

# Comparison of outcomes of open and laparoscopic appendectomy: A retrospective cohort study

Sunil Basukala<sup>1</sup> | Niranjan Thapa<sup>2</sup>  | Ujwal Bhusal<sup>2</sup> | Oshan Shrestha<sup>2</sup>  |  
Sagun Karki<sup>2</sup>  | Shiva K. Regmi<sup>2</sup> | Kunda B. Shah<sup>1</sup> | Aasish Shah<sup>3</sup>

<sup>1</sup>Department of Surgery, Nepalese Army Institute of Health Sciences, Kathmandu, Nepal

<sup>2</sup>College of Medicine, Nepalese Army Institute of Health Sciences, Kathmandu, Nepal

<sup>3</sup>Department of Anaesthesia, Nepalese Army Institute of Health Sciences, Kathmandu, Nepal

## Correspondence

Niranjan Thapa, College of Medicine, Nepalese Army Institute of Health Sciences, Kathmandu 44600, Nepal.

Email: [niranjan.thapa06@naihs.edu.np](mailto:niranjan.thapa06@naihs.edu.np)

## Abstract

**Background:** Open appendectomy has been the conventional choice of treatment for acute appendicitis. However, nowadays laparoscopic approach is emerging for the benefits it provides, like lesser postoperative pain and lesser duration of hospital stay, but at the cost of higher expenses and longer operative duration.

**Methods:** A retrospective cohort study was done at Shree Birendra Hospital from January 2018 to December 2021, with a total study population of 450 participants (300 in open appendectomy and 150 in laparoscopic appendectomy). Preoperative. Intraoperative and postoperative parameters were compared and analyzed between two groups using SPSS-25.

**Results:** The mean age was  $26.72 \pm 9.70$  in the open appendectomy (OA) and years  $23.89 \pm 6.32$  in the laparoscopic appendectomy (LA) group. ( $p = 0.010$ ) There was a significant difference between the mean operative time ( $46.08 \pm 13.10$  min in OA and  $56.86 \pm 11.70$  min in LA,  $p = 0.000$ ), length of hospital stay ( $1.28 \pm 0.80$  days in OA and  $1.07 \pm 0.25$  days in LA,  $p = 0.000$ ), course of oral analgesics ( $3.55 \pm 0.68$  days in OA and 3.00 days in LA  $p = 0.000$ ) between OA groups and LA groups, while the total number of complications was less in the LA group however there was no statistically significant difference postoperative complications ( $p = 0.124$ ) between the two groups in the surgical findings.

**Conclusion:** All in all, the laparoscopic approach is a better option for uncomplicated appendicitis due to its less postoperative pain and shorter duration of hospital stay.

## KEYWORDS

Alvarado score, appendectomy, appendicitis, laparoscopy

## 1 | BACKGROUND

Approximately 7% of the population develop appendicitis in their lifetime, with peak ages between 10 and 30 years of age.<sup>1</sup> MC Burney introduced appendectomy as the treatment of choice for appendicitis which involved the open approach.<sup>2</sup> Nowadays laparoscopic method of appendectomy has come as a new procedure for appendectomy. Minimal surgical trauma, less postoperative pain, and duration of hospital stay are seen in the laparoscopic approach.<sup>3</sup> But the higher cost of the treatment and longer duration of the operation remains the lagging step for laparoscopic surgery. Better outcomes have been shown by some studies favoring the laparoscopic approach,<sup>4</sup> while some studies show laparoscopic surgery has a minimal benefit or no benefit compared to open surgery.<sup>5</sup>

This retrospective cohort study aims to compare the laparoscopic method with the open method in terms of preoperative, operative, and postoperative characteristics.

## 2 | METHODS

### 2.1 | Ethical consideration

The Institutional Review Committee of Nepalese Army Institute of Health Sciences (IRC-NAIHS) approved the study with registration number 608. The manuscript is in line with STROBE guidelines.<sup>6</sup>

### 2.2 | Study design and setting

This is a retrospective cohort study conducted at 750 bedded tertiary care center Shree Birendra Hospital, Nepal. A retrospective analysis of the patients who had undergone open or laparoscopic appendectomy (OA or LA) within 4 years from January 2018 to December 2021 was done.

