

# Clinical Outcomes of Laparoscopic Versus Open Appendectomy

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## ABSTRACT

**Background:** Appendectomy, being the most common surgical procedure performed in general surgery, is still being performed by both open and laparoscopic methods due to a lack of consensus as to which is the most appropriate method. Because further trials are necessary and few such studies have been performed in developing countries, we decided to evaluate the outcomes of the 2 procedures to share our experience with the international community.

**Methods:** Consecutive patients with suspected acute appendicitis who underwent laparoscopic (LA) (n=48) and open (n=52) appendectomy (OA) over a period of 3 years were studied. Clinical outcomes were compared between the 2 groups in relation to operative time, analgesia used, length of hospital stay, return to work, resumption of a regular diet, and postoperative complications.

**Results:** Mean age of patients was 25.8 years in the laparoscopic and 25.5 years in the open group. Patient demographics were similar in both groups ( $P > 0.05$ ). There was significantly less need for analgesia ( $1.0 \pm 0.5$  in LA and  $1.5 \pm 0.6$  doses in OA), a short hospital stay ( $1.4 \pm 0.7$  in LA and  $3.4 \pm 1.0$  days in OA), early return to work ( $12.6 \pm 3.3$  in LA and  $19.1 \pm 3.1$  days in OA), and less time needed to return to a regular diet ( $20.1 \pm 2.9$  in LA and  $22.0 \pm 4.7$ ,  $P < 0.05$  in OA) in the laparoscopic appendectomy group. Operative time was significantly shorter ( $54.9 \pm 14.7$  in LA and  $13.6 \pm 12.6$  minutes in OA) in the open group. Total number of complications was less in the laparoscopic group; however, there was no statistically significant difference.

**Conclusion:** The laparoscopic technique is a safe and clinically beneficial operative procedure. It provides certain advantages over open appendectomy, including short hospital stay, decreased requirement of postoperative an-

algesia, early food tolerance, and earlier return to normal activities. Where feasible, laparoscopy should be undertaken as the initial procedure of choice for most cases of suspected appendicitis.

**Key Words:** Laparoscopic appendectomy, Suspected appendicitis.

## INTRODUCTION

Appendicitis is one of the most common surgical emergencies requiring appendectomy, with a life-time risk of 6%. The overall mortality rate for open appendectomy (OA) is around 0.3% and morbidity about 11%.<sup>1</sup> Open appendectomy has been the treatment of choice for more than a century since its introduction by McBurney in 1894, and the procedure is standardized among surgeons. Kurt Semm was the first to describe laparoscopic appendectomy (LA) in 1983. Encouraged by the success of laparoscopic cholecystectomy, which has become the gold-standard treatment for gallstone disease in a short span of time, laparoscopic surgery has gained in popularity and found application in almost every surgical speciality. Laparoscopic appendectomy has been shown to be feasible and safe in randomized comparisons with open appendectomy. Laparoscopic appendectomy has improved diagnostic accuracy along with advantages in terms of fewer wound infections,<sup>2</sup> less pain,<sup>2,3</sup> faster recovery and earlier return to normal activity.<sup>2-4</sup> On the contrary, laparoscopic appendectomy consumes more operating time<sup>2,3</sup> and is associated with increased hospital costs.<sup>4</sup> The laparoscopic approach has been supported as an alternate to open appendectomy by many comparative studies.<sup>5</sup> Some studies failed to demonstrate clear advantages for laparoscopic over open appendectomy.<sup>6,7</sup> No consensus exists as to whether laparoscopy should be performed in select patients or routinely for all patients with suspected acute appendicitis. Keeping in mind this background and the fact that studies comparing laparoscopic and open appendectomy are fewer in third-world countries, this prospective study was carried out to compare the postoperative outcomes of both procedures in terms of hospital stay, operating time, postoperative morbidity, and time to resume normal activity.

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## PATIENTS AND METHODS

This prospective comparative study was performed in the Department of Surgery, Liaquat University of Medical and Health Sciences Jamshoro, a public sector university, from June 2003 to May 2006. All patients between 15 and 60 years of age admitted through the accident and emergency (A&E) department with a clinical diagnosis of acute appendicitis and those who completed follow-up were included in the study. All those patients in whom a clinical diagnosis of acute appendicitis was not established or had a palpable mass in the right lower quadrant, suggesting an appendiceal abscess and those who did not give consent were excluded from the study.

