

Feasibility of safe laparoscopic surgery performed by junior residents without exposure of open appendectomy: A retrospective study

Satya Prakash Meena¹, Mayank Badkur¹, Mahaveer S. Rodha²,
Mahendra Lodha¹, Ashok Puranik¹, Krashan Kant Premi¹

Departments of ¹General Surgery and ²Trauma and Emergency (General Surgery), All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

ABSTRACT

Context: Appendectomy is the most commonly performed surgery in the emergency department. It is very difficult to determine the minimal duration of the learning curve for junior residents to perform safe laparoscopic surgeries. **Aim:** This study aimed to determine the feasibility of a safe laparoscopic appendectomy performed by junior residents. **Settings and Design:** A retrospective study was conducted at a tertiary healthcare center from May 2018 to May 2020. **Methods and Material:** This study reviewed all the data of laparoscopic appendectomy performed by junior and senior residents. Both groups were compared for the patient outcome in terms of complications, conversion to open, intraoperative findings, operative time, postoperative progress, and hospital stay. **Statistical Analysis:** The data were formulated in an excel sheet and analyzed with SPSS. Mean, median, range, standard deviation, percentages, univariate analysis with χ test and *t*-test were used. **Results:** No significant difference was found in operative time (mean [SD], 84.87 [24.73] vs. 86.95 [24.93], $P = 0.679$), intraoperative complication (9.2% vs. 7.8%, $P = 0.769$), postoperative complications (34.2% vs. 34.4%, $P = 0.984$), conversion to open (6.6% vs. 4.7%, $P = 0.633$), length of postoperative hospital stay (Mean [SD], 2.3 [2] vs. 2.2 [1], $P = 0.739$), and readmission (4% vs. 3%, $P = 0.794$). No major intraoperative complications and mortality were found in both groups. **Conclusions:** Junior residents may be allowed for safe laparoscopic appendectomy under supervision without experience of open appendectomy. The patient's outcomes may be comparable with surgery performed by well-experienced surgeons. They can improve the basic healthcare system in the future with feasible basic laparoscopic surgery for common diseases.

Keywords: Complication, hospital stay, laparoscopic appendectomy, length of surgery, outcome, residents

Introduction

Appendicitis is a commonly diagnosed disease in all age groups of patients at every healthcare center. Laparoscopic appendectomy (LA) is the most commonly performed procedure by all healthcare providers due to better postoperative

outcomes. Now, this technique has become the gold standard for simple appendicitis.^[1-5] The resident doctors can understand the basics of laparoscopic surgery and can improve surgical skills through LA; therefore, can improve healthcare facilities at the primary or comprehensive healthcare center. The learning curve of residents for LA depends on the infrastructure of hospitality and surgical training.^[6-8] There are many controversies in literature for minimal case or duration of experience in laparoscopy and prior experience of open appendectomy for safe LA; therefore, this study has been done.^[9,10] This study

Address for correspondence: Dr. Satya Prakash Meena, Department of General Surgery, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India. E-mail: drsatyaprakash04@gmail.com

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aimed to determine the feasibility of safe LA performed by junior residents.

Material and Methods

Study design and duration

A retrospective study conducted in a tertiary care center of north India and reviewed all data of appendicitis patients in the General Surgery Department after obtaining clearance of institutional ethical committee (AIIMS/IEC/2020-21/2087). We included 140 patients, who underwent the laparoscopic appendectomy performed by the junior and senior residents from May 2018 to May 2020.

Study population

All patients operated by junior and senior residents were posted in the Department of General Surgery. The study included 76 laparoscopic appendectomies that were performed by junior residents under supervision and it was assigned as group A. On the other hand, 64 laparoscopic appendectomies, were performed by senior residents and it was assigned as group B. Senior residents had experience of open appendectomy and laparoscopic appendectomy for 3 to 5 years during residency. Junior residents had an experience of laparoscopic appendectomy for 1 to 2 years and no exposure for open appendectomy. All patients were operated based on clinical findings with an Alvarado score of more than 5 (clinical diagnosis) with or without a radiological diagnosis of appendicitis. These patients were operated upon after radiological confirmation of appendicitis if the Alvarado score was less than 5. Relevant data were collected from medical record room of this hospital. Information reviewed included patient age and sex, initial symptoms, duration of symptoms, abdominal physical examination findings, white blood cell (WBC) count, Alvarado score, the operative findings, and postoperative course. All data were compared for both groups of this study.

