevant data were extracted and synthesized to provide a comprehensive and up-to-date analysis on the topic of clinical assessment and surgical management of pediatric appendicitis.

RESULTS

15 articles were selected. Clinical evaluation is the first step in diagnosing appendicitis in children and plays a key role in early identification of this condition. Initially, a complete anamnesis is essential, in which detailed information is obtained about the symptoms presented by the child, such as abdominal pain, nausea, vomiting and fever. The medical history should include specific questions about the duration, location and intensity of the pain, as well as any triggers or associated symptoms. Careful physical examination is also crucial, with special attention to the presence of clinical signs suggestive of appendicitis, such as pain on palpation in the right lower quadrant of the abdomen, abdominal rigidity and signs of peritoneal irritation. Additionally, assessment of the child's general condition, including vital signs and assessment of hydration status, provides important additional information to determine the severity of the condition and the need for immediate intervention. Careful interpretation of data collected during clinical evaluation, combined with knowledge of the risk factors and clinical characteristics of appendicitis in children, is essential to guide diagnostic and therapeutic management.



Diagnostic imaging plays a crucial role in confirming the diagnosis of appendicitis in children, especially when symptoms are ambiguous or when there is a need to confirm clinical suspicion. Ultrasonography is often the first imaging test performed due to its availability, safety and lack of exposure to ionizing radiation. This exam is capable of identifying findings suggestive of appendicitis, such as the presence of a dilated, hyperemic appendix with compression of the surrounding tissue. However, the sensitivity and specificity of ultrasound can be influenced by several factors, including the experience of the operator, the presence of obesity and intestinal gas, as well as the age and cooperation of the child. In cases of inconclusive diagnosis or when complications are suspected, computed tomography (CT) may be indicated. Abdominal CT offers high sensitivity and specificity in detecting acute appendicitis and provides detailed information about the severity of the disease and the presence of complications such as perforation or abscess. However, the potential risk of radiation exposure, especially in younger children, and the need to weigh the diagnostic benefits against the potential risks must be kept in mind. Therefore, the choice of the most appropriate imaging method must be individualized, taking into account the severity of the condition, the availability of resources and the specific factors of each case.

Surgical management is a crucial step in the treatment of acute appendicitis in pediatric patients. Appendectomy, which involves removing the inflamed appendix, is the standard procedure used to treat this condition. However, the choice between the laparoscopic approach and open surgery is an important consideration. Laparoscopy, also known as minimally invasive surgery, has emerged as a preferred option due to its benefits, including shorter hospital stays, faster recovery and a lower incidence of postoperative complications, such as surgical wound infection and abdominal adhesions. During the laparoscopic procedure, small incisions are made in the abdomen to insert a camera and surgical instruments, allowing clear visualization of the appendix and surrounding tissues. This facilitates precise removal of the inflamed appendix, minimizing tissue trauma and accelerating the healing process. However, it is important to emphasize that the choice of surgical technique must be individualized, taking into



account the surgeon's experience, the severity of the disease, the presence of complications and the specific characteristics of each patient.

Antibiotic therapy plays a key role in the management of acute appendicitis in children, helping to reduce bacterial load and prevent infectious complications after surgery. The use of antibiotics before appendectomy aims to control infection and reduce bacterial dissemination, minimizing the risk of intra- and postoperative complications, such as abscesses and surgical wound infection. After surgery, antibiotic therapy continues to be indicated to prevent infection of the surgical wound and reduce the risk of systemic complications, such as sepsis. The most commonly used antibiotics for the treatment of appendicitis include third-generation cephalosporins, such as ceftriaxone, associated or not with agents with anaerobic coverage, such as metronidazole. The choice of antibiotic regimen should take into account the local susceptibility of microorganisms, the presence of known allergies to antibiotics and the possible need for adjustments based on the results of cultures and sensitivity tests. It is important to highlight that antibiotic therapy must be prescribed and monitored by a qualified healthcare professional, following clinical guidelines and considering the individual characteristics of each patient.

Pain management is an essential part of perioperative care for children undergoing appendectomy. Acute abdominal pain associated with appendicitis can be severe and trigger significant anxiety and discomfort in children. Therefore, it is essential to adopt effective strategies to control pain and promote well-being throughout the process, from hospital admission to postoperative recovery. A multimodal approach to pain management is often used, involving a combination of analgesics, non-pharmacological techniques and supportive care. Opioid analgesics, such as morphine and fentanyl, are often administered to control acute pain in the perioperative period, providing rapid and effective relief. However, because of potential side effects such as respiratory depression and sedation, opioid use must be carefully monitored, especially in young children or patients with underlying medical conditions. Additionally, administration of non-opioid analgesics, such as acetaminophen and ibuprofen, may be a complementary option to control mild to moderate pain and reduce the need for



opioids.