Patients were fully informed about the risks and benefits of the 2 procedures. The qualifying patients were randomized into 2 groups, laparoscopic group (LA) and open group (OA), for treatment purposes. Computer-generated random numbers were used to assign the type of surgery (laparoscopic or open), which were written on a card sealed in a completely opaque envelope. Informed written consent was obtained from every study subject, and data were collected in a specifically designed proforma where the patient's demographic details, operative findings, doses of analgesic, operative time, hospital stay, and postoperative complications were recorded.

Patients were diagnosed on a clinical basis with a history of right lower quadrant pain or periumbilical pain migrating to the right lower quadrant with nausea and/or vomiting, fever of more than 38°C and/or leukocytosis above 10 000 cells per cubic mL, right lower quadrant guarding, and tenderness on physical examination.

The study was approved by the local ethics committee of the hospital and performed in accordance with the Helsinki declaration. Data were recorded on case-record forms, and the study was monitored according to good clinical practice.

### Surgical Procedure

All operations were performed with the patient under general anesthesia by or under the supervision of 4 consultant surgeons who were experienced enough to perform standardized open and laparoscopic techniques. The operative technique was unknown to the data-collecting resident surgeon until 7 days to 10 days after appendectomy.

A standard 3-port technique was used for laparoscopic appendectomy by the open (Hasson) method for estab-

lishing pneumoperitoneum. The mesoappendix was dissected by using electrocautery, and the appendix base was tied and divided between 2 endo-loops (Ethicon, UK) with laparoscopic scissors. An extraction bag was used to retrieve the specimen. The appendicular stump was not routinely buried.

Open appendectomy was performed through a gridiron incision in standard fashion. The mesoappendix was ligated, and the appendix was divided at the base and removed without invagination. All specimens were sent intact for microscopic examination. All patients received a standard perioperative antibiotic regimen of intravenous cefuroxime and metronidazole. Laparoscopy was converted to open appendectomy if technical difficulties, uncertain anatomy, or bleeding were encountered. Appendectomy was performed in macroscopically normal-looking appendix in both groups.

### Postoperative Course

Bowel sounds were checked every 12 hours. Once bowel sounds were present, patients were allowed to take a clear liquid diet and advanced to a regular diet when the liquid diet was tolerated and flatus was passed. Patients were discharged when they tolerated a regular diet and were afebrile for 24 hours.

### Outcome Parameters

Clinical outcomes were recorded in proforma regarding total operative time, hospital stay, and time to resume oral intake. Dosages of parenteral and oral analgesics required were recorded by the data collector blinded to the type of operation. A standardized postoperative pain regimen was given to all and included acetaminophen (paracetamol) 500 mg tablets and shots of intramuscular diclofenac sodium. Return to normal activity was recorded as time taken to resume work and other activities of social life. Patients were observed for developing any complications in postoperative period.

### Follow-up

Patients were advised to attend outpatient clinic at weekly intervals for 3 weeks. Stitches were removed on the first week, and patients were observed for development of any complications on the second- and third-week appointments. Patients were advised to report for development of any complications and were followed for up to 10 months.

**Statistical Analysis**

The data were evaluated with statistical program SPSS version 11.0. Frequencies and percentages of categorical parameters were calculated on 95% confidence interval. The Fisher’s exact and Pearson’s chi-square tests were applied among the categorical variables, and the Student *t* test was used for continuous variables (2-tailed).  $P < 0.05$  was considered statistically significant.

**RESULTS**

Of 114 patients enrolled in this study, 14 were excluded because of protocol violations where 3 patients were converted to open appendectomy and 11 did not complete their follow-up. Reasons for conversion from laparoscopic to open appendectomy in 2 cases were a gangrenous appendix and inflammatory adhesions making access to the appendix difficult.

Mean age of patients in this study was  $25.8 \pm 6.0$  years in the laparoscopic group and  $25.5 \pm 9.7$  years in the open appendectomy group. No significant demographic differences existed between the 2 randomized groups in relation to age, sex, and leucocyte count, as summarized in **Table 1**.

Mean ( $\pm$ SD) white blood cell count in the laparoscopic group was  $13.5 \pm 1.0$  and  $13.8 \pm 1.3$  in the open group.

**Operating Time**

In our study, the mean operative time of  $54.9 \pm 14.7$  minutes for the laparoscopic group was longer than the mean operative time of  $31.6 \pm 12.6$  minutes for open appendectomy, and this difference is statistically highly significant. Mean time to complete the diagnostic laparoscopy was 9 minutes (range, 3 to 45) in the laparoscopic group.

**Analgesia**

The laparoscopic group required fewer doses of parenteral and oral analgesics in the operative and postoperative periods compared with the open appendectomy group as summarized in **Table 2**.