Open appendectomy is a surgical procedure (S/P) for removal of the appendix through a single incision in the lower right abdomen, while LA is a minimally invasive surgery where small ports are made in the abdomen with insufflation of abdominal cavity to an intraabdominal pressure (IAP) of 12–15 mmHg. All patients undergoing open approach had (Gridiron Incision) an oblique incision during surgery. However, wound protector devices were not utilized in the open method, despite their potential to reduce wound infection rates. This omission may be attributed to the significant financial constraints associated with acquiring such devices, particularly in developing countries where medical costs pose a considerable challenge. Patients who were planned for appendectomy (Open/LA group) received prophylactic single dose of IV antibiotics (Inj. Ceftriaxone 1 gm IV) within a 60 min before the initial incision. This also has been the antibiotic protocol of the study hospital. However, No postoperative antibiotics in both cases after the procedure. All specimens were sent for histopathology in both approaches. The inclusion criteria were: patients diagnosed with acute appendicitis

were diagnosed both clinically (Alvarado score, which is a clinical scoring system used to assess the likelihood of acute appendicitis. It considers various signs, symptoms, and laboratory findings to provide a numerical score, aiding in the diagnosis and decision-making process for further evaluation or surgical intervention.) as well as radiologically, and who underwent either OA or LA were included in the study. All patients with a history of a lump at the right iliac fossa, abdominal trauma, previous lower abdominal operation, pregnant women, and patients with severe medical disease (hemodynamic instability, cirrhosis, and coagulation disorders) requiring intensive care, and patients converted from laparoscopic to open surgery were excluded from the study. The limitations of this study include its single institution-based nature and the potential for increased impact if results were compared with those from other institutions.

### 2.3 | Study procedure

We analyzed a total of 450 patients who met the inclusion criteria. Among them, 300 had undergone open appendectomy (OA group), and 150 had undergone Laparoscopic appendectomy (LA group). Preoperative baseline characteristics, including age, sex, duration of symptoms, ALVARADO score, evidence of peritonitis, and leukocyte count, were collected from the individual case sheets of hospital records and analyzed. Intraoperative parameters, including operative time, S/P findings, and intraoperative complications, were extracted from Operation notes. Similarly, postoperative pain levels using visual analogue score (VAS) for pain assessment, and usage of parenteral or oral analgesics, and postoperative bowel movements were recorded from individual patient case sheets. However, being the institution in question a military hospital that offers medical treatment to its patients without any associated charges, we have intentionally not included the cost charges in our study.

### 2.4 | Sample size

All the patients who have undergone either laparoscopic or open appendectomy from January 2018 to December 2021 were included in the study after reviewing the records.

### 2.5 | Study tool

In this study, research proforma and questionnaire was used during follow-up. The study tool used in this study is available as Supporting Information File [S1](#).

### 2.6 | Analytical strategy

After retrospective data collection, the data was cleaned, classified, and coded. The coded data were entered and tabulated using

Statistical Package for Social Science (SPSS) version 25. Categorical variables were presented as frequency and percentage and compared by Chi-square tests and Likelihood Ratio. Parametric and non-parametric variables were presented as mean  $\pm$  standard deviation and compared by student's *t*-test and Mann-Whitney *U* tests, respectively. A *p*-value of  $<0.05$  was considered to be statistically significant.

### 3 | RESULTS

There was a total of 450 appendectomies done during the period of our data collection, among which 300 were open appendectomies (group OA), whereas the remaining 150 were laparoscopic appendectomies (Group LA). Details of other demographic and pre-operative characteristics of the patients are listed in Table 1.

The mean age of OA was  $26.72 \pm 9.70$  years, and that of LA was  $23.89 \pm 6.32$  years ( $p = 0.000$ ) There were 182 males and 118 females in the OA group, and 41 males and 109 females in the LA group. This difference in the proportion of males and females was statistically significant (Pearson  $\chi^2 = 44.44$ ;  $p = 0.010$ ).

**TABLE 1** Demographic and preoperative characteristics of the patients.

	Open appendectomy (n = 300)	Laparoscopic appendectomies (n = 150)	<i>p</i>
Gender			
Male	182	109	0.000
Female	118	41	
Mean Age	$26.72 \pm 9.70$	$23.89 \pm 6.32$	0.010
Duration of symptoms (median)	1	1	
Leukocyte count			0.846
<11,000	63	35	
11,000–16,000	205	100	
>16,000	32	15	
Peritonitis	0	0	
Alvarado Score			0.000
5	19	22	
6	43	0	
7	180	90	
8	31	19	
9	19	12	
10	8	7	

Note: Data are number (*n*), median, or mean  $\pm$  standard deviation values, as indicated.