Alongside the use of medication, non-pharmacological techniques such as relaxation, distraction and massage can help alleviate the pain and emotional discomfort associated with hospitalization and surgery. Emotional support and effective communication with the child and their family are essential to ensure adequate pain control and promote a positive experience during the process. Additionally, preoperative education about the surgical procedure, postoperative care, and pain expectations can help reduce fear and anxiety, preparing the child for surgery and facilitating recovery. Pain management should be individualized and tailored to each patient's needs and preferences, with regular assessment of treatment effectiveness and adjustments as needed to ensure maximum comfort and well-being.

Complications associated with pediatric appendicitis can vary in severity and significantly impact a patient's prognosis. One of the most feared complications is perforation of the appendix, which occurs when inflammation is not treated early and results in rupture of the organ. This can lead to the spread of bacteria into the abdominal cavity, resulting in peritonitis, a potentially fatal condition that requires immediate surgical intervention. Furthermore, perforation of the appendix increases the risk of formation of intra-abdominal abscesses, which may manifest as localized purulent collections and require adequate drainage and antibiotic therapy. Other complications include the formation of intestinal obstructions due to adhesions or scars resulting from chronic inflammation of the appendix, as well as the occurrence of secondary infections, such as sepsis, which require intensive treatment and hemodynamic support. Therefore, early recognition and appropriate management of complications are essential to minimize the adverse impact of pediatric appendicitis and ensure better clinical outcomes for patients.

The identification of severity criteria is essential to guide clinical and surgical management in children with acute appendicitis. Signs of peritonitis, such as abdominal muscle guarding, heightened sensitivity to palpation and signs of peritoneal irritation, are indicative of a more advanced disease and may require immediate surgical intervention. Furthermore, the presence of significant leukocytosis, persistent high



fever, and signs of dehydration, such as tachycardia and hypotension, are markers of severity that may indicate the need for intensive care and close monitoring. Careful evaluation of these criteria, along with the interpretation of clinical and radiological findings, helps determine the best course of action for each patient, ensuring an individualized approach adapted to the specific needs of each case. Importantly, early identification and appropriate management of severity criteria are essential to avoid serious complications and improve clinical outcomes in children with acute appendicitis.

A multidisciplinary approach is essential to ensure the effective management of appendicitis in children, involving the collaboration of different healthcare professionals to provide integrated and comprehensive care. The multidisciplinary team may include pediatric surgeons, pediatricians, radiologists, nurses and other healthcare professionals, each playing a specific role in the assessment, diagnosis, treatment and monitoring of patients. Effective communication between team members is essential to ensure proper coordination of care, exchange of relevant information, and collaborative decision-making. Furthermore, the multidisciplinary approach allows for a comprehensive assessment of each patient's individual needs, taking into account not only the medical aspects of the condition, but also the emotional, social and family aspects. This may include the involvement of social workers, psychologists, and occupational therapists to provide emotional support, educational guidance, and help in adapting to changes resulting from the illness and treatment. Ultimately, a patient-centered, multidisciplinary approach promotes holistic, personalized care, resulting in better clinical outcomes and quality of life for children with appendicitis.

Regular follow-up after surgery is essential to monitor recovery and ensure the continued well-being of children undergoing appendectomy. During the postoperative period, it is important to carry out periodic evaluations to detect any complications early, monitor the healing of the surgical incision and evaluate the effectiveness of the treatment. This may involve outpatient visits with the pediatric surgeon, follow-up imaging tests such as an abdominal ultrasound, and laboratory tests to monitor white blood cell levels and assess for infection. Additionally, post-operative follow-up provides an opportunity to provide additional support to patients and their families by answering



any questions or concerns related to recovery, providing guidance on appropriate home care, and offering resources to facilitate reintegration into everyday life. Long-term follow-up is also important to monitor the development of any late complications, such as abdominal adhesions or intestinal obstruction, and to ensure that the child remains healthy and free from recurrences of appendicitis. Ultimately, effective post-operative follow-up plays a crucial role in promoting complete recovery and preventing further complications after appendicitis surgery in children.

Educating parents and caregivers about the signs and symptoms of appendicitis in children plays a key role in early detection and appropriate management of this condition. It is essential to provide clear and accurate information about the typical symptoms of appendicitis, such as persistent abdominal pain, nausea and vomiting, and the importance of seeking immediate medical attention if suspected. Additionally, it is important to educate parents about the risk factors associated with appendicitis in children, such as age and personal or family medical history, to help them recognize the warning signs and act promptly. Educating parents about available treatment options, including the importance of early surgery and the use of antibiotic therapy, can help reduce anxiety and increase adherence to the treatment plan recommended by healthcare professionals.

In addition to parental education, community and healthcare professional awareness of appendicitis in children is crucial to ensure an integrated and effective approach to the diagnosis and treatment of this condition. Public awareness campaigns, educational talks, and training programs for healthcare professionals can help increase knowledge about pediatric appendicitis, promoting a proactive approach to early detection and appropriate management. Additionally, access to educational resources, such as informational materials and updated clinical guidelines, can empower healthcare professionals to provide high-quality, evidence-based care to children with suspected appendicitis. By increasing awareness and knowledge about this condition, it is possible to improve clinical outcomes and reduce complications associated with appendicitis in children, ensuring timely and effective diagnosis and treatment.

