

## Infective complications in laparoscopic versus open appendectomy: a prospective, randomized, single blind study

Jawad Khalil, Tahira Iqbal

### Abstract

**Objective:** The objective of the study was to compare laparoscopic and open appendectomy in terms of surgical site infection.

**Study design:** Prospective, randomized, single blind study.

**Place and duration of the study:** Surgical "C" unit, Department of Surgery, Khyber Teaching Hospital, Peshawar, Pakistan from November 2008 to May 2010.

**Materials and methods:** In this study 170 patients were randomly allocated to two groups A and B (85 patients in each group) to be subjected to laparoscopic appendectomy (LA) and open appendectomy (OA), respectively. Patients' demographics including age, gender, body mass index (BMI), histopathology reports, and outcome in terms of SSI were recorded on a standardized proforma. Statistical analysis was performed using SPSS version 15 with proportions and mean $\pm$ SD calculated for categorical and continuous variables, respectively. Probability  $\leq 0.05$  was taken as significant.

**Results:** One hundred and forty three patients were analyzed (71 in LA and 72 in OA group). The two groups were comparable in terms of demographic variables like age, gender and BMI. The operative duration was significantly longer in LA ( $47.54 \pm 12.82$  minutes versus  $31.36 \pm 11.43$  minutes;  $P < 0.001$ ). The length of hospital stay was  $1.52 \pm 0.76$  days in LA and  $1.70 \pm 1.06$  days in OA, which was not statistically significant ( $P = 0.294$ ). There was no significant difference between the two procedures regarding overall SSI rate ( $P = 0.359$ ). On stratifying SSI into Incisional and deep SSI, there was no statistically significant difference between the two procedures either.

**Conclusion:** In conclusion laparoscopic appendectomy took longer to perform and did not offer significant advantage over its open counter part in terms of SSI.

**Keywords:** Surgical site infection, laparoscopic appendectomy, open appendectomy, surgical site infection.

### Introduction:

Open Appendectomy (OA) has been the treatment of choice for acute appendicitis since its first description by McBurney in 1894.<sup>1</sup> Acute appendicitis is deemed as one of the most common intra-abdominal conditions requiring surgical intervention, with a life time risk of 6%.<sup>2,3</sup> Laparoscopic appendectomy (LA) was introduced in 1983 by a German gynecologist, Kurt Semm, and since then a consensus cannot be arrived at as to what should be the ideal modality of appendectomy between the two.<sup>4</sup>

According to Cochrane systematic review, surgi-

cal site infections (SSI) are 50% as less after LA as after OA. In contrast the incidence of intra-abdominal infections are commoner (almost 3 times) in laparoscopic appendectomy.<sup>5</sup> Surgical site infection is among the most common nosocomial infections.<sup>6</sup> Almost 60% of SSI are diagnosed after hospital discharge and lead to major clinical problems like morbidity, mortality, increasing the hospital stay and costs of treatment.<sup>7</sup> The impact of laparoscopy on Surgical Site Infection has been under discussed in the surgical literature.<sup>8</sup>

In contrast to simple appendicitis, some sur-

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**Khyber Teaching Hospital, Peshawar**  
J Khalil  
T Iqbal

**Correspondence:**  
Dr. Jawad Khalil, Clinic B-11, Second Floor, Khushal Medical Center, Dbgari Gardens, Peshawar, Pakistan.  
Cell: + 92-347-9791350  
Email: jawadkhalil238@gmail.com

geons feel resistant to embark on laparoscopic appendectomy in complicated appendicitis for the fear of increasing the rate of organ space SSI.<sup>9</sup> There are, however, others who disagree with the fact that laparoscopic appendectomy is associated with an increased incidence of SSI.<sup>10</sup> In addition the lack of post discharge surveillance and presence of confounding variables might be responsible for the observed differences of SSI between laparoscopic appendectomy and Open Appendectomy.<sup>11</sup>

Keeping in mind, the conflict of opinion that exists thus far regarding surgical site infection between laparoscopic appendectomy and open appendectomy, and scarcity of locally published studies on this issue, we aimed to undertake a study to compare the LA and OA in terms of surgical site infection, thereby, decreasing morbidity of the patients due to SSI by instituting measures in light of results of the present study.

