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Review Article

# Non-Operative, Open, and Laparoscopic Management of Non-Perforated Appendicitis in Adults

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**Received:** December 20, 2019; **Published:** December 30, 2019

## Abstract

**Introduction:** Appendicitis is the leading cause of abdominal surgery all over the world and in all age groups. About 9 percent of males and 7 percent of females will have appendicitis at least once in their life. The maximal age of incidence is between 10 and 30 years of age. Open appendectomy has been the gold standard approach for appendicitis management. Nowadays, the optimal management of appendicitis is of debate. Laparoscopic appendectomy becomes more common with many evidence suggesting superiority; initial antibiotic therapy followed by interval appendectomy is another possible approach.

**Aim of Work:** In this review, a thorough discussion of the management of non-perforated appendicitis in adults will be presented; appendicitis in children and specific group will not be discussed in this review.

**Methodology:** A comprehensive and systematic search was conducted regarding management of uncomplicated appendicitis in adults. PubMed search engine and Google Scholar search were the mainly used database for search process. All relevant available and accessible articles of all types were reviewed and included.

**Conclusion:** Most patients with acute appendicitis present with no perforation. Data from clinical trials suggest that antibiotics provided successful clinical response in most patients, with a reduction in white blood cell count, preventing peritonitis, and general symptom reduction. Compared with immediate appendectomy, patients treated with antibiotics have similar or even lower pain scores, require fewer doses of narcotics, have a quicker return to work, with no difference in perforation rate. However, experts believe that antibiotics should be used to augment rather than to replace surgery. Antibiotics could be justifiable alone in patients unfit for or refuse surgery.

Short in-hospital delay of 12 to 24 hours before surgery was not associated with an increased risk of perforation. Pre-operative preparation for appendectomy include adequate hydration with intravenous fluids, checking for electrolyte abnormalities, and peri-operative antibiotics. Laparoscopic approach was superior for a lower rate of wound infections, less pain on first day postoperatively, shorter duration of hospital stay. On the other hand, open appendectomy was superior for a lower rate of intra-abdominal abscesses, shorter operative time.

***Keywords:*** *Non-Operative; Open; Laparoscopic Management; Appendicitis*

## Introduction

Appendicitis is the leading cause of abdominal surgery all over the world and in all age groups [1,2]. About 9 percent of males and 7 percent of females will have appendicitis at least once in their life [3]. The maximal age of incidence is between 10 and 30 years of age [4]. Since it was first described in the late eighties, open appendectomy has been the gold standard approach for appendicitis management. Nowadays, the optimal management of appendicitis is of debate. Laparoscopic appendectomy becomes more common with many evidence suggesting superiority initial antibiotic therapy followed by interval appendectomy is another possible approach; and several trials have even suggested non-operative management with antibiotics alone.

In this review, a thorough discussion of the management of non-perforated appendicitis in adults will be presented; appendicitis in children and specific group will not be discussed in this review.

## Methodology

A comprehensive and systematic search was conducted regarding surgical and non-surgical management of uncomplicated appendicitis in adults. PubMed search engine and Google Scholar search were the mainly used database for search process. All relevant available and accessible articles of all types were reviewed and included. Management of perforated appendicitis, appendectomy in children, and appendectomy in specific situation as pregnancy were not included. The term used in search were, appendicitis in adults, uncomplicated appendicitis, non-perforated appendicitis, management, laparoscopic versus open appendectomy, and surgical techniques for appendectomy.

### Non-operative management

Simple appendicitis or uncomplicated appendicitis is acute inflammation of the appendix without clinical or radiographic signs of perforation as a phlegmon or abscess. Most patients with acute appendicitis present with no perforation. Although many evidence support non-surgical managements, experts believe that antibiotics should be used to augment rather than to replace surgery and not by its own. Appendectomy has been safe, effective, and definitive therapy for appendicitis for more than a century. Antibiotics could be justifiable alone in patients unfit for or refuse surgery. Nevertheless, guidelines and societies still support the decision of appendectomy such as the American College of Surgeons, Society of American Gastrointestinal and Endoscopic Surgeons, European Association of Endoscopic Surgery, and World Society of Emergency Surgery [5-7]. Until recently, as demonstrated by national wide survey, acute uncomplicated appendicitis were managed by surgery most of the time. Only 1.8 percent of 4282 cases with acute appendicitis were managed non-operatively [8]. Laparoscopic was slightly more common than traditional open surgery in this survey.

