SYSTEMATIC REVIEW

Is Appendicectomy Becoming Obsolete: A Review

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Abstract

Introduction: Appendicectomy has long been the chosen method for treating acute uncomplicated appendicitis; recently however, there has been debate about whether antibiotic therapy can provide a similar level of treatment. The primary aim of this review is to compare the efficacy of surgical and non-surgical interventions for acute uncomplicated appendicitis.

Methods: Relevant databases were searched for systematic reviews comparing appendicectomy against antibiotic therapy for treatment of acute uncomplicated appendicitis. The primary outcome for antibiotic therapy was improvement without recurrence of acute appendicitis within a median follow-up of one year. For surgical treatment it was confirmed appendicitis at operation with no subsequent need for surgery for acute appendicitis. The secondary outcomes include percentage of patients experiencing post-treatment complications, mean C-reactive protein on admission, and mean length of hospital stay.

Results: Eight systematic reviews satisfied the inclusion criteria. Of the 1169 patients initially treated with antibiotic therapy, 759 patients (64.93%) did not need follow up treatment within one year. This was compared to a 94.17% efficacy rate in the surgical group. There was a minor difference between post-treatment complication rates in the antibiotic and surgical groups (7.26% and 16.27%, respectively). No clear difference was found between C-reactive protein and length of hospital stay.

Discussion: This analysis shows that appendicectomy has a greater efficacy than antibiotic therapy for definitive treatment of acute uncomplicated appendicitis. However, because the rate of post-treatment complications is higher in the surgical group, patients might consider antibiotic therapy as a first option.

Keywords: *Appendicitis, conservative, operative*

Introduction

Appendicitis is defined as inflammation of the vermiform appendix. Acute appendicitis (AA) carries an estimated lifetime risk of 7–8% and is one of the most common indications for emergency surgery1. The precise causes of AA are poorly understood. Several pathophysiological pathways are proposed, stemming from infection, environmental influences, genetics, hygiene, and obstruction2.

Variable location of the appendix makes AA diagnosis challenging. History, physical examination, imaging, and biomarkers are the main diagnostic criteria. Strong clinical signs for ruling in AA in adults are right lower quadrant pain, abdominal rigidity, and radiation of pain from the periumbilical region to the right lower quadrant3. Radiological imaging, including ultrasound (US), computed tomography (CT), and magnetic resonance imaging (MRI), aid in the diagnosis of AA3. Patients identified with acute, localized, and uncomplicated appendicitis are then eligible for appendicectomy or nonoperative treatment4.

Appendicectomy performed by open and laparoscopic surgical techniques has historically been the gold standard treatment for AA. Laparoscopic appendicectomy demonstrates both fewer incidences of wound infections as well as faster recovery periods4. However, surgery requires general anaesthesia and often an overnight hospital stay. The main benefit of surgical treatment is that appendicitis cannot recur4. Nevertheless, negative appendicectomy is possible, with the frequency of appendicectomy having a higher incidence than that of appendicitis5.

Surgery also carries the risk of postoperative complications, including surgical site infection, post-operative intra-abdominal collection, and mortality1. With the aim of avoiding surgery, there has been a recent yet controversial push toward nonoperative treatment involving analgesia and antibiotic treatment. Hospitalisation is not typically required, and there does not appear to be an associated increased risk of appendiceal rupture4. Still, nonoperative treatment carries a failure rate at one year of approximately 25–30% requiring readmission or surgery1.

Opposing benefits and risks of appendicectomy versus nonoperative treatment are presented. Given the

recent debate regarding a superior treatment option, it is of interest whether appendicectomy is challenged by nonoperative treatment in terms of efficacy, safety, and incurred patient disability, despite being the longstanding standard of treatment. The aim of this review is to analyse current literature that compares outcomes (treatment efficacy, percentage of patients with postoperative complications, mean C-reactive protein (CRP) on admission, and mean length of hospital stay) of operative and nonoperative treatment of AA in adult patients for such parameters.

Methods

The papers considered for this review were identified in a series of computerised searches across Google Scholar, Web of Science, Medline, Embase, and PubMed with the key words: appendicitis, conservative, and operative. The 72 papers identified were first screened for duplicates using EndNote's automatic function, and 21 papers were removed. Again, using EndNote software, a subsequent search across the papers for the key term "systematic review" in the titles, keywords, or abstracts was run and 25 papers were excluded. This left 26 papers to be manually screened both to ensure the software's accuracy and to ensure all reviews were relevant to the topic. Examples of reasons for exclusion were paediatric-focused reviews and reviews focusing on complicated appendicitis. Ultimately, the final selection included eight systematic reviews.