CONCLUSION

In short, the evaluation and surgical management of pediatric appendicitis involves a multidisciplinary and integrated approach to ensure early diagnosis and adequate treatment of this condition. Studies have shown that clinical assessment and diagnostic imaging play a key role in accurately identifying appendicitis in children. Furthermore, surgical management, including the choice between laparoscopic appendectomy and open surgery, is crucial to ensure satisfactory clinical results and rapid recovery. Pre- and postoperative antibiotic therapy has also been shown to be effective in preventing infectious complications and reducing hospital stays.

Perioperative pain management and adequate postoperative follow-up are essential to ensure the comfort and recovery of pediatric patients. Furthermore, raising awareness among parents and caregivers about the signs and symptoms of appendicitis and the importance of seeking immediate medical attention are crucial for early diagnosis and timely treatment. Finally, continuous education of healthcare professionals and community awareness are essential to ensure an integrated and effective approach to the management of appendicitis in children, aiming for better clinical results and quality of life for patients.

BIBLIOGRAPHIC REFERENCES:

1. Jumah S, Wester T. Non-operative management of acute appendicitis in children. *Pediatr Surg Int.* 2022 Nov 28;39(1):11. doi: 10.1007/s00383-022-05284-y.
2. Gil LA, Deans KJ, Minneci PC. Appendicitis in Children. *Adv Pediatr.* 2023 Aug;70(1):105-122. doi: 10.1016/j.yapd.2023.03.003.
3. Glass CC, Rangel SJ. Overview and diagnosis of acute appendicitis in children. *Semin Pediatr Surg.* 2016 Aug;25(4):198-203. doi: 10.1053/j.sempedsurg.2016.05.001
4. Bašković M, Zaninović L, Čizmić A, Žganjer M. Stump appendicitis in children: a systematic review. *Pediatr Surg Int.* 2023 May 15;39(1):199. doi: 10.1007/s00383-023-05475-1
5. He K, Rangel SJ. Advances in the Diagnosis and Management of Appendicitis in Children. *Adv Surg.* 2021 Sep;55:9-33. doi: 10.1016/j.yasu.2021.05.002.
6. López JJ, Deans KJ, Minneci PC. Nonoperative management of appendicitis in children. *Curr Opin Pediatr.* 2017 Jun;29(3):358-362. doi: 10.1097/MOP.0000000000000487



7. Wekell P, Wester T. Familial Mediterranean fever may mimic acute appendicitis in children. *Pediatr Surg Int.* 2022 Aug;38(8):1099-1104. doi: 10.1007/s00383-022-05153-8. Epub 2022 Jun 23.
8. Hall NJ, Eaton S. Non-operative management of appendicitis in children. *Arch Dis Child.* 2018 May;103(5):498-502. doi: 10.1136/archdischild-2017-313267.
9. Podda M, Gerardi C, Cillara N, Fearnhead N, Gomes CA, Birindelli A, Mulliri A, Davies RJ, Di Saverio S. Antibiotic Treatment and Appendectomy for Uncomplicated Acute Appendicitis in Adults and Children: A Systematic Review and Meta-analysis. *Ann Surg.* 2019 Dec;270(6):1028-1040. doi: 10.1097/SLA.0000000000003225.
10. Rentea RM, St Peter SD. Contemporary Management of Appendicitis in Children. *Adv Pediatr.* 2017 Aug;64(1):225-251. doi: 10.1016/j.yapd.2017.03.008.
11. Ayyıldız HN, Mirapoglu S, Akış Yıldız Z, Şahin C, Güvenç FT, Arpacık M, Ilce Z. What has changed in children's appendicitis during the COVID-19 pandemic? *Ulus Travma Acil Cerrahi Derg.* 2022 Dec;28(12):1674-1681. doi: 10.14744/tjtes.2021.51000.
12. Rassi R, Muse F, Cuestas E. Acute appendicitis in children under 4 years of age: A diagnostic dilemma. [Acute appendicitis in children under 4 years: a diagnostic dilemma]. *Rev Fac Cien Med Univ Nac Cordoba.* 2019 Aug 29;76(3):180-184. Spanish. doi: 10.31053/1853.0605.v76.n3.23661.
13. Xu J, Adams S, Liu YC, Karpelowsky J. Nonoperative management in children with early acute appendicitis: A systematic review. *J Pediatr Surg.* 2017 Sep;52(9):1409-1415. doi: 10.1016/j.jpedsurg.2017.05.003.
14. Almaramhy HH. Acute appendicitis in young children less than 5 years: review article. *Ital J Pediatr.* 2017 Jan 26;43(1):15. doi: 10.1186/s13052-017-0335-2.
15. Köhler F, Müller S, Hendricks A, Kastner C, Reese L, Boerner K, Flemming S, Lock JF, Germer CT, Wiegering A. Changes in appendicitis treatment during the COVID-19 pandemic - A systematic review and meta-analysis. *Int J Surg.* 2021 Nov;95:106148. doi: 10.1016/j.ijssu.2021.106148.