#### **Materials and Methods:**

This study was conducted at Surgical 'C' Unit, Department of Surgery, Khyber Teaching Hospital, Peshawar, Pakistan, from November 2008 to May 2010, as part of a single center, prospective, single blind, randomized clinical trial. The objective of the study was to compare LA and OA in terms of surgical site infection. Based on current literature findings, we hypothesized that there was no significant difference between LA and OA in terms of surgical site infection. Approval for the study was obtained from the Ethics Committee of the hospital.

In this study, a total of 170 consecutive patients presenting to outpatient department (OPD) with, signs and symptoms suggestive of acute appendicitis, age between 12 to 60 years, and American Society of Anesthesiologists class I were included. Any patient with, duration of symptoms for more than 5 days, previous abdominal surgery, large ventral hernia, mass right iliac fossa and failing to abide by the follow up protocol, was excluded from the study. All the patients were selected through non-probability consecutive technique. The patients were explained the risks and benefits of the two proce-

dures (LA and OA) and an informed consent regarding participation in the trial was obtained.

The included patients were admitted in the ward through OPD a day before the surgery. A detailed history, clinical examination and investigations were performed. The patients were randomly allocated to two groups, A and B, using table of random numbers just before the operation. The patients in group A were subjected to LA and group B to OA. Appendicitis was confirmed on histopathology which also showed different grades of inflammation.

The patients in both groups were operated by a single consultant surgeon, under general anesthesia, with sufficient capability of performing the two procedures. Skin was prepared with aqueous povidine iodine solution. The patients were given, in both groups, a prophylactic parenteral dose of Ceftriaxone and Metronidazole at induction as part of the protocol, with two doses of the same repeated postoperatively at 8 hours and 16 hours. Patients with complicated appendicitis (gangrenous, perforated) were given antibiotics for 5 days or until patients became afebrile without any signs of sepsis and the white blood cell count returned to normal levels.

Laparoscopic appendectomy (LA) was performed through a 3 port technique with carbon dioxide used for creation of pneumoperitoneum through a 5mm infra-umbilical port upto a pressure of 12 mmHg. The other two ports were placed in the lower abdomen according to individual surgeon's choice. After identification of the appendix the mesoappendix was ligated, with vicryl 1 after creation of a window in its base, and cut. The base of the appendix was crushed and ligated using Vicryl 1 endoloop. The appendiceal specimen was retrieved through a 10 mm infra-umbilical port. Endodathermy was used for hemostasis. If conversion to OA was required, its reasons were recorded. Open appendectomy was performed through standard Lanz incision. After the incision, peritoneum was accessed and opened to deliver the appendix which was re whole abdomen, to blind the patient, in both the procedures. The opera-

Table 1: Patients demographics

	Group A N=71	Group B N=72	P Value
Age (Y)			0.78
Mean (SD)	23.2 (8.5)	22.7 (10.1)	
Median (Range)	21 (12-60)	20 (10-60)	
Gender, N. (%)			0.57
Male	39 (54.9)	42 (58.3)	
Female	32 (45)	30 (41.6)	
Body Mass Index			0.49
Mean (SD)	25.3 (3.03)	25.0 (2.61)	
Median (Range)	25 (21-37)	25 (21-35)	

Table 2: Outcome based on histopathology report

	Group A N=71	Group B N=72	P Value
Outcome, N. (%)			
Acutely inflamed	60 (84.5)	55 (76.3)	0.221
Phlegmonous	2 (2.8)	3 (4.1)	0.660
Gangrenous	0 (0)	1 (1.3)	0.319
Perforated	6 (8.4)	8 (11.1)	0.592
Non-inflamed	3 (4.2)	5 (7)	0.479