Objectives and outcome measures

The objective of this study was to compare patients' outcomes, who underwent LA performed by junior and senior residents. The primary outcome measure was to compare intraoperative or postoperative complications and secondary outcome measure included a comparison of operative duration, conversion rate, postoperative hospital stay, reoperation, readmissions, and mortality.

Surgical technique and perioperative management

Preoperatively, intravenous ceftriaxone and metronidazole antibiotics were administered to all patients. All patients had asked to pass urine before shifting over to the operation theater table. Written informed consent was taken for surgery and participants were explained all possible complications in patient language. The position was made as head low and right upside after general anesthesia. Three-port technique was used and a 10-mm supraumbilical port was made for the camera

after pneumoperitoneum. One 5-mm working port is made in midline two fingers above pubic symphysis followed by a second 5 mm port in the left lumbar region in-between umbilicus and pubic symphysis under the vision of the camera. The operative findings of the appendix like normal [Figure 1a], simple appendicitis [Figure 1b], and complicated appendicitis [Figure 1c] were noted. The ultrasonic coagulation was used for the dissection of appendicular mesentery and artery. The appendicular base was ligated with 2-0 vicryl sutures without needle by intracorporeal technique. [Figure 1d] The operative time noted in minutes from incision to closure of skin.

Postoperatively, a single dose of intravenous antibiotics was administered for simple appendicitis, and 5 days antibiotics were given for complicated appendicitis according to operative findings. All patients were allowed liquid orally after 6 h and semisolid diets after 12 h of surgery. These patients were encouraged for early mobilization, return to normal activity, and discharged within 48 h. However, few patients had postoperative stay more than 48 h and the reason was noted like intraoperative and postoperative complication, conversion, postoperative pain score scale more than five, vomiting more than one episode, urine retention, and abdominal distension. All patients followed up in the second week after discharge and documented for pain score of more than three, delay complications, wound infection, histopathology reports, readmission, and reoperation.

Statistical analysis

The data were formulated in an excel sheet and analyzed using the IBM Statistical Package for the Social Sciences (SPSS) for window, version 20 (IBM Corp, Armonk, New York, US). Mean, median, range, and standard deviation were used to describe the continuous variables, and percentages were used to describe the categorical data. To identify differences between both study groups (SR and JR), univariate analysis with χ test and *t*-test

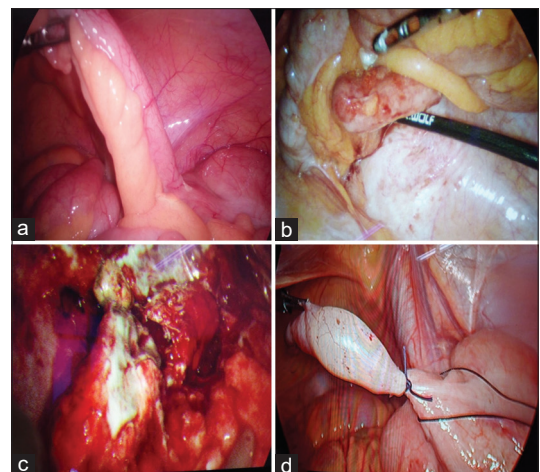


Figure 1: Image showing normal looking appendix (1a), inflammation of tip of appendix and showing as a simple appendicitis (1b), rupture appendix with faecolith outside lumen of appendix and showing as a complicated appendicitis (1c), and intracorporeal suturing at base of appendix (1d)

was used. The *P* value less than 0.05 was considered statistically significant for all comparisons.

