

# Efficiency of Laparoscopic Appendicectomy in Perforated Appendicitis

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## ABSTRACT

Minimal access surgery is nowadays widely practiced in both diagnosis and management of various infective conditions of abdomen. Laparoscopic appendicectomy (LA) is a procedure of choice in acute or chronic appendicitis in any age group. Laparoscopy is also recommended in appendicolithiasis, perforated appendicitis, and appendicular abscess with evidence of less morbidity and hospital stay in comparison to open approach.

Some studies reported formation of postoperative intra-abdominal abscess (IAA) and challenged the laparoscopic management in perforated appendicitis. We searched through internet for relevant articles with the keywords like LA in acute appendicitis, burst appendix, appendicular abscess, intra-abdominal abscess, perforated appendicitis, etc. Individual case report or case series lack in control group for comparison were excluded from our review.

This study reviewed the efficacy of LA in perforated appendicitis. Parameters we concentrated were on operation techniques related to operation time, conversion rate, surgical site infection, IAA formation, hospital stay, use of analgesics, and the cost.

**Keywords:** Burst appendix, Complicated appendicitis, Intra-abdominal abscess, Laparoscopic appendicectomy, Perforated appendicitis.

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## INTRODUCTION

Laparoscopic appendicectomy was first reported by Semm.<sup>1</sup> Since then a lot of studies comparing LA *vs* open appendicectomy (OA) were performed.<sup>2,3</sup> Minimal access technique has better visualization of the pathology and the surrounding anatomy with more accessibility in comparison to open surgery.

Some authors suggested that complicated appendicitis could be better managed with laparoscopy<sup>4,5</sup> because

open approach needs larger incision, more tissue dissection, obscured surrounding anatomy, excessive traction by abdominal retractors, increased operation time, more surgical stress to the patients, and, moreover, higher surgical site infection rate. But several studies also assessed the role of laparoscopy in complicated appendicitis, and the results are controversial.<sup>6-9</sup>

In a retrospective comparative study by Lin et al,<sup>10</sup> 91 of 99 patients with perforated appendicitis were managed by LA with lower wound infection rate (15.2%) than OA (30.7%). Some study also reported the benefit of LA than OA in terms of hospital stay, antibiotic usage, wound infection, resuming enteral feeding, etc.,<sup>11-13</sup> but some studies reported higher incidence of IAA with LA in complicated appendicitis,<sup>14-18</sup> which makes the efficacy of LA in perforated appendicitis debatable.

## MATERIALS AND METHODS

We performed extensive literature search through PubMed, Science Direct, Google Scholar, Wiley Online Library with the keywords: Laparoscopic appendicectomy, perforated appendicitis, complicated appendicitis with no definite timeline. All the articles found were further screened and those articles including data representing the outcome of laparoscopic treatment of clinically and radiologically diagnosed complicated appendicitis were included in our review. Complicated appendicitis may define as clinical history suggestive of acute appendicitis in which perforation with or without IAA or generalized peritonitis.

Various parameters like operation time, rate of conversion to open, hospital stay, usages of antibiotics and analgesics, superficial and deep surgical site infection, and the treatment cost were compared to evaluate the efficacy of laparoscopy in complicated appendicitis.

## LITERATURE REVIEWS

According to the 2010 Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) guideline, laparoscopy is preferred in the following cases:

- Perforated appendicitis
- Appendicitis in elderly and obese patients
- Women of childbearing age with presumed appendicitis<sup>19</sup>

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## Operative Steps and Procedure Analysis

Multiport technique is most commonly performed for appendectomy. Single-port LA is a more less-invasive procedure. But conversion rate from single port to multiport was higher (25% need additional trocars) in complicated appendicitis.<sup>20</sup> Although Muensterer et al<sup>20</sup> still considered single-port approach is applicable for children with complicated appendicitis, so far multiport technique is a more effective approach to deal with perforated appendicitis.

Safe and effective closure of appendiceal stump could play a vital role for the outcomes of perforated appendicitis management. Various methods including titanium endoclips, absorbable endoloops knot, nonmetallic hemlocks, or staplers have been used for securing appendiceal stumps during LA.<sup>21</sup> A study by Beldi et al<sup>22</sup> reported that stapler usage is safer to overcome IAA formation compared with endoloops. But endoloops are 6 to 12 times cheaper than stapling devices and convenient to use by most of the surgeons. Sahm et al<sup>23</sup> reported that there was no significant difference after using staplers or endoloops in perforated appendicitis for developing IAA (4.2 vs 3.5%,  $p = 0.870$ ), but only a few cases required staplers. Operating surgeon is the best judge for choosing the stump ligation device.

