



# Outcome of Laparoscopic Appendicectomy and Assessment of the Learning Curve

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## ABSTRACT

**Introduction:** Laparoscopic appendicectomy is being performed for the management of acute appendicitis. However there are conflicting reports about outcome and minimum number of these procedures required to achieve proficiency. **Aims and Objective:** The aim of this study is to assess the outcome of laparoscopic appendectomies and to evaluate the effect of learning curve on patient outcome. **Material and Methods:** All patients undergoing laparoscopic appendectomies performed by two consultants during the study period from March 2010 to June 2017 were reviewed. Both consultants were already doing laparoscopic cholecystectomies and open appendicectomy. Data on patient demographics, operative time, operative findings, complication and hospital stay was analyzed. We evaluated the effect of the learning curve by dividing patients into two groups: first group consisting of the initial 40 patients (group-A) and a second group consisting of the last 40 patients (group-B). Moreover, initial 40 patients of group A were subdivided into four subgroups and moving average method was used to determine the learning curve. **Place and Duration of Study:** This Study was conducted at department of surgery, Hameed Latif Hospital, from March 2010 to June 2017. **Results:** Out of 155 participants 80(51.6%) were females and 75(48.4%) were male. The mean age was  $25.77 \pm 13.20$ . The mean operative time was  $(41.94 \pm 14.46)$  minutes. The mean duration of postoperative stay was  $(1.68 \pm 1.01)$  days ranging from 1 to 7 days. The difference in post-operative ileus and hospital stay in group A and group B is statistically significant (p-value,  $<0.001$ ). Three patients (1.9%) had acute urinary retention. There were three conversion 3(1.9%) and 2(1.3%) patients had port site infection. By moving average method learning curve stabilized after 30 cases. **Conclusion:** Laparoscopic appendicectomy is safe procedure for the management of acute and complicated appendicitis. Learning curve of consultant stabilizes after 30 cases.

**Key words:** Laparoscopic appendicectomy, learning curve, perforated appendix

## INTRODUCTION

Since its first description by Reginald Fitz in 1886, acute appendicitis remains the most common intraabdominal condition requiring emergency surgery.<sup>1</sup> McBurny in 1884 described open appendicectomy.<sup>2</sup> Owing to its safety and efficacy, open approach remained gold standard for more than 100 years. First Laparoscopic appendicectomy was performed by Semm in 1983.<sup>3</sup> Although the popularity and acceptability of laparoscopic approach is toward rise but it has not been adopted

by the majority as a preferred approach for the management of acute appendicitis. Several early randomized controlled trials did not show any advantage for laparoscopy and others showed equivocal results. Prolonged operative time and increased risk of intra abdominal collection outweighed the advantage of less wound infection and better cosmesis.<sup>4</sup>

Current literature shows a paradigm shift in favor of laparoscopic appendicectomy, probably because of better exposure of minimal access surgery at all level of training and use of modern energy devices. Laparoscopic approach is now

being reported to have many advantages like short hospital stay, early return to work, less postoperative pain, less intraabdominal infections and better cosmetic effects.<sup>5,6</sup>

So far, evidence is not clear for the minimum number of procedures required to become proficient and safe in laparoscopic appendectomy.<sup>7</sup> The aim of this study is to assess the outcome of laparoscopic appendectomies and to evaluate the learning curve and its impact on patient outcome.

## **MATERIAL AND METHODS**

Patients who underwent laparoscopic appendectomy at department of surgery, Hameed Latif Hospital, from March 2010 to June 2017 were identified and included in the study. All the procedures included, were performed by two consultants who were proficient in laparoscopic cholecystectomy. All the data was retrieved from electronic medical record files. Outcome variables of interest include demographics, operative time, operative findings, duration of ileus, hospital stay, complications, and conversions to open surgery. To study the learning curve, first consecutive 40 cases of laparoscopic appendectomies were grouped as group A and further subdivided into four subgroups of 10 each and the last 40 cases were grouped as group-B and demographics, operative time, postoperative outcome parameters Ileus, pain, hospital stay and complications were compared.