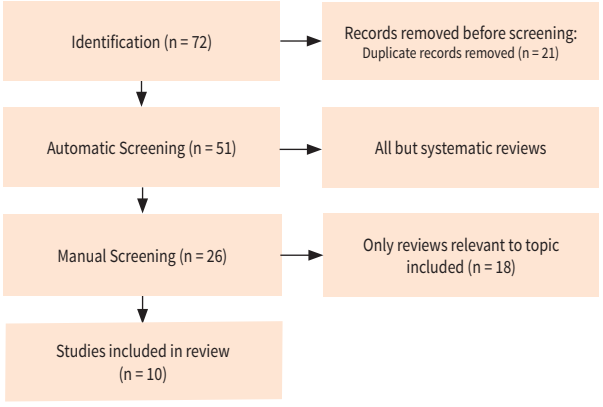

Figure 1. **PRISMA Diagram**

Results

Each systematic review we analysed referenced at least 4 randomised control trials (RCTs), as well as a variable number of retrospective cohort studies and prospective cohort studies. There was a significant recurrence of RCTs between the reviews and therefore each RCT was analysed independently using data collaboratively elucidated from the 8 systematic reviews as shown in Table 15,7,11,13–15,17,18. Thus, all the data represented in Table 1 was obtained from the systematic reviews alone.

Only the RCTs and one prospective population study present in the reviews were analysed as they contained evidence of a higher order than prospective and retrospective studies6. One RCT in a systematic review was excluded from analysis as it was retracted7.

In the studies included, diagnosis of appendicitis was decided from one or a combination of the following: clinical signs, AA history, and radiological signs. If complicated appendicitis was clinically suspected, these patients were excluded.

Our review contains data from 1983 patients above 18 years of age, with a mean age of 32.97 in the antibiotic group and 35.17 in the surgical group (Table 1).

The primary outcome our review analysed was treatment efficacy. Efficacy for antibiotic treatment was defined as definite improvement without the need for readmission for AA within a median follow-up of 1 year. Efficacy for surgical treatment was confirmed appendicitis at operation without the subsequent need for surgery for AA. The mean percentage of patients who underwent effective treatment was determined to be 63.62% for the antibiotic group and 94.17% for the surgical group (Table 1).

Secondary outcomes evaluated include the percentage of patients experiencing post-treatment complications, mean CRP on admission, and mean length of hospital stay. The mean percentage of patients experiencing post-treatment complications was 7.26% for the antibiotic group and 16.27% for the surgical group (Table 1). Our complications category included both major and minor complications ranging from wound infection to bowel obstruction. One potential limitation for complications is that most of the reviews in our study did not consider subsequent admission for recurrence of appendicectomy in the antibiotic group to be a complication; rather they considered it a failure in efficacy. The broad range of complications was also a potential source of bias and may not illustrate the complexities of each treatment method.

No large difference was found for mean CRP on admission (Table 1), although this figure was not available for two RCTs8,9. There was also no pronounced difference for mean length of hospital stay (Table 1); data was not available for one RCT in this category8

Discussion

This study has conducted a systematic review and meta-analysis to compare the efficacy (i.e., recurrence of appendicitis within one year), percentage of post-treatment complication, and mean duration hospital stay between surgical and non-surgical management of AA. In regard to efficacy, conservative treatment of appendicitis with antibiotics had an average efficacy of 63.62% compared to 94.17% for surgical treatment of appendicitis (Table 1). The disparity in the results suggest that surgical treatment should be the preferred choice as there is a much lower recurrence of appendicitis. This was similar to previous findings, where the recurrence of appendicitis decreased following an appendicectomy10. In comparison, conservative treatment with antibiotics results in the treatment of an inflamed appendix but not its removal. The appendix is therefore susceptible to infection, tumour, or faecal matter blockade, which may result in appendicitis recurrence7.