Table 3: Reasons of conversion of LA

Reasons	No. of Cases
Adhesion	2
Intra-operative bleeding	1
Instrument failure	1

Table 4: Comparison of SSI between LA and OA

Parameter	Group A N=71	Group B N=72	P Value
Surgical site infection (%)	4 (5.6)	7 (9.7)	0.359
Incisional SSI			
SISI	2 (2.8)	4 (5.5)	0.414
DISSI		2 (2.7)	0.157
Deep SSI	2 (2.8)	1 (1.3)	0.551

SSI = Surgical site infection, SISI = Superficial incisional surgical site infection, DISSI = Deep incisional surgi-

tive record was kept moved in the usual manner. Skin incision in both the procedures was closed with continuous subcuticular stitches using prolene 2/0 (Ethicon) suture. Port (LA) and wound sites (OA) were dressed with three dressings along with an abdominal blinder covering the in sealed envelop during the patient's hospital stay to keep the patient blinded to the operative procedure performed.

Post-operatively, the patients were kept Nil by mouth until they were fully recovered from anesthesia and had their bowel sounds returned when clear fluids were started. Soft diet followed by regular diet was introduced when the patients

tolerated the liquid diet and had passed flatus. Patients were discharged once they were, able to take regular diet, afebrile, ambulatory, and had good pain control. Before discharging the patient from the hospital, the dressing was removed to examine the surgical site. A standardized questionnaire was used to record the data like age, gender, histopathology reports, operative duration, rate and reasons for conversion to open surgery and SSI for the two procedures. The patients were followed up till one month post-operatively (fortnightly) in OPD. Any patients missing follow up visit were telephoned and were asked a standardized set of questions. Confounding variables were controlled through strictly following the exclusion criteria.

Surgical site infection was defined, using center for disease control and prevention (CDC) classification, incisional and deep SSI. Incisional SSI was further divided into superficial and deep with involvement of superficial subcutaneous tissue and deep subcutaneous tissue and muscles, respectively. The findings/features of purulent or seropurulent discharge, redness or pain, at the incision site within 30 days postoperatively were used to identify SSI. A febrile patient with fever, elevated white cell count (WBC > 10,000g/dl), paralytic ileus and imaging detected fluid collection with characteristics of an abscess were labeled as having intra-abdominal abscess.

### Statistical Analysis:

The data was analyzed using SPSS version 11 for windows. Continuous variables were presented as Mean±SD while categorical variables were expressed with frequency and percentages using 95% confidence interval. Student t-test was used to compare the means of continuous variables while categorical variables were compared using Pearson Chi Square or Fisher exact test, as appropriate. Probability equal to or less than 0.05 (P ≤ 0.05) was considered significant.

### Results:

In this study, out of the selected 170 patients, 85 patients in each group, 14 patients in group A and 13 patients in group B were lost due to fol-

Figure 1: Sequence of allocation

Patients included	
170	
Randomized to group A N = 85	Randomized to group B N = 85
Follow up lost N = 14	Follow up lost N = 13
Final analysis N = 71	Final analysis N = 72

low up. Therefore, a total of 71 patients in group A and 72 in group B were included in the final analysis, as shown in Figure 1. The patients with converted LA appendectomy were analyzed in the pool of laparoscopic procedures with an intention-to-treat principle. The mean age of patients in group A and B was 23.2±8.5 years and 22.7±10.1 years, respectively. There were 39 males and 32 females in group A (M/F ratio 1.2:1) compared to 42 males and 30 females (M/F 1.4:1) in group B, as shown in Table 1.