**Oral Intake**

Time taken to tolerate oral intake was significantly less in the laparoscopic group with mean ( $\pm$ SD)  $20.1 \pm 2.9$  hours compared with mean ( $\pm$ SD)  $22.0 \pm 4.7$  hours in the open group, as summarized in **Table 2**.

**Hospital Stay**

Hospital stay was significantly shorter in the laparoscopic group with a mean ( $\pm$ SD)  $1.4 \pm 0.7$  days compared with a mean ( $\pm$ SD)  $3.4 \pm 1.0$  days for the open group, as shown in **Table 2**.

**Activity**

A highly significant difference existed between the 2 groups in time taken to return to routine daily activities, which was less in the laparoscopic group with a mean ( $\pm$ SD)  $12.6 \pm 3.3$  compared with mean ( $\pm$ SD)  $19.1 \pm 3.1$  in the open appendectomy group, as summarized in **Table 2**.

**Complications**

In this study, the overall incidence of complications was greater in open surgery than in laparoscopic surgery. A total of 18 complications (15 minor and 3 major) occurred in the laparoscopic group, while 49 complications (46 minor and 3 major) occurred in the open appendectomy group.

Vomiting and paralytic ileus were the 2 complications with a statistically highly significant difference. Wound infection rate was greater in the open group than in the laparoscopic

**Table 1.**  
Demographic Profile of the Patients (n = 100)

Characteristics	Laparoscopic Appendectomy (n = 48)	Open Appendectomy (n = 52)	P Value
Age (Years)*	$25.8 \pm 6.0$	$25.5 \pm 9.7$	0.84
Sex			0.51
Male	35 (72.9%)	34 (65.4%)	
Female	13 (27.1%)	18 (34.6%)	
White Blood Cell Count ( $\times 10^9$ /L)*	$13.5 \pm 1.04$	$13.8 \pm 1.3$	0.14

\* Results expressed as mean  $\pm$  standard deviation.

**Table 2.**  
Comparison of Variables Between the 2 Groups

	Laparoscopic Appendectomy (n = 48)	Open Appendectomy (n = 52)	P Value*
Preoperative Histopathological and Ultrasound Findings			
Operative			
Inflamed appendix	40 (83.3%)	41 (78.8%)	0.61
Normal looking appendix	8 (16.7%)	11 (21.2%)	
Histopathological			
Inflamed appendix	43 (89.6%)	45 (88.5%)	NS†
Normal looking appendix	5 (10.4%)	7 (11.5%)	
Ultrasound			
Inflamed appendix	30 (62.5%)	41 (78.8%)	0.08
Normal looking appendix	18 (37.5%)	11 (21.2%)	
Postoperative Subjective Outcome*			
Operative time (min)	54.9 ± 14.7	31.6 ± 12.6	< 0.001 <sup>§</sup>
Parenteral analgesics (doses)	1.0 ± 0.5 (1–3)	1.5 ± 0.6 (2–5)	0.001
Oral analgesics (doses)	2.5 ± 0.8 (2–4)	3.0 ± 1.5 (2–6)	0.05
Time to oral intake (hrs)	20.1 ± 2.9 (15–25)	22.0 ± 4.7 (15–30)	0.02
Hospital stay (d)	1.4 ± 0.7	3.4 ± 1.0	< 0.001 <sup>§</sup>
Returned to normal activity (d)	12.6 ± 3.3	19.1 ± 3.1	< 0.001 <sup>§</sup>
Postoperative Complications			
Minor			
Vomiting	9 (18.8%)	27 (51.9%)	0.001
Paralytic ileus	3 (6.3%)	12 (21.2%)	0.04
Wound infection	3 (6.3%)	7 (13.7%)	0.32
Major			
Wound dehiscence	0	1 (1.9%)	NS†
Intra abdominal abscess	2 (4.2%)	1 (1.9%)	NS†
Small bowel obstruction	1 (2.1%)	1 (1.9%)	NS†

\*P value <0.05 is statistically significant.

†NS = Not significant.

‡Results are expressed as mean ± standard deviation (range).

§P value is statistically highly significant.

group, but statistically it was not significant. Differences in other complications like wound dehiscence, intraabdominal abscess, and small bowel obstruction were not significantly different as summarized in **Table 2**.