Until our search, only 6 randomized trials have compared antibiotics with appendectomy for non-perforated appendicitis in adults [9-14]. More systematic review have been published [15-21]. Data from these trials suggest that antibiotics provided successful clinical response in most patients, with a reduction in white blood cell count [11] preventing peritonitis [9] and general symptom reduction [10,12,13]. Compared with immediate appendectomy, patients treated with antibiotics have similar or even lower pain scores [9-11] require fewer doses of narcotics [11] have a quicker return to work [10,11] with no difference in perforation rate. Treatment with antibiotic leads to avoidance of surgery in 90 percent of cases in the initial presentation. However, no data are suggesting predictable parameter for which patients will not response to medical treatment. During first year following the attack, 70 percent successfully managed with antibiotics will not need surgery. The other 30 percent eventually require appendectomy after approximately 4 - 7 for recurrent appendicitis [9,11,12]. No data are available longer follow up from the RCTs. However, observational study following 257 patients treated with antibiotic for 5 years has estimated that cumulative incidence of recurrent appendicitis was about 27, 34, 35, 37 and 39 percent for each year respectively [22]. No patients suffered a major complication. Compared with the antibiotic group, the appendectomy group had a higher rate of complication, similar time for hospital discharge, longer sick leave. However, the difference would likely be less when appendectomy performed by laparoscope. All of these studies agree that it is acceptable to manage uncomplicated appendicitis in non-operative

approach. The choice is predetermined by the underlying pathophysiology. It is suggested that appendicitis that destined to resolve without surgery will improve with or without antibiotics. However, there is no reliable clinical, laboratory, and radiologic predictor of which patient will resolve spontaneously or is destined to fail non-operative management.

In spite of all these data, many questions and concerns are still rendering non-operative approach as acceptable choice for policy maker approach. For one, as non-operative approach is only suggested for uncomplicated appendicitis, and preoperative abdominal CT cannot reliably distinguish uncomplicated from complicated appendicitis. For instance, about 20 percent of patient with complicated appendicitis were identified at the time of surgery [9]. Secondly, Non-operative approach may carry a great risk in older patients, immunocompromised patients, or patients with medical comorbidities. In these individuals, appendicitis severity could be underestimated, and the risk of unexpected lesions in the appendix, such as carcinoid and carcinoma, may be higher [23-27]. These patients could no benefits the most from non-surgical treatment, however, all clinical trials have excluded them from their study. Thus, the efficacy of such approach remains unknown.

Non-operative management could be resorted to a selective case of patients with either prior history of surgical complications or severe phobia to appendectomy [28]. Non-operative management could be achieved through initial intravenous antibiotics for one to three days, followed by oral antibiotics for up to 10 days; the choices of antibiotics differs between cases [19]. Patients are typically admitted to the hospital during the first few days for close observation.

### Surgical appendectomy

The current standard treatment for appendicitis is appendectomy, which can be performed open or laparoscopically [29]. As appendicitis is an acute condition that may present at any time of the day, it is not clear if it is an emergency to operate as soon as presentation for uncomplicated appendicitis or could be postponed to the morning. A meta-analysis of 11 nonrandomized clinical trials showed that a short in-hospital delay of 12 to 24 hours before surgery was not associated with an increased risk of perforation [30]. The randomized trials on treating appendicitis with antibiotics alone suggest indirect evidence to support this approach [18]. Appendectomy should not be postponed for longer than 48 hours as this was associated with increased surgical site infections and other complications [30].

Pre-operative preparation for appendectomy include adequate hydration with intravenous fluids, checking for electrolyte abnormalities, and perioperative antibiotics [31]. In addition, vital signs and urine output should be monitored; a Foley catheter may be required in severely dehydrated patients. Prophylactic antibiotics are essential prevent wound infection and intra-abdominal abscess following appendectomy [31]. The flora of the appendix is similar to that of the colon that of the colon and includes gram-negative aerobes and anaerobes. Antibiotic should be given in a window of 60 minutes before even in patients proceeding directly from the emergency room to the operating room [32,33]. A single preoperative dose for surgical wound prophylaxis is adequate. The following antibiotic are suggested by guidelines: Two gram of cefoxitin as a single dose intravenously, or 2g of cefotetan (2g IV), or the combination of cefazolin and metronidazole. If the patient is allergic to penicillin and cephalosporin, clindamycin plus any one of the following: ciprofloxacin, levofloxacin, gentamicin, or aztreonam could be given [34,35]. Postoperative antibiotics are unnecessary [36].