Standard three ports technique was used, pneumoperitoneum was created by veress needle and intra abdominal pressure was kept at 12 mm Hg and first 10 mm port was placed at supraumbilical position, second 5mm port was placed as standard anterior to left anterior iliac supine. The placement of third port was lateral to the camera port in left midclavicular line for pelvic position of appendix and for retrocecal appendicitis third 5mm port was placed in supra pubic position just lateral to midline. Suprapubic positions and a 5-mm port in the left iliac fossa. The appendix was skeletonized by the use of harmonic scalpel, and appendix base was ligated in double with vicryl (polyglactin)-0 loop applied by a knot pusher. The appendix was removed either through a 10-mm supra umbilical port using endobag and 5mm telescope was used through lateral port during retrieval of appendix. Peritoneal toilet with saline was performed for perforated

appendix and presence of pus. Pelvic drain was placed in cases of perforated appendix. Supraumbilical 10-mm port facial closure was achieved with vicryl Johnson & Johnson Ethicon 1/0 suture. Local anesthesia was infiltrated at all port site with 0.25% bupivacaine. Skin closure was performed using monocryl 4/0 (Johnson & Johnson Ethicon) inverted single stitch for 5mm and two inverted interrupted stitches for 10 mm port incision.

## **Statistical Analysis:**

A consecutive series of four groups of 10 patients were compared by using moving average method to see the changing trend in operation time. Moving average method was used to estimate the learning curve of laparoscopic procedure. An independent sample t-test were conducted on prior group A of 40 patients and last group B of 40 patients according to outcome variables age, operative time, length of stay and duration of postoperative ileus. Moreover, chi-square test was used to determine the association between gender, Intra operative findings (IOF) and complications. Further analysis of predicting learning curve analysis of variance technique used to check the difference between groups 1,2,3,4. Data was analyzed with statistical package for social sciences (SPSS version 21.0).

## **RESULTS**

During the 7 year study period, 155 patients underwent laparoscopic appendectomy by a single surgeon. Of the 155 patients in the study, the mean age was  $(25.77 \pm 13.20)$  years range from 7 to 73 years old. The mean operative time was  $(41.94 \pm 14.46)$  minutes range from minimum 22 minutes to maximum 90 minutes. The mean duration of postoperative ileus was  $(14.96 \pm 11.02)$  hours which ranges from 6 hours to 60 hours. The mean duration of postoperative stay was  $(1.68 \pm 1.01)$  days ranging from minimum 1 day and maximum 7 days' hospital stay (Table-1). There was no readmission within 30 days. Table-2 shows that out of the 155 participants 80(51.6%) were females and 75(48.4%) were male. Intra operative findings (IOF) acutely inflamed appendix (AA) was found in 122(78.7%) patients, 19(12.3%) patients were of acute Suppurative appendix (ASA), 10(6.5%) patients were of perforated appendix (PA) and in 4(2.6%) patients appendix was found normal and later confirmed on histopathology.

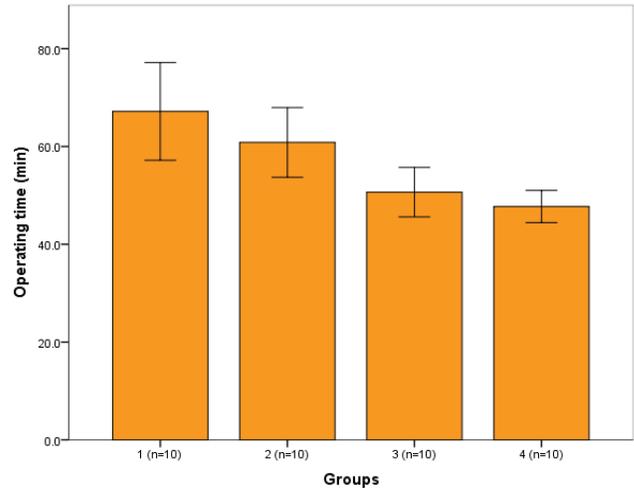
	Numbers	Minimum	Maximum	Mean	Std. Deviation
Age in Years	155	7	73	25.77	13.308
Operative time (minutes)	155	22	90	41.94	14.464
ILEUS (hours)	155	6	60	14.96	11.02
Duration of Stay (days)	155	1	7	1.68	1.019