The median duration of symptoms was one day in both groups. Peritonitis was not present in any of the 450 cases. Alvarado's score was significantly different in the two groups. (Pearson  $\chi^2 = 31.22$ ;  $p = 0.000$ ) Leukocyte count was not significantly different in the two groups (Pearson  $\chi^2 = 0.334$ ;  $p = 0.846$ ). The operative characteristics of the patients are shown in Table 2.

The mean operative time in the OA group was  $46.08 \pm 13.10$  min whereas in the LA group was  $58.86 \pm 11.70$  min. The difference in operative time was statistically significant; ( $p = 0.000$ ) S/P findings are shown in Table 3.

Noteworthy, we did not observe differences between the two groups in S/P findings. Our Study showed the number of acutely inflamed tip was higher compared with other S/P findings. Postoperative characteristics are shown in Table 4.

**TABLE 2** Operative characteristics.

	Open appendectomy (n = 300)	Laparoscopic appendectomies (n = 150)	<i>p</i> -Value
Operative time (mins)	$46.08 \pm 13.10$	$58.86 \pm 11.70$	0.000

Note: Data are mean  $\pm$  standard deviation values.

**TABLE 3** Surgical procedure findings.

	Open appendectomy (n = 300)	Laparoscopic appendectomies (n = 150)	<i>p</i> -Value
S/P findings			0.074
Normal appendix	52	26	
Acutely inflamed tip	223	117	
Gangrenous appendix	16	7	
Perforated appendix	9	0	

Note: Data are number (*n*).

Abbreviation: S/P, surgical procedure.

**TABLE 4** Postoperative characteristics.

	Open appendectomy (n = 300)	Laparoscopic appendectomies (n = 150)	<i>p</i> -Value
Length of hospital stay (days)	$1.28 \pm 0.80$	$1.07 \pm 0.25$	0.000
Time to first bowel movement (days)	$1.12 \pm 0.32$	$1.07 \pm 0.25$	0.096
Oral analgesics (days)	$3.55 \pm 0.68$	3.00	0.000
Parenteral analgesics (days)	$1.20 \pm 0.53$	$1.07 \pm 0.25$	0.009

Note: Data are mean  $\pm$  standard deviation values.

**TABLE 5** Intraoperative complications.

	Open appendectomy (n = 300)	Laparoscopic appendectomies (n = 150)	p-Value
Intraoperative complication			0.470
None	296	147	
Ileal injury	2	3	
Limited colectomy	2	0	

**TABLE 6** Late complications.

	Open appendectomy (n = 300)	Laparoscopic appendectomies (n = 150)	p-Value
Surgical findings			0.124
None	282	144	
Intrabdominal abscess	4	2	
ECF	1	0	
SSI	13	2	
STUMP appendix	0	2	

Note: Data are number (n).

Abbreviations: ECF, enterocutaneous fistula; SSI, surgical site infection.

The length of hospital stay of the OA group ( $1.28 \pm 0.80$  days) was significantly higher than the LA group ( $1.07 \pm 0.25$  days) ( $p = 0.000$ ). The average number of days for the first bowel movement was  $1.12 \pm 0.32$  days in the OA group whereas, in the LA group, it was  $1.07 \pm 0.25$  days. This was not statistically different ( $p = 0.096$ ).

The LA group needed a shorter course of oral (3.55 ± 0.68 days vs. 3.00) (as well as parenteral analgesics ( $1.07 \pm 0.25$  days vs.  $1.20 \pm 0.53$  days) ( $p = 0.000$ ).

The group LA patients reported lower levels of postoperative pain compared to the OA group. ( $p = 0.000$ ). There was no significant difference in the incidence of intraoperative complications in the two groups. Results are shown in Table 5.

The occurrence of late complications was also similar in the two groups. Results are shown in Table 6.

