

# Laparoscopic Appendectomy: Is it the Gold Standard Approach for Management of Acute Appendicitis?

MA Bahram

## ABSTRACT

**Aim:** Evaluation of laparoscopic approach for management of patients with confirmed or suspected acute appendicitis.

**Background:** Although appendicitis is the most common condition requiring surgery in patients with right lower abdominal pain, this pain can be indicative of a vast list of differential diagnoses and is thus a challenge for clinicians. A definite diagnosis is obtained in 96% of patients undergoing laparoscopic appendectomy (LA) compared with 72% of those undergoing open procedures so patients can avoid the disadvantages of misdiagnosis beside other benefits of LA.

**Study design:** A prospective outcome analysis was done for 573 patients over the last 6 years, from 2008 to 2013. All patients were planned to go for LA. Modified Alvarado scoring system was used as a guide in diagnosing all patients. The following were recorded: operative time, conversion to open procedure, intraoperative findings, infection complications and length of hospital stay.

**Results:** The mean operative time in this study was  $42 \pm 17.54$  minutes. Nonappendiceal pathology was found in 31 patients (5.4%). Conversion to open procedure was done in 11 patients (1.9%). The accurate pathology was detected in 535 (93.3%) patients. The infection complications had occurred in 16 patients (2.6% of all patients). The mean hospital stay in this study was  $1 \pm 0.21$  days.

**Conclusion:** Laparoscopic appendectomy is safe and can provide less postoperative morbidity, accurate method in diagnosing abdominal pathology other than acute appendicitis, and drawbacks of undiagnosed or misdiagnosed pathology that mimic acute appendicitis can be avoided.

**Keywords:** Appendicitis, Laparoscopy, Right lower abdominal pain.

**Abbreviations:** OA: Open appendectomy; LA: Laparoscopic appendectomy; CT: Computed tomography; ECG: Electrocardiography; SPSS: Statistical package for the social sciences; DM: Diabetic mellitus; HCV: Hepatitis C virus; IAA: Intra-abdominal abscess.

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Assistant Professor

Department of General Surgery, Hepatobiliary and Laparoscopic Surgery, Faculty of Medicine, Menoufia University, Egypt

**Corresponding Author:** MA Bahram, Assistant Professor Department of General Surgery, Hepatobiliary and Laparoscopic Surgery, Faculty of Medicine, Menoufia University, Egypt, Phone: 00971551095027, e-mail: mahmoubahreem@yahoo.com

## INTRODUCTION

Right lower abdominal pain is one of the most common causes of patients visit to the emergency department. Although appendicitis is the most common condition requiring surgery in those patients, this pain can be indicative of a vast list of differential diagnoses and is thus a challenge for clinicians. Other causes of right lower quadrant pain aside from appendicitis include inflammatory and infectious conditions involving the ileocecal region, diverticulitis, malignancies, conditions affecting the epiploic appendages, omentum, and mesentery.<sup>1</sup>

The differential diagnosis of most of those patients is based on clinical ground, laboratory data and diagnostic imaging. The problem, however, is to obtain a correct diagnosis even in sure cases, to determine surgical indications and to decide the best surgical approach.<sup>2</sup>

During open appendectomy (OA) when the appendix looks apparently normal, the exact diagnosis of abdominal pain may not be reached and the management of these patients represents a dilemma for the surgeon and so far, no guidelines are available in this field.<sup>3</sup> Also if the cause cannot be managed through ordinary McBurney's incision, it is imperative to shift to another incision for management of the surgical problem.<sup>4</sup>

McBurney's procedure represented the gold-standard for acute appendicitis until 1981, when Semm, 1993,<sup>5</sup> performed the first laparoscopic appendectomy (LA) in Germany. The number of LA has progressively increased. But is LA the best choice for appendectomy? Are there selected groups of patients in which laparoscopic approach should be preferred?<sup>6</sup>

The aim of this study is to evaluate the laparoscopic approach for management of patients with confirmed or suspected acute appendicitis.

