Clinical Outcomes and Cost Analysis of Laparoscopic versus Open Appendectomy for Treatment of Acute Appendicitis in St. Luke's Medical Center - Quezon City

Ma. Faustine J. Cabel [1], Jonathan Joy D. Adora [2]

1 Institute of Surgery, St. Luke's Medical Center, Quezon City
2 Institute of Surgery, St. Luke's Medical Center, Quezon City
Correspondence to: mfjcabel@stlukes.com.ph

Abstract

Introduction: With a lifetime incidence of 8.6% in men and 6.7% in women, appendicitis is a significant public health concern (1). Acute Appendicitis is one of the top 100 diagnosis requiring admission at St. Luke's Medical Center Quezon City (2). In our institution, there's increasing number of cases performed via the laparoscopic approach. Based from the institutional registry, 5% of appendectomies were performed laparoscopically in 2014 reaching up to 25% in 2018.

Methodology: Data from 277 patients diagnosed with acute appendicitis in 2019 at SLMC QC were collected retrospectively and studied. These comprised 164 patients who underwent open appendectomy and 113 patients treated laparoscopically. The two groups were compared for operative time, operative blood loss, length of hospital stay, postoperative pain, postoperative ileus, complication rate, analgesic requirements and hospital costs.

Results: Laparoscopic appendectomy was significantly associated with a shorter hospital stay (1.87±1.37 days in Laparoscopic Appendectomy and 2.64±2.15 days in Open Appendectomy), with less need for analgesia. Operative time was shorter in the open group (84.61 ± 40.10 min in OA and 90 ± 39.25 in LA). Complication rate was significantly less in the laparoscopic group (9.7 % vs 20.7 %, p 0.01). The total cost of treatment was higher in the laparoscopic group.

Conclusion: The laparoscopic approach is comparable with the open approach and it provides clinically beneficial advantages such as shorter hospital stay, decreased need for postoperative analgesia, lower rate of complications against only marginally higher hospital costs.

Keywords: open appendectomy, laparoscopic appendectomy, hospital cost, appendicitis, cost-analysis

Submitted 12 June, 2021. Accepted for publication July 3, 2021.
View this article at: http://

Introduction

Open appendectomy remains unchallenged in that it has a relatively small scar, short operative time, early recovery after the surgery, low morbidity and low cost (3). Laparoscopic appendectomy was first introduced in the early 1980s and since then, the benefit and cost-effectiveness of laparoscopic appendectomy have been validated and studies were done comparing open appendectomy and laparoscopic appendectomy. Over time, laparoscopic approach has been widely used but open appendectomy remains to be the treatment of choice for most surgeons (4).

In our institution, there is increasing number of cases performed via the laparoscopic approach. Based from the institutional registry, 5% of appendectomies were

up to 25% in 2018. However, this is not a reflection of the country because the open technique is known to be the preferred approach in the rural and urban areas, given the limited resources and training of surgeons.

Several studies, trials and meta-analyses comparing laparoscopic and open appendectomy have provided inconsistent results showing better clinical outcomes with the laparoscopic approach (5-8) while others show marginal or no clinical benefits (9,13) and higher surgical costs (10-12,14).

The trend towards minimally invasive surgery has incited general surgeons to scrutinize nearly all operations for possible conversion to laparoscopic techniques. Considering that laparoscopic appendectomy has not been established to be superior to open appendectomy for acute appendicitis, this study has been designed.

Methodology

This study received approval by the SLMC Institutional Ethics Review Committee for the collection of information from the medical records and statement of accounts. Confidentiality of personal information was kept by the investigators.

PATIENTS

A retrospective observational study of patients admitted to a single institution, St. Luke's Medical Center Quezon City between January to December 2019 with the diagnosis of appendicitis was conducted. Pregnant women and patients with severe medical condition such as hemodynamic instability, chronic medical or psychiatric illness, cirrhosis and coagulation disorders were excluded. Analysis of the clinical data and hospital costs of 277 patients that met the inclusion criteria was done. The patients were divided into two groups: open appendectomy group and laparoscopic appendectomy group. The collected clinical data included demographic data, comorbidities, preoperative white blood cell counts, operative time, operative blood loss, intraoperative findings (congestive, suppurative, gangrenous or ruptured appendix), time to flatus, postoperative length of hospital stay, analgesics requirements and postoperative complications. Analysis on costs was done separately using the statements of accounts. The diagnosis was made clinically with history and physical examination. Additional imaging studies were requested for patients with inconclusive findings. All patients were given prophylactic dose of antibiotics at least an hour prior to the surgery. Open appendectomy was performed through standard Rockey Davis incision while a standard 3-port technique was used for laparoscopic group. Pneumoperitoneum was produced by insufflation of carbon dioxide via the open Hasson approach. All specimens were sent for histopathology.

The operative time (minutes) was initiated from the skin incision to the last skin stitch done. The length of hospital stay (days) included only the number of days spent at the hospital after the surgery. Surgical site infection was defined as presence of purulent or seropurulent discharge from the incision site. Seroma was defined as presence of clear fluid discharge. Postoperative paralytic ileus was defined as delay of bowel motility within three days of the surgery.

STATISTICAL ANALYSIS

Qualitative data were represented as percentages and frequencies and compared by the Chi- square test. Continuous variables in the form of standard deviation and means was represented by the Mann–Whitney U test and Student's T-test respectively. Comparisons were designated as intention-to-treat basis. Thus, those who underwent laparoscopic appendectomy, then converted to open, was not excluded from the analysis. Sample size was calculated based on an analysis of sample sizes required for each of the parameters (operative time, length of hospital stay, postoperative pain, complication rate, return to normal activity and cost) for an $\alpha = 0.05$ and a power of 90 %. A P- value of 0.05 was considered as significant. Calculations were

done with the SPSS software package version 22.0 (SPSS Inc., Chicago, IL).