Results

Demographics

In this study period of 2 years, 140 patients underwent laparoscopic appendectomies by junior residents and senior residents. A total of 76 patients were operated by junior residents or group A and in group B, 64 patients were operated by senior residents. The mean age (SD) of patients was 31.9 (11.7) years in group A and 29.1 (10.4) years in group B. In this study, 82.9% and 76.6% were males in group A and group B, respectively. Most of the patients were in the age group of 18–30 years. The median (IQR) of the duration of symptoms was 3 (2–4) in group A and 4 (3–5) in group B. The median (IQR) of appendix diameter was 9 (8–11) in group A and 9 (7.25–10) in group B. In group A, 47.3% of patients had acute appendicitis with or without suppuration and 14.5% had perforated or gangrenous appendix in histology. In group B, 53% of patients had acute appendicitis with or without suppuration and 6.3% had perforated or gangrenous appendix in histology. Intraoperatively, 63% and 67% of patients had simple appendicitis in group A and group B, respectively. Also, 32% and 25% of patients had complicated appendicitis in group A and group B in terms of abscess, dense adhesions, perforation, and appendicular lumps. [Table 1]

Operative time

The mean (SD) operative time to perform the laparoscopic appendectomy was 84.87 (24.73) in group A and 86.95 (24.93) in group B. The operative time was not significantly different between groups A and B (*P* = 0.679). In group A, 19.7%, 40.8%, 28.9%, and 10.6% of patients had operative time equal to or less than 60 min, 61 to 90 min, 91 to 120 min, and more than 120 min, respectively. In group B, 20.3%, 45.3%, 26.6%, and 7.8%

of patients had operative duration equal or less than 60 min, 61 to 90 min, 91 to 120 min, and more than 120 min, respectively. The maximum number of patients had surgery within 60–90 min in both groups. [Table 2]

Complications

Both groups had intraoperative bleedings from the appendicular artery, which was 9.2% in group A and 7.8% in group B (*P* = 0.769). There was no other intraoperative complication and mortality found in any patients. In this study, 34.2% and 34.4% of patients had postoperative complications in group A and group B, respectively. The patients who had postoperative morbidity like pain score more than 3, vomiting more than one episode, and nausea were 14 patients in group A and 10 in group B. The cause of the abdomen distension was documented for four patients in group A and five in group B due to ileus for more than 3 days. Residual abdominal abscess collection was found in two patients of group A and one patient of group B. Surgical site infection and fascial dehiscence were found equal in both groups. One patient in group A had postoperative intestinal obstruction due to port site hernia with bowel strangulation [Tables 3 and 4].

Conversion to open surgery

Five patients (6.6%) in group A and three patients (4.7%) in group B were converted to open surgery, out of them one patient with a gridiron incision and seven with a lower midline incision. No significant difference found between both groups (*P* = 0.633). The cause of conversion was the intraoperative finding of a mature lump, retrocecal appendix, gangrenous changes over the cecum or near the base of the gangrenous appendix, and loculated abscess [Table 4].

Length of hospital stay

The mean (SD) length of hospital stay for the patients who underwent laparoscopic appendectomies was 2.3 (2) in group A

Table 1: Baseline characteristics and demographics among operated patients

Parameters	Junior resident (n=76)	Senior resident (n=64)
Age: Mean (SD)	31.9 (11.7)	29.1 (10.4)
Gender: n (%)		
Female	13 (17.1)	15 (23.4)
Male	63 (82.9)	49 (76.6)
WBC count (per cubic mm): Median (Range)	10,195 (3,000-35,560)	10,350 (3,180-39,040)
Symptom duration in days: Median (IQR)	3 (2-4)	4 (3-5)
Appendix diameter: Median (IQR)	9 (8-11)	9 (7.25-10)
Histopathology findings: n (%)		
Acute appendicitis	29 (38.1)	30 (46.8)
Acute suppurative appendicitis	7 (9.2)	4 (6.3)
Resolving appendicitis	26 (34.2)	26 (40.6)
Perforated appendix	7 (9.2)	1 (1.6)
Gangrenous appendix	4 (5.3)	3 (4.7)
Appendicular malignancy	3 (4.0)	0 (0)
Intraoperative findings: n (%)		
Simple appendicitis	48 (63.2)	43 (67.2)
Complicated appendicitis	25 (32.8)	16 (25)
Normal appendix	3 (4.0)	5 (7.8)