Appendectomy is commonly performed as urgent or emergency operation. Patient on aspirin, clopidogrel, or both, have no increased risk for bleeding compared with matched control in a retrospective case-control study of patients undergoing laparoscopic appendectomy; neither was any difference in complications, length of hospital stay, readmission, or mortality [37]. Thus, prehospital use of aspirin or clopidogrel should not preclude or delay laparoscopic appendectomy. If the patient is scheduled for appendectomy in the next morning, they should admitted to the hospital and started on intravenous antibiotics as soon as possible, rather than waiting until just before surgery. Additional prophylactic antibiotics may be needed if patients did not receive antibiotics before incision.

## Open versus laparoscopic appendectomy

A great number of randomized control trials (RCTs) and systematic review have compared open with laparoscopic appendectomy. A systematic review on 9 meta-analysis was published in 2015 and concluded that the laparoscopic approach was superior for a lower rate of wound infections, less pain on first day postoperatively, shorter duration of hospital stay [38]. On the other hand, open appendectomy was superior for a lower rate of intra-abdominal abscesses, shorter operative time [38]. Another systematic review also found laparoscopic appendectomy to be associated with fewer short-term and long-term adhesive bowel obstructions [39]. The laparoscopic appendectomy has been gaining widespread acceptance in last few years. However, there are benefits and limitations to this approach. Hence, the operative approach is best decided by the surgeon based on personal experience, institutional capabilities, and individual patient factors such as the confidence in the diagnosis; history of prior surgery; the patient's age, gender and body habitus; and severity of disease. Evidence suggests that laparoscopy may be the preferred approach many circumstances. If the diagnosis of appendicitis is not certain, laparoscopic appendectomy provides an advantage since it permits inspection of other abdominal organs. This benefit may be greater for women of childbearing age, who traditionally have had higher negative appendectomy rates, and in whom laparoscopy may reveal other causes of pelvic pathology [23,40]. One study on 181 women who underwent laparoscopy for suspected acute appendicitis found that 48 percent have a gynecologic disorder as the etiology of the symptoms [40]. Laparoscopic appendectomy is also preferred in overweight or obese patient, since exposure of the right lower quadrant during open appendectomy may require larger incisions [41-43]. Older adult patients may also benefit significantly from a laparoscopic approach, as hospital stay is shorter and discharge rates to home are higher in this population than with an open appendectomy.

## Laparoscopic appendectomy

Laparoscopic appendectomy was first described in the eighties [44]. The approach has gained wide acceptance since then despite the open appendectomy was the traditional for over a century prior to that [45,46]. The rates of complication, conversion, reoperation, and duration of hospital stay has declined over the following years as shown by a prospective trend analysis [46]. The procedure is typically performed under general anesthesia. An oro-gastric tube is typically placed to decompress the stomach; Foley catheter or immediate preoperative voiding could be used to decompress the bladder. The patient should be placed in supine position on the operating table with the left arm tucked. The video monitor is placed to the patient's right side because both the surgeon and assistant are usually stand on the patient's left side. For adequate visualization and exposure of the appendix, triangulation of instrument ports is usually performed in all suggested techniques. In one technique, pneumoperitoneum is obtained through a 12-mm periumbilical port, through which the laparoscope is inserted and exploratory laparoscopy performed. The other two ports are 5-mm and are placed in the left lower quadrant and suprapubic in the midline. A single-incision laparoscopy is an alternative access method. In this method, all instruments and the laparoscope are inserted through a multi-channel portal placed at the umbilicus [47,48]. In a meta-analysis of 11 randomized clinical trials (RCTs) comparing the two methods, single-incision technique was associated with a shorter length of stay and a quicker return to activities but a longer operative time and a higher conversion rate [49].