### Surgical Findings

Of 100 evaluable cases, preoperative ultrasound showed an inflamed appendix in 71 patients and a normal appendix in 29. Operative findings revealed 81 patients as having an inflamed appendix, while 19 had normal-looking appendi-

ces. This finding shows the false-negative report of ultrasonography in 10 patients as summarized in **Table 2**. There was a slight difference between preoperative findings and histopathologic findings, resulting in a tendency towards a more advanced diagnosis of appendicitis on microscopy. On the histopathological report, only 12 specimens were normal, while 88 had some degree of inflammation. This shows that of 19 appendices that appeared normal preoperatively on naked eye examination, 12 were normal and the remaining 7 were inflamed (**Table 2**).

## DISCUSSION

The success of laparoscopic surgery in gallbladder ailments and many other fields has led to the re-evaluation of many long-accepted surgical doctrines. Acute appendicitis is one of the most commonly encountered surgical conditions that requires emergency surgery. Laparoscopic surgery is a major surgical advance in the last 2 decades. Metaanalyses<sup>8,9</sup> have confirmed that laparoscopic appendectomy is safe and results in a faster return to normal activities with fewer wound complications, at the expense of longer operating time. The perception also exists in many quarters that laparoscopic appendectomy has marginal advantages and may not be worth the trouble.<sup>10</sup>

Because no consensus has been reached, both procedures are still being practiced actively despite randomized trials and metaanalyses. The subject still needs additional comparisons. Furthermore, very few studies have been conducted in third-world countries where minimally invasive surgery has not been established fully. Keeping this background in mind, this prospective comparative study was carried out to compare the postoperative outcomes of both procedures in clinically diagnosed acute appendicitis.

Total operative time in this series was significantly longer in the laparoscopic group (mean  $\pm$ SD, 54.9 $\pm$ 14.7 minutes) including 9 minutes (range, 3 to 45) consumed during diagnostic laparoscopy than in the open group (mean  $\pm$ SD, 31.6 $\pm$ 12.6 minutes), which was measured as actual skin-to-skin time. Our finding is in agreement with other studies showing the same results.<sup>2,3,7</sup> This may be due to additional steps of operation like setup of instruments, insufflation, and making ports under direct vision in laparoscopic surgery and diagnostic laparoscopy. Laparoscopic operating time should improve with increasing experience. Longer operating room times results in higher costs that can be compensated by shorter hospital stay. The cost was not included in this study, because this study was conducted in a public sector university hospital where subjects undergoing both procedures are not required to pay. Several other randomized studies<sup>2-4,11-13</sup> suggest this advantage by demonstrating quicker time to recovery and activity, whereas other studies have refuted this advantage.<sup>7,14</sup>

Length of hospital stay is a very important variable that directly influences the economy and well-being of the patient. Our study shows a significant short hospital stay (1.4 $\pm$ 0.7 days) in the laparoscopic group compared with that in the open group (3.4 $\pm$ 1.0,  $P \leq 0.001$ ). Our results are

consistent with those of early publications<sup>15</sup> as well as recent studies<sup>16</sup> that demonstrate a significantly short hospital stay. Some studies<sup>8</sup> show no significant difference between the 2 groups. Longer hospital stay in various European studies<sup>3,12</sup> could be the consequence of different social standards and insurance systems. Some authors argue that the appendiceal pathology was a major determinant of length of hospital stay; however, in our study appendiceal pathologies were similar in both groups, and the short hospital stay is likely to be due to use of a different surgical approach.

Total analgesic requirement is a quantitative method of recording the postoperative pain in various procedures. The majority of patients in this study were not educated and were not good at responding to the various scales/response sheets for severity of pain. Therefore, the total number of postoperative analgesic doses required by individual patients was used to compare the analgesic requirement between the 2 groups. In this series, total parenteral and oral analgesic requirements were less in the laparoscopic group [parenteral 1.0 (range, 1 to 3); oral 2.5 (range, 2 to 4)] than in the open appendectomy group [parenteral 1.5 (range, 2 to 5); oral 3.0 (range, 2 to 5)], and this difference is statistically significant. Our finding is in agreement with findings of many other studies<sup>2,11,17</sup> that demonstrate less pain and less analgesic requirements in laparoscopic groups.

Very few studies are available that have compared tolerance to oral intake between the 2 groups. Some studies have shown significantly less time to tolerate oral intake in laparoscopic groups<sup>18</sup> compared with open groups, while others show no significant difference.<sup>7</sup> In this study, significantly less time was needed for patients to tolerate oral intake with a mean ( $\pm$ SD) 20.1 $\pm$ 2.9 hours in the laparoscopic group compared with a mean ( $\pm$ SD) 22.0 $\pm$ 4.7 in the open group.