Surgical toileting is one of the must do steps in the presence of generalized peritonitis either in open or laparoscopic approach. But the efficacy of lavage remains controversial. The peritoneal lavage is effective before wound closure to reduce wound contamination in perforated appendicitis or appendicular abscess,<sup>10</sup> and it is also suggested by European guideline that through lavage (with 6–8 L normal saline) we can effectively lower the rate of IAA in perforated appendicitis.<sup>24</sup> In contrast, the lavage itself might spread the infection. Whenever a study documents a higher IAA rate with peritoneal irrigation in perforated appendicitis,<sup>25</sup> the role of lavage remains controversial. Abdominal drains are commonly used either in laparoscopy or open approach to evacuate the residual abdominal collection and prevent concurrent IAA in routine or emergency surgery.<sup>26</sup> Sleem et al<sup>12</sup> documented that pelvic drain could not reduce the rate of IAA after LA or OA. Allemann et al<sup>27</sup> reported overall less complication without drains vs with drain (7.7 vs 18.5%,  $p = 0.01$ ) with shorter hospital stay (4.2 vs 7.3 days,  $p = 0.0001$ ). Pessaux et al<sup>28</sup> documented higher infection rate related to abdominal drains after LA.

Conversion from LA to OA could negatively impact the outcome due to longer operation time, excess use of anesthetic agents, and overall more stress to the surgeon and patient. The conversion rates have been reported from LA to OA as 0 to 47%<sup>11,17</sup> correlating with surgeon's

experience.<sup>6</sup> In converted cases, the benefit of LA in complicated appendicitis would be underestimated.<sup>21</sup> Basically, conversion rate varies depending on the evaluation of anatomy, condition of the pathology, and the surgical skills also.

## Postoperative Complication Analysis

### Infection

A lot of studies documented less wound infection in LA than OA, both in adults<sup>8,10-14,17,18</sup> and children<sup>6</sup> in complicated appendicitis. Several studies documented the infection rate for LA as 0 to 15% and OA as 2 to 48%.<sup>21</sup> Practically, we used to retrieve the infected appendix with endobag to avoid port-site contamination. It has been suggested to handle the appendix during LA with an atraumatic grasper and every attempt to avoid the rupture of appendix.<sup>29</sup> But the development of IAA formation during postoperative period is not uncommon in perforated appendicitis because it would increase treatment cost due to prolonged antibiotic usages, prolonged hospital stays, and may even require readmission. To overcome such complications, LA could play a big role compared with OA.<sup>13,30,31</sup> Masoomi et al<sup>13</sup> reported the reduced rate of IAA in LA vs OA (1.65 vs 3.57%,  $p < 0.01$ ). But, some recent reports suggested the incidences of IAA were still significant in LA for perforated appendicitis.<sup>18,32</sup>

### Postoperative Analgesia

Pain is a subjective issue. As the multiple small incisions are more immune than a single large incision, multiple small-port incisions could effectively lower the need for postoperative analgesics. Some studies also documented on adults that LA causes less pain in perforated appendicitis compared with OA.<sup>10,11,17</sup> But the children may show no difference.<sup>33</sup>

### Treatment Cost

After diagnosis and surgery, the treatment cost varies, especially due to postoperative complications, including infection, sepsis, intensive care support, prolonged antibiotics, analgesics, increased hospital stay, etc. Uncomplicated appendicitis managed by LA reported reduced hospital stay and treatment cost<sup>34</sup> as well as in perforated appendicitis irrespective of patient's age.<sup>11,17,35,36</sup> From the nationwide inpatient sample data of 573,244 adults, Masoomi et al<sup>13</sup> have concluded the length of hospital stay in LA vs OA (4.0 vs 6.0 days,  $p \leq 0.01$ ). Tiwari et al<sup>29</sup> also reported reduced medical cost in LA than OA. Treatment cost largely varies from institutional practices by using disposable laparoscopic instruments, expensive electrosurgical devices and stapling devices, etc.

## Mortality and Morbidity

Acute appendicitis is the most commonly diagnosed cause of acute abdomen and managed surgically by LA around the world. But in case of complicated appendicitis, the outcome varies according to the presentation, age, and other associated comorbidities. Mortality and morbidity issue is a high concern in laparoscopic management of perforated appendicitis. It has been claimed by some authors that in-hospital mortality was significantly lower with LA compared with OA.<sup>13</sup> Moreover, it is reported that overall complication rate was reduced by LA vs OA (17.43 vs 26.68%,  $p \leq 0.0001$ ).<sup>29</sup> Other studies also documented consistently lower postoperative morbidities for perforated appendicitis with LA than OA (12.8–39.5% for LA and 26–37% for OA).<sup>6,10,17</sup>

## Outcome in Elderly and Obese Patients

In elderly and obese patients, the presentation of appendicitis is not commonly typical and becomes complicated easily due to diagnostic delay and other associated comorbidities. In the elderly, appendix might become gangrenous at the tip and perforated due to atherosclerotic changes in blood vessels and 50% higher perforation rate is also documented in geriatric than younger population.<sup>37,38</sup> Creation of pneumoperitoneum in elderly patients might be hazardous for cardiopulmonary activities proportionately with the duration of operation time in perforated appendicitis. So many surgeons discourage laparoscopy in complicated appendicitis in elderly population. Though few studies reported better outcome in terms of shorter hospital stay and less infection with LA than OA with comparable operation time,<sup>8,33,39,40</sup> the benefit of minimal access surgery in elderly patient needs more study.