According to histopathology reports, appendix was acutely inflamed in 60 (84%) patients, phlogmonous in 2 (2.8%) patients, gangrenous in 0 patients, perforated in 6 (8.4%) patients and normal in 3 (4.2%) patients in laparoscopic appendectomy group. The corresponding figures in open appendectomy group were 55 (76%) acute inflamed, 3 (4.1%) phlogmonous, 1 (1.3%) gangrenous, 8 (11%) perforated, and 5 (7%) normal, Table 2. There was conversion of LA to OA in 3 (4.2%) cases, the reasons for which are listed in Table 3. The operative duration was 47.54±12.82 minutes in LA compared to 31.36±11.43 minutes in OA, proving to be statistically significant (P < 0.001). The length of hospital stay was 1.52±0.76 days in LA and 1.70±1.06 days in OA, which was not statistically significant (P = 0.294).

Surgical site infection was observed, overall SSI rate, in 4 (5.6%) patients in LA group and 7 (9.7%) patients in OA group which was statistically insignificant. As shown in Table 4, out of 4 (5.6%) patients who developed SSI in LA group, there were two (50%) cases each of incisional and deep SSI. In contrast, the corresponding figures in the open appendectomy group, were 6 (86%) and 1 (14%), respectively. In the LA

group the incisional SSI rate according to different grades of inflammation was 1 (1.6%) for acute appendicitis and 1 (50%) for phlogmonous appendicitis with no infection (incisional) in gangrenous and perforated appendix. Incisional SSI rate in open appendectomy group in different inflammatory grades was 2 (3.7%) for acute appendicitis, 1 (33.3%) for phlogmonous appendicitis, 1 (100%) for gangrenous and 2 (25%) for perforated appendicitis. The deep/organ space SSI rate in LA group was 2 (33%) for perforated appendicitis and 0% for other grades of inflammation. The deep SSI rate in OA group was 1 (21.5%) for perforated appendicitis and 0% for other grades of acute appendicitis. In LA group, 3 (75%) patients with SSI were detected post hospital discharge within 10 days. While in OA group, 4 (57%) patients developed SSI within 7 days of hospital discharge. The site of infection in LA group was the infra-umbilical port in 3 (75%) patients (the site of appendix retrieval).

**Discussion:**

Nosocomial infections are deemed a major public health problem occurring all over the world causing thousands of deaths annually in the United States.<sup>12</sup> Surgical site infections are, along with urinary tract infections, pneumonia and blood borne infections, ranked as the second or third most common type of nosocomial infections.<sup>13</sup> Almost no surgical procedure is free of the risk of surgical site infection despite advances in surgical techniques, use of antibiotic prophylaxis and efforts to control infection.<sup>14</sup> Laparoscopic appendectomy, in contrast to laparoscopic cholecystectomy, has not flourished its superiority over OA as yet.<sup>15</sup> A meta-analysis of prospective randomized trials, comparing LA and OA, found significant difference between the two modalities in terms of SSI.<sup>16</sup> Others, however, failed to reproduce these results.<sup>17,18</sup>

The findings of the current study show that 4/71 (5.6%) patients in LA and 7/72 (9.7%) patients in OA group developed SSI (overall), the difference was, however, statistically insignificant. The prevalence of incisional SSI was not statistically significant different between the two groups ei-

ther. These figures are in accordance with others.<sup>5,19,20</sup> Golub R et al, in a meta-analysis of prospective randomized studies, contradicted our results as incisional SSI was significantly less in LA than OA in their findings.<sup>21</sup> All these cases of incisional SSI were treated with opening of wound, toilet, povidine iodine packing and oral antibiotics with an uneventful recovery.

On further stratifying SSI, we found that there was no statistically significant difference between the two groups in terms of deep (organ-space) SSI, 2/71 (2.8%) for LA and 1/72 (1.3%) for OA. All the deep infections (in both the groups) occurred in patients with perforated appendicitis. The location of abscess in LA group was right lower quadrant in one patient and pelvic in the other while in the OA group it was right lower quadrant. Tang et al, in a study comparing LA and OA in complicated appendicitis, showed that the rate of intra-abdominal infection was 11% in LA and 3% in OA, proving to be statistically insignificant.<sup>22</sup> Others have reported significantly increased incidence of intra-abdominal abscess in complicated appendicitis in LA compared to OA<sup>4,15,23,24</sup>. The patients with organ space SSI, in this study, were diagnosed using ultrasonography and were managed conservatively with parenteral antibiotics and radiological drainage.