In this study, mean time to full recovery, ie, time to resumption of work, was 12.6 $\pm$ 3.3 days in the laparoscopic group and 19.1 $\pm$ 3.1 days in the open appendectomy group ( $P \leq 0.001$ ). Our finding is in agreement with a similar study by Hellberg et al<sup>3</sup> that demonstrates median time to full recovery as 13 days in the laparoscopic group and 21 days in the open group ( $P \leq 0.001$ ) and other randomized clinical trials and meta-analysis.<sup>11</sup> However, other studies<sup>14,16,19</sup> show no difference with respect to performance of daily activities and time to full recovery. Generally, there are more expectations to resume work earlier after appendectomy, especially after laparoscopic appendectomy. These expectations make some sense,

because laparoscopic procedures being minimally invasive should allow a short hospital stay, quicker recovery, and earlier return to work. Return to activity after appendectomy has remained a subject of intense debate. In many metaanalyses, results are statistically “highly heterogeneous” because of variable definitions of activity. We used the return to work as an end point, because in our population group there was not much employment heterogeneity and involvement of insurance. Our population group being a lower income group wanted to resume work earlier; therefore, we thought it would be a more reflective end point.

Laparoscopic appendectomy has been attributed to a low incidence of complications compared with open appendectomy by many studies.<sup>8,9,20</sup> Our study is also in agreement with these studies, demonstrating 49 major and minor complications in open appendectomy versus 18 major and minor complications in the laparoscopic group. One study<sup>19</sup> demonstrates the same rate of complications in both groups.

Wound infections may not be serious complications per se but represent a major inconvenience to the patient, impacting his or her convalescence time and quality of life. The majority of studies<sup>1,11,21,22</sup> have concluded that wound infections are significantly lower after laparoscopic appendectomy. Furthermore, laparoscopic surgery is associated with better preservation of the immune system than open surgery is. This results in a decreased incidence of infectious complications.<sup>23</sup> In our series, 3 patients (6.3%) in the laparoscopic group and 7 (13.7%) in the open group had wound/port infections. Wound infections were more common in the open group; however, this difference was not statistically significant. One study<sup>19</sup> shows no statistically significant differences in infectious complications between the laparoscopic and open group.

Intraabdominal abscess formation is a serious complication and can potentially be life threatening. In this study, intraabdominal abscesses developed in 2 (4.2%) patients in the laparoscopic group and in 1 (2.9%) patient in the open group. Of 2 patients in the laparoscopic group, intraabdominal abscesses complicated one simple appendicitis and one suppurative appendicitis. This finding is consistent with findings in other studies that show an increased risk of intraabdominal abscess after laparoscopic appendectomy compared with open surgery,<sup>4</sup> while others have reported the opposite.<sup>24</sup> However, this finding is not statistically significant. In a recently published analysis of 54 studies on laparoscopic appendectomy by the Cochrane group, the incidence of intraab-

dominal abscess was increased (OR=2.48, CI 1.45 to 4.21) in patients who underwent laparoscopy.<sup>21</sup> Increase in intraabdominal pressure might contribute to the diffusion of infection as postulated by Cuschieri.<sup>25</sup> Moreover, the learning period might also influence the occurrence of intraabdominal abscess.

Many surgeons advocate appendectomy in a macroscopically normal appendix stating that inflammation on the mucosa may be missed<sup>26,27</sup>; others have shown that a normal-looking appendix may be left in place safely.<sup>28</sup> This series has demonstrated that appendicitis can be missed on naked eye examination as shown in Table 2. So, we recommend that normal-looking appendix should be removed after excluding other pathologies mimicking acute appendicitis.

It is encouraging to find that our conclusions are supported by other very recent studies in which laparoscopic appendectomy was performed on another subset of patients. These studies have concluded that laparoscopy should be used routinely for all young females presenting with right iliac fossa pain,<sup>29</sup> that laparoscopic appendectomy is not associated with an increase in morbidity in elderly patients,<sup>30</sup> and that laparoscopic appendectomy is safe for advanced appendicitis in children.<sup>31</sup> Furthermore, patients' preference (during counseling/consent) and satisfaction after the surgery (follow-up) in the laparoscopic group is evidence that the laparoscopic approach may be adopted safely in cases of suspected appendicitis.

## CONCLUSION

This series has demonstrated that laparoscopic appendectomy is a safe and clinically beneficial operative procedure. It provides certain advantages over open appendectomy, including short hospital stay, decreased need for postoperative analgesia, early food tolerance, and earlier return to normal activities. Where feasible, laparoscopy should be undertaken as the initial procedure of choice for most cases of suspected appendicitis.

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