There are some mechanical problems with laparoscopic approach in obese population that include difficult port

position, excess IAA and extra-abdominal fat, ventilation problem with pneumoperitoneum, which contribute to higher perioperative complications. According to SAGES guideline, LA is safe and effective in obese patients (level II, grade II).<sup>19</sup> Laparoscopy with longer trocars and instruments has some additional advantages like better exposure of anatomy, proper visualization, and lower wound complications.<sup>41</sup> Varela et al<sup>42</sup> documented less overall complications, less hospital stays, and comparable or even lower treatment cost with LA than OA in over 906 morbid obesity patients. Table 1 depicts the results of two different studies over obese patients with perforated appendicitis.<sup>43</sup>

## DISCUSSION

Most of the studies have reported the positive outcomes of LA than OA in terms of shorter hospital stays, lower infection rate, lower IAA, and comparable treatment cost in perforated appendicitis (Table 2). Conversion rate and postoperative IAA remain two significant issues of debate for LA in perforated appendicitis management.

**Table 1:** Population-based studies for obese patients with perforated appendicitis

Study	Varela et al <sup>42</sup>	Masoomi et al <sup>13</sup>
Study period	2002–2007	2006–2008
Patient number	LA: 238 OA: 441	LA: 6769 OA: 7110
Definition of obesity	BMI $\geq 40$ kg/m <sup>2</sup>	BMI $\geq 30$ kg/m <sup>2</sup>
Length of hospital stay	LA: 5 OA: 7 <sup>a</sup>	LA: 4.4 OA: 6.5
Mortality	LA: 0% OA: 0%	LA: 0% OA: 0.50% <sup>a</sup>
Overall complication rate	LA: 18% OA: 27% <sup>a</sup>	LA: 22.34% OA: 34.65% <sup>a</sup>
Mean cost, USD	LA: 12300 OA: 16600	LA: 36483 OA: 43901 <sup>a</sup>

<sup>a</sup> $p < 0.01$  vs perforated appendicitis (OA); BMI: Body mass index

**Table 2:** Summary of various study results

Study	Patient population	Patient number	LOS, days	Wound infection	IAA	Treatment cost, USD
Tuggle et al <sup>18</sup>	Adult	LA: 2060	LA: 3.97 <sup>a</sup>	LA: 2.56%	LA: 6.74%	
		OA: 730	OA: 5.13	OA: 8.05%	OA: 3.69%	
Tiwari et al <sup>29</sup>	Adult	LA: 5212	LA: 4.34 <sup>a</sup>			LA: 12125 <sup>a</sup>
		OA: 5323	OA: 7.31			OA: 17594
Masoomi et al <sup>13</sup>	Adult	LA: 69810	LA: 4.0 <sup>a</sup>	LA: 0.58%	LA: 1.65%	LA: 32487 <sup>a</sup>
		OA: 68344	OA: 6.0	OA: 2.09%	OA: 3.57%	OA: 38503
Oyetunji et al <sup>45</sup>	<18 years	LA: 21254	LA: 5.06 <sup>a</sup>		LA: 4.9%	LA: 27951 <sup>a</sup>
		OA: 51533	OA: 5.60		OA: 3.8%	OA: 24965
Jen et al <sup>46</sup>	<18 years	LA: 9246	LA: 5.2 <sup>a</sup>	LA: 5.5%		
		OA: 21347	OA: 5.5	OA: 6.4%		
Mohamed et al <sup>47</sup>	Adult	LA: 42	LA: 5.3 <sup>a</sup>	LA: 8.3%		
		OA: 32	OA: 7.2	OA: 24.4%		
Gerg et al <sup>4</sup>	All age group	LA: 49	LA: 3.0 <sup>a</sup>	LA: 8.2%	LA: 8.2%	
		OA: 61	OA: 6.0	OA: 24.6%	OA: 22.9%	

<sup>a</sup> $p < 0.01$  vs perforated appendicitis (OA) group, LOS: length of stay, LA: Laparoscopic appendicectomy, IAA: Intra-abdominal abscess



Risk factors for IAA include improper appendiceal stump closure, inadequate peritoneal irrigation, and the use of abdominal drains could equally affect the LA and OA outcomes. Individual surgical skill and team effort could lower the conversion rate and duration of operation time as well. However, the delay for conversion might be associated with more complications and morbidities. Recommendation for routine use of peritoneal irrigation and abdominal drains in perforated appendicitis to reduce IAA is individualized. Laparoscopic appendectomy might be effective for elderly and obese population. WSES 2013 guideline also recommends laparoscopic management in intraabdominal infections.<sup>44</sup> As the endoscopic surgical performance and its outcome varies with the surgeon's skill, team effort, and instrumental advancement, it is not so easy to conclude the definitive role of LA in the management of perforated appendicitis.

## CONCLUSION

In perforated appendicitis, laparoscopic approach carries definite advantages with less postoperative complications and better outcome. Especially in children and obese group, it is a more feasible and better alternative than open approach in complicated appendicitis.

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