**Table-1:** Distribution of sampled population (n=155)

There was no mortality in our series, out of total of 155 patients 144(92.9%) had no complications, 3(1.9%) had long postoperative ileus. Three patients (1.9%) had acute urinary retention, and 2(1.3%) patients had port site infection, 3(1.9%) patients required conversion to open surgery by gridiron incision (Table-2). The reasons for conversion were dense adhesions preventing safe dissection (n = 2), perforation at base with retrocecal position (n = 1). Table-3 shows comparison of outcome variables age, operative time (min), length of stay (days) and postoperative ileus (hours) in group A and group B. Total number of patients in group A and group B was 40 each. On comparison, the mean ages of the group A patients were (28.10 ± 13.88) years and (26.61 ± 14.80) years, however this difference is not statistically significant. Mean operation time in group A was (58.08 ± 13.92) minutes and group B was (33.50 ± 6.11) minutes respectively, there was statistically significant difference between group A and group B (P-value <0.001). Mean length stay of group A was (2.13 ± 1.06) days and group B was (1.3 ± 0.68) days. The difference is statistically significant with p-value < 0.001. Mean duration of postoperative ileus in group A was (20.07 ± 10.36) hours and group B was (10.37 ± 8.51). The difference in post-operative ileus hours in group A and group B is statistically significant (p-value, <0.001). Table-4 shows there was no association between gender, complication and IOF (p-value, >0.05).

Moving average method for operating time has been used in constructing learning curves for adopting new laparoscopic procedure skills. Laparoscopic appendectomy patients of group A were divided into consecutive series of 4 groups 10 patients each as groups 1,2,3,4 and the moving average was obtained (Fig-1). The figure-1 shows

the mean difference in operative time between groups. The mean operative time of group 1 was (67.16 ± 4.99) minutes; group 2 (60.83 ± 3.56) minutes; group 3 (50.66 ± 2.53) minutes and group 4 (47.72 ± 1.64) minutes with p-value less than 0.05.



**Fig-1:** Operating time by moving average method for consecutive group of ten patients (mean ± SEM): group 1 = 67.16 ± 4.99; group 2 = 60.83 ± 3.56; group 3 = 50.66 ± 2.53; group 4 = 47.72 ± 1.64. \*P<0.05

## DISCUSSION

Laparoscopic appendectomy is now being globally performed for both acute and perforated appendicitis.<sup>8</sup> In comparison with open appendectomy, it is associated with less postoperative pain, short hospital stay and less wound infection.<sup>9,10</sup> Despite these advantages, laparoscopic appendectomy is still not widely adopted as the gold standard treatment for the management of acute appendicitis.<sup>11</sup> The adoption of laparoscopic appendectomy in many institution is slow, probably because of its reported long operative time, cost of equipment and increased incidence of intra abdominal collection.<sup>12</sup>

Early randomized trials failed to establish advantage of laparoscopic appendectomy over open appendectomy. The operative time was longer with no significant difference in postop hospital stay and return to work.<sup>13,14</sup> The decrease in operative time, postoperative ileus and hospital stay agrees with several studies.<sup>15</sup> On review of pre-2000 and post-2000 literature there is noteworthy shift in favor of laparoscopy and can be explained by improved technique after passing the learning curve

standardization of technique, better visualization with high definition laparoscope, availability of modern energy devices like harmonic scalpel, preformed endoloop for ligation of appendix.

There was no mortality in our series, three patients (1.9%) had acute urinary retention, in these patients one 5mm port was in suprapubic region may be cause of irritation to urinary bladder. Later on we standardized our working ports position in left midclavicular position. In accordance with other similar studies,<sup>16,17,18</sup> there were fewer wound infection with laparoscopic appendicectomy. We routinely use endobag for removal of appendix to avoid contamination, this finding has also been reported in Cochrane review.<sup>19</sup> In our study, there was no case of postoperative intraabdominal infection. As we routinely place drain in case of perforated appendix may be an explanation for no intraabdominal collection in our study.