Surgical site infection has been traditionally used to compare the two modalities of treatments for acute appendicitis. It may not be a serious complication on its own but may hamper patients' convalescence time and quality of life with the deep SSI proving to be life threatening in many a patients.<sup>20</sup> Some believe that intra-abdominal abscess can be reduced especially in LA if, the patient is placed in Trendelenburg position, sigmoid colon is retracted and the pelvis is completely irrigated and aspirated, good surgical technique and proper antibiotic use employed.<sup>25,26</sup>

The present study shows that the operative duration was significantly longer in LA, which is consistent with the results yielded by others.<sup>20,27</sup> Others however failed to reproduce these re-

sults.<sup>2,4</sup> All the laparoscopic appendectomies in our study were performed by a single consultant surgeon with sufficient case load. The significantly increased operating room duration in our study can be explained by the fact that LA involves increased instrumentation, diagnostic laparoscopy and setup time. Operative duration has been a center of discussion among experts whenever laparoscopic and open appendectomies are compared.<sup>28</sup> Some feel that in addition to less postoperative pain, early recovery, shorter hospital stay and good pain control, diagnostic laparoscopy, especially in doubtful cases, is one of the main advantages of laparoscopic approach and the ultimate benefit of LA will not be the operative duration, but the above mentioned advantages.<sup>4,26</sup> Others, however, argue that the cost of treatment is directly influenced by the length of the procedure which is increased in LA.<sup>29</sup>

According to the findings in this study, there was no significant difference in the hospital stay of the two procedures. In consistence with our results, others have suggested no significant difference in the length of hospital stay.<sup>2,20,29</sup> Aziz O et al, in a meta-analysis comparing LA and OA, found significantly shorter hospital stay in favor of LA.<sup>4</sup> Open appendectomy performed through a smaller right iliac fossa incision, is venturing as an alternative procedure and the difference in length of hospital stay is only marginal, if any, in this era.<sup>30</sup> The difference in the hospital stay between the two procedures may be explained by the differences in the pathological status of the appendix and clinical status of the patients.<sup>29</sup>

It is important to address the limitations of the present study which are as follows. First, this was a single blind study and the outcome assessment was not blinded which could lead to observer bias. Second, the post discharge follow up through telephone in patients not turning for follow up in outpatients' clinic can not be highly relied upon as different patients would perceive same finding differently.

#### **Conclusion:**

In conclusion, there was no significant differ-

ence between open and laparoscopic appendectomies in terms of surgical site infection. On stratification of SSI, the two modalities were comparable as regards incisional and deep SSI, even for complicated appendicitis. This is in contrast to others who question the use of laparoscopic approach in complicated appendicitis for the apprehension of increased rate of intra-abdominal abscess formation.

Regarding results of our trial, we would like to suggest that laparoscopic and open appendectomies are equivalent procedures in terms of SSI and neither has superiority over the other. This study also shows that laparoscopic approach can be put to use as an alternative to OA in complicated appendicitis, provided that surgical expertise and equipment are available.

The final decision about the choice of procedure should therefore, be made by the patient or the surgeon.

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#### **Role and contribution of authors:**

Dr. Jawad Khalil, Resident General Surgery, Surgical C Unit, Khyber Teaching Hospital, Peshawar, collected the data, references and wrote the introduction, discussion result and conclusion.

Dr. Tahira Iqbal, Resident Medical Officer, Gynae C Unit, Khyber Teaching Hospital, critically review the article and made the necessary changes.

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