## PATIENTS AND METHODS

This prospective study was conducted over the last 6 years, from 2008 to 2013. Five hundred and seventy-three patients were included in this study. Patients presented with acute right lower abdominal pain either suspected or confirmed acute appendicitis were included in the study (total 573 patients).

**Exclusion criteria:** Patients unfit for general anesthesia, children below 10 years, pregnancy (second and third trimester), chronic medical diseases, such as cirrhosis, coagulation disorders and previous laparotomy for bowel obstruction.

Preoperative workup in the form of complete history taking, complete clinical examination, laboratory (complete blood picture and urine analysis), and radiological examination includes abdominal ultrasonography for all patients and CT abdomen was done for some patients with unproved diagnosis. Modified Alvarado scoring system (Table 1) was used as a guide in diagnosing all patients.<sup>7</sup> Written fully informed consent was given by all patients.

**Technique of the procedure:** A 10 mm trocar was placed just above the umbilicus for the camera and 2 additional working 5 mm trocars were inserted, one suprapubic and the site of the other trocar depends on the pathology detected and abdominal configuration of the patient mostly left iliac fossa (sometimes this trocar was replaced by 10 mm depending on the size of the appendix as it is the extraction port). The patient was placed in a Trendelenburg position, with right side slightly up (a slight rotation to the left). The abdominal cavity was thoroughly inspected in order to exclude other intra-abdominal or pelvic pathology. The mesoappendix was transected by diathermy after applying titanium hemoclip early in this study but later on, blood vessel sealing device was used (ligasure 5 mm). The bases of the appendix were ligated with two endo-loops constructed with a Roeder's knot on a no-1 vicryl thread. The specimen was directly extracted or placed in an endo-bag and then extracted. All specimens were sent for histopathology. Drain was inserted in patients with pus in the peritoneal cavity or with abscess formation.

Prior to the surgery, all the patients received a standard regimen of intravenous antibiotics (1.5 gm of cefuroxime). Further antibiotic regimen was determined according to the operative findings.

The parameters examined in this study included: operation time (from skin incision to wound closure), conversion to open procedure, intraoperative findings and length of hospital stay. Complications included wound infections, intra-abdominal abscess, as well as 30 day readmission for complications.

The discharge criteria included: afebrile patient with audible bowel sounds and were able to tolerate a liquid diet.

Statistical analysis was performed using SPSS statistical software, version 12.0 (SPSS Inc, Chicago, IL). The data were expressed as mean and standard deviation.

## RESULTS

In this study, all patients were planned to go for LA. The demographic data (age, gender), comorbidities and clinical presentation of the patients were included in Table 2.

In the present study, out of total 573 patients, appendiceal pathology was found in 504 patients (87.9%). No pathology was observed in the appendix after histopathological examination in 38 (6.7%) patients. Non appendiceal pathology was found in 31 patients (5.4%). Conversion to open procedure was done in 11 (1.9%) patients. The causes of conversion were: right hemicolectomy in five patients, small intestinal resection (minilaparotomy for Mickle's diverticulitis in four patients and appendicular mass in two patients (in one case the appendix was amputated from the cecum during dissection and the stump cannot be identified and the other case due to suspected cecal injury but on open procedure it was negative). The mean operative time in this study was  $42 \pm 17.54$  minutes (Table 3).

Wound infection had occurred in 16 patients (2.8%). One patient developed postoperative intra-abdominal abscess (IAA), she was from the start appendicular abscess and the drain was removed after 4 days but she

**Table 1:** Modified Alvarado score (Ganesh Babu et al, 2012)

		Score
Symptoms	Migratory right iliac fossa pain	1
	anorexia	1
	Nausea and or vomiting	1
Signs	Tenderness in right iliac fossa	2
	Rebound tenderness	1
	Elevated temperature	1
	Extra signs; cough test, Rovsing sign	1
Laboratory	Leukocytosis	2
Total score		10

**Interpretation:** Score 1 to 4: Acute appendicitis very unlikely; Score 5 to 7: Acute appendicitis probable; Score 8 to 10: Acute Appendicitis definitive