Table 1. **Studies included in the review**

Title	Authors	Date	Level of Incidence	Number in Group A/B	Mean age (A/B) Years	Male: Female A/B	Treatment Efficacy	Percentage Experiencing Post-Treatment Complications A/B (%)	Mean CRP Concentration on Admission A/B (mg/L)	Mean Hospitals Stay A/B (Days)	Appendicectomy: Open/ Laparoscopic
Randomised controlled trial of appendicectomy versus antibiotic therapy for acute appendicitis	Eriksson & Granström	1995	1B	20.0/20.0	27.8/35.0	14:6/13:7	60.0/85.0	0.0/10.0	41.0/40.0	3.1/3.4	20.0/0.0
Appendicectomy versus antibiotic treatment in acute appendicitis. A prospective multicentre randomised controlled trial	Styrud et al.	2006	1B	128.0/124.0	34.0/34.0	128:0/124:0	75.8/96.8	3.1/13.7	55.0/54.0	3.0/2.6	116.0/8.0
Randomised clinical trial of Antibiotic Therapy versus appendicectomy as primary treatment of acute appendicitis in unselected patients	Hanssone et al.	2009	1B	202.0/167.0	38.0/38.0	103:0/92:75	41.1/85.0	25.2/32.9	55.0/54.0	3.0/3.0	NS: LA + OA
Antibiotic therapy vs appendicectomy for treatment for treatment of uncomplicated acute appendicitis	Salminen et al.	2015	1B	257.0/273.0	33.0/35.0 (median)	155:102/174:99	72.8/100.0	2.3/22.3	29.0/36.0	3.2/2.8	257.0/175.0
Amoxicillin plus clavulanix acid versus appendicectomy for treatment of acute uncomplicated appendicitis: an open-label, non-inferiority, randomised controlled trial	Vons et al.	2011	1B	120.0/119.0	31.0/34.0	73.5/70.5	63.3/100.0	10.0/2.5	NS	NS	41.0/78.0
Antibiotics as first-line therapy for acute appendicitis: evidence for a change in clinical practice	Hansson et al.	2012	2B	442.0/111.0	34.0/35.0	229:218/58:53	68.8/98.2	2.9/16.2	NS	2.3/2.9	NS
Mean					**32.97/35.2**		**63.6/94.2**	**7.3/16.3**	**45.0/46.0**	**2.9/2.9**	
Total				**1983.0**							**434.0/101.0**

A: Antibiotics B:Surgical Group

When analysing post-treatment complication, the surgical group had a 16.27% complication rate, more than double compared to the antibiotic group (7.26%) (Table 1). Appendicectomy has generally been considered as the first line approach to AA. However, conflicting evidence for long term complications suggests that there might be more research needed11. Additionally, emergency appendectomy for AA, performed in instances such as bowel perforation, may cause other complications such as unplanned bowel resection (i.e., ileocecal resection or right hemicolectomy)12.

There was no substantial difference in duration of hospital stay between antibiotic treatment and surgical treatment, 2.92 and 2.94 days respectively (Table 1). This can be attributed to relatively short recovery for laparoscopic appendicectomy as well as monitoring of antibiotic treatment13.

Limitations of the study include unknown surgical methods performed with the studies selected. There was no clarification on whether open or laparoscopic appendicectomy was performed. Type of surgery is an important consideration as laparoscopic appendicectomy is a more accurate representation of the surgical treatment currently provided14.

The results we considered were only from studies that compared surgical and antibiotic treatment together. All other studies were not considered. Future research should focus on the incidence of major and minor complications between surgical and non-surgical groups in AA. Additionally, all the studies in this review included more males than females, potentially creating a source of bias. Future studies should include a more equal representation between sexes. We suggest further research in comparing management of AA in different areas of the world (resource poor vs resource rich settings) be considered.

Conclusion

This study provides arguments for both conservative and surgical treatment of appendicitis as primary treatment options. Patients looking to avoid appendicectomy should be advised that antibiotic treatment of appendicitis is a safe choice but does result in lower efficacy compared to surgical treatment. However, patients must also be informed that surgical treatment poses a higher complication rate as compared to the conservative treatment. An interesting note to highlight is that the decision to use surgical vs non-surgical management also depends on clinician judgement, experience, and resources available. Lastly, patients must be aware that recurrence of AA may occur in post-antibiotic treatment. While this study provides evidence to suggest that conservative treatment with antibiotics is safe and effective, more well-constructed studies are still required to establish the most optimal treatment for appendicitis. ◄

Declarations

There are no conflicting interests.