Three (1.9%) patients required conversion to open surgery. The reasons for conversion were dense adhesions preventing safe mobilization of appendix (n = 2), perforation at base with retrocecal position (n = 1). The rate of conversion did not decline with learning curve as the conversion is decided on the basis of pathological status of the appendix.

In our study, with the hypothesis that operative time will decline after the learning curve, first 40 cases of laparoscopic appendicectomy were divided into four subgroups of 10 patients 1,2,3,4 and the moving average was obtained. Based on this, the learning curve was defined as 30 cases.

Currently there are fewer studies suggesting minimum number of laparoscopic appendectomies to become proficient in the procedure. The European Association recommends a minimum number of 20 cases<sup>20</sup>, Song Yi Kim et al on the basis of moving average hypothesize that the learning curve is 30 cases.<sup>21</sup>

Moving average method for operative time has been used in constructing learning curves for adopting new laparoscopic procedure. Laparoscopic appendectomy patients were divided into consecutive series of 4 subgroups 10 patients each as subgroups 1,2,3,4 and the moving average was obtained. Our series demonstrate the learning curve stabilizes after 30 cases performed.

The reduction in operative time was due to standardization of technique especially site of port placement, availability of modern energy devices and familiarity of surgeons and operating theater staff with the procedure. A similar reduction in operative time has been reported during the learning curve of other advanced laparoscopic procedures such as laparoscopic hernia repair and colorectal procedures.<sup>22</sup>

In this study, learning curve has been defined on the basis of the analysis of the results of two surgeons who were expert in laparoscopic cholecystectomy and open appendicectomy, it has limitation in suggesting a learning curve for surgeons who already are not doing laparoscopic procedures.

<b>Variable</b>		<b>Frequency (%)</b>
<b>Gender</b>	Female	80(51.6%)
	Male	75(48.4%)
<b>IOF</b>	Acutely Inflamed Appendix	122(78.7%)
	Acute Suppurative Appendix	19(12.3%)
	Perforated Appendix	10(6.5%)
	Normal Appendix	4(2.6%)
<b>Complications</b>	No complication	144(92.9%)
	Long ILEUS	3(1.9%)
	Urinary Retention	3(1.9%)
	Wound Infection	2(1.3%)
	Conversion	3(1.9%)

**Table-2:** Demographic Profile

Variables	Group A	Group B	p-value
No. of Patients	40	40	
Mean age of Patients (years)	28.10 ± 13.88	26.61 ± 14.80	0.642
Mean operative time (minutes)	58.08 ± 13.92	33.50 ± 6.11	<0.001
Mean length of Stay (days)	2.13 ± 1.06	1.3 ± 0.68	<0.001
Mean ILEUS (hours)	20.07 ± 10.36	10.37 ± 8.51	<0.001

**Table-3:** Comparison of Outcome variables in group A and group B

	IOF				p-value
	Acutely Inflamed Appendix	Acute Suppurative Appendix	Perforated Appendix	Normal Appendix	
<b>Gender</b>					0.731
<b>Female</b>	61(50)	10(52.6)	6(60)	3(75)	
<b>Male</b>	61(50)	9(47.4)	4(40)	1(25)	
<b>Complication</b>					0.218
<b>No complication</b>	117(95.9)	15(78.9%)	8(80)	4(100)	
<b>Long ILEUS</b>	2(1.6)	-	1(10)	-	
<b>Urinary Retention</b>	2(1.6)	1(5.3%)	-	-	
<b>Wound infection</b>	1(0.8)	-	1(10)	-	
<b>Conversion</b>	-	3(15.7%)	-	-	

**Table-4:** Cross tabulation of IOF by Gender and Complication Level

**CONCLUSION**

Laparoscopic appendicitis is safe and effective procedure for management of acute and perforated appendicitis and the learning curve stabilizes by 30 cases.

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