**Table 2:** Demographic data, clinical presentation and comorbidities of the patients

Age	Range	12-65 years	
	Mean $\pm$ SD	23 $\pm$ 11.65 years	
Sex	Male	151	Total = 573
	Female	422	
Clinical presentation	Alvarado score $\geq 8$	466	Total = 573
	Alvarado score 5-7	107	
Comorbidities	DM	34	Total = 77
	HCV	25	
	Pulmonary disease	18	

**Table 3:** Operative finding of laparoscopic appendectomy in all patients

		No.	Percentage	
Pathology detected	Appendiceal pathology (no. = 504)	Acute appendicitis	456	
		Gangrenous appendicitis	25	
		Perforated appendicitis	2	87.9
		Appendiceal abscess	12	
		Appendicular mass	9	
	No pathology detected (no. = 38)	Normal appendix	38	6.7
		Inflamed Mickle's diverticulum	4	
		Inflamed cecal diverticulum	3	
	Nonappendiceal pathology (no. = 31)	Inflamed sigmoid diverticulum	1	
		Omental infarction	4	
Ileocecal TB		1	5.4	
Chron's disease		1		
Complicated ovarian cyst		16		
Perforated gallbladder		1		
Total number		31		
Conversion to open procedure		11	1.9	
Operative time	Range	25-150 minutes		
	Mean ± SD	42 ± 17.54 minutes		

**Table 4:** Postoperative complications

		No.	Percentage
Hospital stay	Range	0.5-10 days	
	Mean ± SD	1 ± 0.21 days	
Post-operative infection	Surgical incision	2	2.8
	Wound infection	Drain site	9
		Extraction port site	4
	Intra-abdominal abscess	1	
	Readmission	1	
Total		16	

developed IAA after 3 weeks and readmitted again for open drainage of the abscess and the same patient developed wound infection. The mean hospital stay in this study was 1 ± 0.21 days (Table 4).

**DISCUSSION**

Laparoscopic appendectomy has become the approach of choice by many surgeons in the treatment of both simple and complicated cases of acute appendicitis. The rate of LA between 1998 and 2008 has significantly increased from 20.6 to 70.8%. A definite diagnosis was obtained in 96% during LA compared with 72% in OA.<sup>8</sup>

Despite the obvious advantages of LA described in many studies,<sup>8-10</sup> LA still remains a matter of debate because of concerns about possible longer operative time and higher rate of postoperative IAA compared to OA.

In this study, the mean operative time was 42 ± 17.5 minute. throughout the study and it is comparable to the time recorded in study done by Minutolo et al,<sup>8</sup>

2014 who recorded 52 minute for LA, Saeed Kargar et al,<sup>9</sup> 2010, who recorded 34.4 minute and Ioannis at,<sup>11</sup> 2008, who recorded 47 minute. The following studies<sup>8,9,11-13</sup> recorded that statistically there is no significant difference between LA and OA. This was attributed to the worldwide spread of training in laparoscopic techniques that lead to a significant reduction in difference of operative time compared to open procedures.

The infection complications had occurred in 16 patients (2.8%), most of them were patients with complicated appendicitis (12 from 16 patients: 75%).

Kehagias et al, 2008<sup>11</sup> and Tsai et al, 2012,<sup>14</sup> who evaluated LA in all stages of appendiceal inflammation, had recorded wound infection rate of 5.3% and 4.7 respectively but both of them recorded lower rate of wound infection in LA in comparison to OA. Moreover, Ohtani et al 2012,<sup>15</sup> recorded 1.6% rate of wound infection in LA that was significantly lower than OA. This can be explained with the use of the extraction bag in LA, which prevents the direct contact between the infected appendix and the wound during its removal.<sup>13,15</sup>

Intra-abdominal abscess is a serious complication following appendectomy and can potentially be life-threatening; many investigators pay close attention to this complication and still there is no definite conclusion about this complication.