and 2.2 (1) in group B. Few patients had a hospital stay longer due to postoperative complications. Length of hospital stay was not significantly different between groups A and B ($P = 0.739$).

Readmission

In group A, three patients were readmitted, out of them two patients had features of intestinal obstruction and one had surgical site infection in the laparotomy suture line. One patient was reoperated for port site hernia with bowel strangulation. In group B, one patient readmitted with the feature of intestinal obstruction and conservatively managed. No significant difference was found in the readmission rate in both groups ($P = 0.794$).

Discussion

Laparoscopic appendectomy is a procedure of choice in appendicitis and becomes a good platform for basic laparoscopic training among residents. This is the most common surgery that has been done in an emergency in large volume and exposed to all doctors at all healthcare centers frequently.^[11,12] This surgery can improve skills in the laparoscopic mobilization of the bowel, intracorporeal knotting during ligation of the base of the appendix, dissection during handling mesoappendix or retrocecal appendix, and peritoneal lavage in case of an appendicular abscess.^[13-16]

This minimal access surgery is associated with cosmesis, less hospital stay, early mobilization, early acceptability of diet, less

postoperative pain, and complications. It also has a diagnostic modality to rule out other possibilities like Meckel diverticulum and ovarian cyst torsion in females. We have the ability to lavage the peritoneal cavity in case of an appendicular abscess and appendicular perforation. However, it is very difficult in the open appendectomy through gridiron incision.^[17,18]

This study included all novice junior residents in group A, who had 1–2 years prior experience of observation, assistance before allowing under supervision laparoscopic appendectomy. It has been observed that there is no need for open appendectomy experience before laparoscopic appendectomy. All residents did very well open appendectomy in a few indicated patients like established peritonitis in appendicular perforation.^[19] Few studies reported that all residents should have experience of 25 to 50 open appendectomies before performing a laparoscopic appendectomy.^[20-22]

Siam *et al.*'s^[23] study showed the mean operative time to perform the laparoscopic appendectomy was significantly shorter in the senior surgeon group (mean [SD], 39.9 [20.9] vs. 48.6 [20.2] min; $P < 0.001$). The novice resident had more operative time in complicated appendicitis due to difficulty in the identification of retrocecal appendix, base ligation of the perforated or gangrenous appendix, and dissection of the appendicular lump. Bencini *et al.*^[24] showed that the median operating time was comparable in residents and experienced surgeon group (67 min vs. 60 min, $P = 0.23$). In this study, the mean (SD) operative time to perform the laparoscopic appendectomy was 84.87 (24.73) vs. 86.95 (24.93) and not significantly different between JRs and SRs ($P = 0.679$).

Bencini *et al.*'s^[24] study showed that the residents had fewer conversions with laparoscopic appendectomy (8% vs. 17%, $P = 0.04$), and similar complication rates (12% vs. 13%, $P = 0.16$), compared with experienced surgeons. The study by Lee *et al.*^[25] concluded similar complications, conversion rates but prolonged hospital stay and operation time. Shabtai *et al.*^[26] showed no significant difference in hospital stay and conversion rate in senior and junior resident groups; however, shorter operative time was found for senior residents. In this study, both groups had no significant difference in conversion rate ($P = 0.633$) and hospital stay ($P = 0.739$).