Following adequate visualization, any adhesions to surrounding structures can be dissected with a combination of blunt and sharp instrument. Surgeon should be careful to avoid injuring underlying retroperitoneal structures, specifically the right ureter and iliac vessels. Once the appendix is cleared from attachment, the surgeon should focus on not leaving a significant stump [50]. It is sometimes necessary to include part of the cecum within the stapler to ensure that the staples are placed in healthy, uninfected tissue. Other methods of appendiceal stump closure as suture knot, clip, and LigaSure method have been described. However, these methods are less commonly used due to limited data [51]. The stump is typically not inverted after laparoscopic appendectomy. The appendix is then removed through the umbilical port in a specimen bag to prevent wound infection. The operative field is inspected for hemostasis and irrigated with saline if needed and then the fascial defect and skin incisions are closed.

### Open appendectomy

Open appendectomy was described by McBurney in nineteen century [52]. Since then, no great changes have been made on the technique. In adults, anesthesia could be achieved by general or spinal anesthesia. After the induction of general anesthesia, the patient should be re-examined as this allows deep palpation of the abdomen. If there is a palpated mass representing the inflamed appendix, the incision can be located over the mass. If no mass is detected, the incision should be centered over McBurney's point, one-third of the distance from the anterior superior iliac spine to the umbilicus. A curvilinear incision allows for an excellent cosmetic result. It is important to place the incision in adequate site and avoid too medial or too lateral incision. An incision placed too medially opens onto the anterior rectus sheath, rather than the desired oblique muscles, while an incision placed too laterally may be lateral to the abdominal cavity. The incision can be oriented transversely or perpendicular to the line connecting the anterior superior iliac spine to the umbilicus. Some surgeons prefer a transverse incision because it can be more easily extended to increased exposure if needed. The surgeon then dissect through the subcutaneous tissue to the external oblique fascia, which is sharply incised lateral to the rectus sheath. Using a muscle-splitting technique, the external oblique is bluntly separated in the direction of the muscle fibers; the internal oblique and transversus abdominis muscles are bluntly separated in a similar fashion. The peritoneum is sharply entered. Care should be taken to avoid injury to the underlying intestine. The surgeons can usually locate the appendix by sweeping their finger from lateral to medial in the right paracolic gutter. Thin adhesions between the appendix and surrounding structures may be freed with blunt dissection; occasionally, sharp dissection is required for more dense adhesions. If the appendix cannot be identified through palpation, it can be located by following the teniae coli to its origin at the cecal base. After identifying and dissecting the appendix from surrounding adhesion, the appendix is delivered through the incision. The appendiceal artery should be divided and tied with 3-0 absorbable sutures. A non-absorbable suture is placed in the cecal wall around the appendix. The appendiceal base should be crushed with a Kelly clamp and the appendix is doubly tied with absorbable sutures then excised with a scalpel. The remaining stump is cauterized to prevent a mucocele. The appendiceal stump is typically inverted into the cecum while the suture is tightened; although the usefulness of stump inversion is debatable [53-55]. Similarly, the surgical bed could be irrigated with saline.

The incision is closed in layers with a continuous absorbable suture, beginning with the peritoneum, followed by the transversus abdominis, internal oblique, and then external oblique. Irrigation is performed at each layer. To improve analgesia and limit postoperative narcotic requirements, the external oblique fascia may be injected with local anesthetic. Finally, the skin may be closed primarily with a low risk of wound infection in uncomplicated appendicitis.

### Postoperative management

Following either open or laparoscopic appendectomy for non-perforated appendicitis, patients may be started on a clear liquid diet and advanced as tolerated to a regular diet. Antibiotics are not required postoperatively in uncomplicated appendicitis. Most patients are discharged within 24 to 48 hours of surgery. Same-day discharge is also feasible, most commonly occur after a laparoscopic appendectomy [56,57].

## Conclusion

Appendicitis is the leading cause of abdominal surgery all over the world and in all age groups. About 9 percent of males and 7 percent of females will have appendicitis at least once in their life. Most patients with acute appendicitis present with no perforation. Data from clinical trials suggest that antibiotics provided successful clinical response in most patients, with a reduction in white blood cell count, preventing peritonitis, and general symptom reduction. Compared with immediate appendectomy, patients treated with antibiotics have similar or even lower pain scores, require fewer doses of narcotics, have a quicker return to work, with no difference in perforation rate. However, experts believe that antibiotics should be used to augment rather than to replace surgery. Antibiotics could be justifiable alone in patients unfit for or refuse surgery.

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**Volume 16 Issue 1 January 2020**