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References

1. Akingboye AA, Mahmood F, Zaman S, Wright J, Mannan F, Mohamedahmed AYY. Early versus delayed (interval) appendicectomy for the management of appendicular abscess and phlegmon: a systematic review and meta-analysis. *Langenbecks Arch Surg*. 2021;406(5):1341-51.
2. Ansaloni L, Catena F, Coccolini F, Ercolani G, Gazzotti F, Pasqualini E, et al. Surgery versus conservative antibiotic treatment in acute appendicitis: a systematic review and meta-analysis of randomized controlled trials. *Dig Surg*. 2011;28(3):210-21.
3. Bhangu A, Soreide K, Di Saverio S, Assarsson JH, Drake FT. Acute appendicitis: modern understanding of pathogenesis, diagnosis, and management. *Lancet*. 2015;386(10000):1278-87.
4. Carr NJ. The pathology of acute appendicitis. *Ann Diagn Pathol*. 2000;4(1):46-58.
5. Ehlers AP, Talan DA, Moran GJ, Flum DR, Davidson GH. Evidence for an antibiotics-first strategy for uncomplicated appendicitis in adults: A systematic review and gap analysis. *J Am Coll Surg*. 2016;222(3):309-14.
6. Eriksson S, Granstrom L. Randomized controlled trial of appendicectomy versus antibiotic therapy for acute appendicitis. *Br J Surg*. 1995;82(2):166-9.
7. Findlay JM, Kafsi JE, Hammer C, Gilmour J, Gillies RS, Maynard ND. Nonoperative management of appendicitis in adults: A systematic review and meta-analysis of randomized controlled trials. *J Am Coll Surg*. 2016;223(6):814-24 e2.
8. Hansson J, Korner U, Khorram-Manesh A, Solberg A, Lundholm K. Randomized clinical trial of antibiotic therapy versus appendicectomy as primary treatment of acute appendicitis in unselected patients. *Br J Surg*. 2009;96(5):473-81.
9. Hansson J, Korner U, Ludwigs K, Johnsson E, Jonsson C, Lundholm K. Antibiotics as first-line therapy for acute appendicitis: evidence for a change in clinical practice. *World J Surg*. 2012;36(9):2028-36.
10. Harnoss JC, Zelienka I, Probst P, Grummich K, Muller-Lantzsch C, Harnoss JM, et al. Antibiotics versus surgical therapy for uncomplicated appendicitis: Systematic review and meta-analysis of controlled trials. *Ann Surg*. 2017;265(5):889-900.
11. Olsen J, Skovdal J, Qvist N, Bisgaard T. Treatment of appendiceal mass a qualitative systematic review. *Dan Med J*. 2014;61(8):A4881.
12. Podda M, Cillara N, Di Saverio S, Lai A, Feroci F, Luridiana G, et al. Antibiotics-first strategy for uncomplicated acute appendicitis in adults is associated with increased rates of peritonitis at surgery. A systematic review with meta-analysis of randomized controlled trials comparing appendectomy and non-operative management with antibiotics. *Surgeon*. 2017;15(5):303-14.
13. 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.
14. Poprom N, Numthavaj P, Wilasrusmee C, Rattanasiri S, Attia J, McEvoy M, et al. The efficacy of antibiotic treatment versus surgical treatment of uncomplicated acute appendicitis: Systematic review and network meta-analysis of randomized controlled trial. *Am J Surg*. 2019;218(1):192-200.
15. Prechal D, Damirov F, Grilli M, Ronellenfitsch U. Antibiotic therapy for acute uncomplicated appendicitis: a systematic review and meta-analysis. *Int J Colorectal Dis*. 2019;34(6):963-71.
16. Sakran JV, Mylonas KS, Gryparis A, Stawicki SP, Burns CJ, Matar MM, et al. Operation versus antibiotics--The "appendicitis conundrum" continues: A meta-analysis. *J Trauma Acute Care Surg*. 2017;82(6):1129-37.
17. Salminen P, Paajanen H, Rautio T, Nordstrom P, Aarnio M, Rantanen T, et al. Antibiotic Therapy vs appendectomy for treatment of uncomplicated acute appendicitis: The APPAC randomized clinical trial. *JAMA*. 2015;313(23):2340-8.
18. Snyder MJ, Guthrie M, Cagle S. Acute appendicitis: Efficient diagnosis and management. *Am Fam Physician*. 2018;98(1):25-33.
19. Styrud J, Eriksson S, Nilsson I, Ahlberg G, Haapaniemi S, Neovius G, et al. Appendectomy versus antibiotic treatment in acute appendicitis. a prospective multicenter randomized controlled trial. *World J Surg*. 2006;30(6):1033-7.
20. Talan DA, Di Saverio S. Treatment of acute uncomplicated appendicitis. *N Engl J Med*. 2021;385(12):1116-23.
21. Vons C, Barry C, Maitre S, Pautrat K, Leconte M, Costaglioli B, et al. Amoxicillin plus clavulanic acid versus appendicectomy for treatment of acute uncomplicated appendicitis: an open-label, non-inferiority, randomised controlled trial. *Lancet*. 2011;377(9777):1573-9.