The risk of complications ($P = 0.209$) and mortality ($P = 1.000$) were similar in surgeon and supervised residents in Graat *et al.*'s study.^[27] A study by Sweeney *et al.*^[28] showed no significant difference in conversion rate, complications in experienced,

Table 2: Operative time in junior and senior resident groups

Operative time	Group A, n (%)	Group B, n (%)
Within 60 min	15 (19.7)	13 (20.3)
60-90 min	31 (40.8)	29 (45.3)
90-120 min	22 (28.9)	17 (26.6)
More than 120 min	8 (10.6)	5 (7.8)

Table 3: Postoperative complications of appendectomy, performed by junior and senior residents groups

Postoperative complications	Group A, n (%)	Group B, n (%)
PONV and pain	14 (18)	10 (15)
Ileus	4 (5)	5 (7)
Superficial surgical site infection	5 (6)	5 (7)
Fascial dehiscence	1 (1)	1 (1.5)
Residual abdominal collection	2 (2.5)	1 (1.5)
Mortality	0	0

Table 4: Outcomes of appendectomy patients based on whether operated by junior and senior resident groups

Outcome	Junior resident n/total (%)	Senior resident n/total (%)	Odds ratio	P
Intraoperative complications	7/(9.2)	5 (7.8)	1.20 (0.36-3.97)	0.769
Postoperative complications	26/(34.2)	22 (34.4)	0.993 (0.49-2.00)	0.984
Conversion	5/(6.6)	3 (4.7)	1.43 (0.33-6.24)	0.633
Readmission	3/(3.9)	2 (3.1)	1.27 (0.21-7.87)	0.794

and inexperienced surgeon group, however, operative time was shorter in the inexperienced group. A study by Emmanuel *et al.*^[29] showed not a significant difference in conversion, complication, hospital stay, and duration of surgery in consultant surgeon and trainee groups. These studies are comparable with our study for conversion rate and complications, which was nonsignificant in both groups. In this study, both groups have intraoperative complications in terms of bleeding from the appendicular artery but no bowel, bladder, or major vascular injury was found. Also, postoperative complications were found in terms of surgical site infection, pain, vomiting, ileus, however, the overall complication rate was nonsignificant in both groups. In the study, no mortality was found and did not observe any significant differences in readmission rates between the two groups.

As we know that the junior residents are the future healthcare providers of primary or comprehensive healthcare systems hence, they can improve healthcare facilities with adequate and feasible experience of basic laparoscopy. Many senior doctors or faculty have a lack of confidence to give laparoscopic appendectomy under supervision or independently to prevent associated complications. Also, they have faith that adequate numbers of open appendectomies are required for better patient outcomes after laparoscopic appendectomy. The study concluded that the postoperative outcome was the same for all appendectomy patients operated by junior residents without experience of open appendectomy and well-experienced senior residents or senior doctors. Hence, we should encourage basic laparoscopic training via laparoscopic appendectomy for junior residents to improve the basic healthcare system. Although the experience of open appendectomy is a must to prevent complications during conversion.^[30]

We analyzed the limitations that our study is a retrospective observational study. Therefore, we require more prospective studies for different levels of exposure of residents in the same environment to determine minimum experience to perform safe laparoscopic surgery. Although this is very difficult to say the cut-off level of experience in patient safety concerns due to the various factors like the subjective finding of ultrasonography, intraoperative findings, the general condition of patients, and associated medical comorbidities.

Conclusion

Junior residents may be allowed for safe laparoscopic appendectomy after adequate training without experience of open appendectomy. Laparoscopic appendectomy may help to improve basic laparoscopic surgical skills under safety parameters of patients. The patient's outcomes may be comparable with surgery performed by senior residents or well-experienced surgeons. They can improve the basic healthcare system in the future with feasible basic laparoscopic surgery for common diseases.

Key message

Junior residents may safely perform laparoscopic appendectomy under supervision without experience of open appendectomy.

The basic healthcare system can improve with adequate and feasible basic laparoscopic training of junior residents under the safety parameter of patients.

Institutional ethical committee clearance

AIIMS/IEC/2020-21/2087.

Patients consent

Informed consent was obtained from all individual participants included in the study.

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Conflicts of interest

There are no conflicts of interest.

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