## 4 | DISCUSSION

The mean age of the OA group and that of the LA group was found to be similar to some studies.<sup>7</sup> Some similar studies reported the mean age in both groups as around the 30s which is not consistent with our study.<sup>8-11</sup>

There were 60.67% males in OA, whereas only 27.33% males in LA. This statistically significant difference in the sex was also reported by a similar retrospective study by Biondi et al.<sup>8</sup> A nationwide population-based study from Taiwan also showed that a

higher proportion of females had undergone laparoscopic surgery.<sup>11</sup> The mean duration of symptoms was 1.58 days in OA and 1.33 days in the LA group. Leukocyte count was not significantly different in the two groups.

The total operative time, similar to the literature, was significantly longer for LA than OA.<sup>7,12,13</sup> The longer duration of LA is not surprising due to the increased instrumentation, additional steps for setup, and a learning curve for the surgeons. In our study, the length of hospital stay was significantly shorter among the laparoscopic group, which is per several studies.<sup>7,12-14</sup> Although the average number of days for the first bowel movement was earlier in the LA group, it was not statistically different. However, several studies have reported earlier bowel movement and reduced time to oral intake postoperatively in favor of the laparoscopic approach.<sup>7,15</sup>

In our study, patients with laparoscopic appendectomy reported lower levels of pain compared with the open appendectomy group. The decreased abdominal wall damage is a key contributor to postoperative pain.<sup>16</sup> of ours is in line with various studies which reported lower postoperative pain with a laparoscopic approach.<sup>4,7</sup> Furthermore, as in our study, parenteral analgesic needs significantly more in the open group are also reported in the literature.<sup>7,17</sup>

Intraoperative complications observed were ileal injury and limited colectomy. There were no cases of appendicular abscess, pelvic abscess, or appendicular tumor. However, there was no significant difference in the incidence of intraoperative complications in the two groups. Similar findings are reported in the literature.<sup>14</sup> A study found purulent peritonitis to be common among OA groups.<sup>18</sup>

Better abdominal muscle mobility and early ambulation with a laparoscopic approach decrease the need for analgesics and the risk of early postoperative complications.<sup>16</sup> Late complications such as intra-abdominal abscess, enterocutaneous fistula surgical site infection, and stump appendix were observed. Other complications, such as portal pyemia, sepsis, venous thromboembolism, and respiratory problems, were not seen in our study. Overall, the incidence of late complications was more in open appendectomy, as reported by multiple studies.<sup>4,17-19</sup> The most common complication of LA in contrast to OA, was an intra-abdominal abscess in various prior studies, which was not the case in our study.<sup>17,19</sup> However, lower overall morbidity, mortality, and shorter hospital stays have been shown for LA than OA in large nationwide data from the United States.<sup>20</sup> Other large studies from Sweden and Denmark with ten 10-year study duration also noted a significant decrease in general complications, including the intra-abdominal abscess.<sup>21,22</sup>

## 5 | CONCLUSION

The operative time with the laparoscopic technique was statistically longer than the open approach. However, higher levels of postoperative pain, longer duration need for parenteral anesthetics and prolonged length of hospital stay all were significantly associated with open-approach appendectomy. Hence, a laparoscopic approach

can be the better option for the treatment of uncomplicated appendicitis.

## AUTHOR CONTRIBUTIONS

**Sunil Basukala:** Conceptualization; formal analysis; investigation. **Niranjan Thapa:** Conceptualization; methodology; resources; supervision; validation. **Ujwal Bhusal:** Data curation; formal analysis; methodology. **Oshan Shrestha:** Conceptualization; investigation; project administration. **Sagun Karki:** Data curation; formal analysis, supervision. **Shiva Kumar Regmi:** Conceptualization; data curation; formal analysis; investigation; methodology; resources; supervision. **Kunda Bikram Shah:** Methodology; supervision. **Aasish Shah:** Data curation; supervision.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

Curated data that was analyzed is available from the corresponding author upon reasonable request.

## ETHICS STATEMENT

Approval from the institutional review committee board was obtained before the study, all patients' details were kept confidential, and no information revealing the patient's identity was disclosed in the article.

## TRANSPARENCY STATEMENT

The lead author Niranjan Thapa affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

## ORCID

Niranjan Thapa  <http://orcid.org/0000-0001-9043-3368>

Oshan Shrestha  <http://orcid.org/0000-0002-8655-9168>

Sagun Karki  <http://orcid.org/0000-0002-4858-2885>

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#### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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