Old studies done by some authors reported that the incidence of IAA was higher with LA.<sup>16-21</sup> It had been suggested that carbon dioxide insufflation may promote mechanical spread of bacteria in the peritoneal cavity, especially in cases of ruptured appendix, also improper laparoscopic technique, such as aggressive manipulation of the infected appendix and increased use of irrigation



fluid, possibly producing greater contamination of the peritoneal cavity, might have an impact on IAA formation after LA.<sup>19</sup>

However, recent meta-analysis of randomized controlled trial published by Wei et al, 2011,<sup>22</sup> shows a low incidence of intra-abdominal infections, with no significant difference between LA and OA. A multivariate analysis has shown that development of abscesses has a higher correlation with the initial diagnosis rather than with the type of surgical approach.<sup>6,14</sup>

Intra-abdominal abscess had occurred in one patient (0.02) in this study. This is comparable to the result recorded by Ching et al,<sup>14</sup> 2012 who did not record cases with IAA and Brümmer et al,<sup>21</sup> 2009, who recorded rate of IAA with LA 0.31% of their patients. Katkhouda et al (2000)<sup>23</sup> and Vincenzo Minutolo et al,<sup>8</sup> 2014, believed that mastery of the learning curve and the use of standardized surgical techniques reduced the incidence of IAA after LA.

Laparoscopy can be considered the first choice in suspected appendicitis allowing correct evaluation of intra-peritoneal pathology.<sup>6,15,24,25</sup>

The correct pathology was detected in 535 or 93.3% of the patients, while another pathology rather than acute appendicitis was detected in 31 or 5.4% of the patients. From those 31 patients, 27 patients gained extra benefit from laparoscopic approach: eight patients avoided undiagnosed pathology, 15 patients avoided wound extensions and excess tissue manipulation for pathology management and four patients avoided adding another surgical incision to McBurney incision (Table 5).

The results in this study concedes with the results in the study conducted by Ma et al,<sup>26</sup> from 271 patients with a normal appendix, extra-appendiceal pathology was found in 71 (4.8% of all appendectomies).

Conversion from LA to OA is one of the drawbacks of laparoscopic approach as it prolongs the operative time, hospital stay and may even increase the morbidity

especially if the conversion was due to improper surgical laparoscopic technique.

The conversion rate in this study was in 11 (1.9%) of patients and the main cause of conversion was due to non appendiceal pathology detected (9 from 11) and the other two patients were due to appendiceal inflammation. This rate of conversion is nearly equal to the result recorded by Minutolo et al, 2014,<sup>8</sup> who recorded a rate of conversion 1.4% (2 from 139 patients).

Higher conversion rate may be due to gaining experiences with the laparoscopic procedure so surgeons might attempt to perform LA for complicated cases of appendicitis, most of which might have been treated previously by open approach.<sup>13</sup>

Another advantage of LA is shorter hospital stay, in this study; the mean hospital stay was  $1 \pm 0.21$  days. This differs from the results recorded by Minutolo et al, 2014<sup>8</sup> who recorded mean hospital stay in LA 2.75 days and also Ioannis et al, 2008, recorded hospital stay for LA 2.2 days but both of them stated that there was a significant difference between both LA and OP regarding hospital stay.

## CONCLUSION

Laparoscopic appendectomy is safe with accepted post-operative morbidity. Most cases of acute appendicitis can be treated laparoscopically. LA is an accurate method in diagnosing abdominal pathology other than acute appendicitis, avoiding patients the drawbacks of undiagnosed or misdiagnosed pathology that mimic acute appendicitis. With better training in laparoscopic surgery and availability of equipment: LA will be sooner the gold standard for acute appendicitis.

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**Table 5:** Benefits of laparoscopic approach in detecting nonappendiceal pathology

Patients avoided misdiagnosis	Sigmoid diverticulitis	1	
	Omental infarction	3	
	Left ovarian cyst	4	
Patients avoided extension of McBurney incision	Ovarian cyst	12	4.7%
	Ileo-cecal disease	3	
Patients avoided shift to another incision	Perforated GB	1	
	Ileo-ceal TB	1	
	Cecal diverticulum	2	
Total		27	

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