Results

Out of 277 patients with acute appendicitis, 164 patients underwent open appendectomy and 113 patients underwent laparoscopic appendectomy. One case in the laparoscopic appendectomy group was converted to open surgery. Demographic data and preoperative clinical feature between Open Appendectomy group and Laparoscopic Appendectomy group are shown in Table 1.

There were no significant differences with respect to age, gender and associated comorbidities. The age ranged between 19 and 85 years in the open appendectomy group (mean of 38.59 years) while similarly the laparoscopic patients were between 19 and 77 years (mean of 38.36 years). Of the total operated patients for open appendectomy, 86 were males (52%) and 78 were females (48%), while for laparoscopic appendectomy, 52 were males (46%) and 61 were females (54%). Also, the difference in the white blood cell count at presentation was not statistically significant. Both groups showed elevated white blood cell counts.

	Open Appendectomy (n = 164)	Laparoscopic Appendectomy (n = 113)	P-value
Mean Age	38.59 ± 1.33	38.36 ± 1.93	.451001
Gender Male Female	 86 (52.4) 78 (47.6)	 52 (46.02) 61 (53.98)	.298
WBC count (mm^3)	14700.06 ± 2.84[5]	13728.66 ± 4.6[5]	.246
Comorbidities Yes No Hypertension Diabetes Mellitus Bronchial Asthma Others	 49 (29.9) 115 70.1) 26 14 4 21	 26 (23.0) 87 (77.0) 16 7 4 4	.206

Table 1. Demographic and clinical profile of patients

	Open Appendectomy (n = 164)	Laparoscopic Appendectomy (n = 113)	P-value
Surgical findings			.07299
Congestive	54 (33)	55 (49)	
Suppurative	58 (35)	31 (27)	
Gangrenous	14 (9)	7 (6)	
Ruptured	38 (23)	20 (18)	

Table 2. Surgical findings

Out of the total 164 open procedures, 112 (68 %) were performed for uncomplicated appendicitis and 52 (32 %) for complicated disease. In the laparoscopic group, 86 (76 %) procedures involved uncomplicated disease and 27 (14 %) complicated appendicitis. Noteworthy, we did not observe differences between groups for all the grades of appendicitis as shown in Table 2.

	Open Appendectomy (n = 164)		Laparoscopic Appendectomy (n = 113)		P-value
	Mean	Std Dev	Mean	Std Dev	
Operative time (minutes)	84.61	40.10	90	39.25	.268
Operative blood loss (cc)	15.76	21.9	9	12.31	.001
Length of hospital stay (days)	2.64	2.15	1.87	1.37	<.001
Time before flatus (days)	0.71	.95	0.345	.68	<.001
Pain Score	1	1.48	0.38	.93	<.001
Parenteral Analgesics (doses)	151 (92)		94 (83)		0.0341
Oral analgesics (doses)	136 (82.9)		80 (70)		0.0187
Hospital Costs (Php)	109191.81	2.11^{6}	151664.19	3.07^{6}	<.001

Table 3. Operative and post-operative clinical data

In our study, the mean operative time of 90 ± 39.25 min for the Laparoscopic Appendectomy group was longer than the mean operative time of 84.61 ± 40.10 min for open appendectomy (P value .268) but is statistically not significant. Difference in operative blood loss, however, is significant with mean value of 15.76 cc for open appendectomy and 9 cc for laparoscopic appendectomy.

The mean duration of postoperative hospital stay was 2.64 days in open appendectomy group as compared to 1.87 days for laparoscopic appendectomy group which is significant (p value <.001) as shown in Table 3. Presence of flatus was observed with mean duration of 17 hours in the OA group as compared to 8 hours in LA group with P value <.001. In the study, average pain score was 1 ± 1.48 in OA group as compared to 0.38 ±0.93 in LA group with P value <.001 which was highly significant. The LA group required fewer doses of parenteral and oral analgesics in the postoperative periods compared with the OA group (P 0.0341 and P 0.0187, respectively). In the OA group, 13 (8%) patients did not need IV analgesics postoperatively while 19 (17%) patients for the LA group. Also, in the OA group, 28 (17.1%) patients did not need oral analgesics postoperatively while 33 (30%) patients for the LA group.

	Open Appendectomy (n = 164)	Laparoscopic Appendectomy (n = 113)	P-value
Mean	15.76 ± 21.9	9 ± 12.3	.001
≤ 5cc	70 (42.7)	74 (65.5)	
6 - 10cc	49 (29.9)	26 (23)	
11 - 20 cc	20 (12.2)	7 (6)	
21- 50cc	15(9)	5 (4)	
≥ 51 cc	10 (6)	1 (1)	

Table 4. Post-operative blood loss

In OA group, 70 cases had operative blood loss of approximately 5cc or less, 49 cases had approximately 6 to 10 cc, 20 cases had 11 to 20cc, 15 cases had 21 to 50cc and 10 cases had more than 51 cc of operative blood loss with mean value of 15.76 ± 21.9 cc. In LA group, 74 cases had operative blood loss of approximately 5cc or less, 26 cases had approximately 6 to 10 cc, 7 cases had 11 to 20cc, 5 cases had 21 to 50cc and 1 case had more than 51 cc of operative blood loss with mean value of 9 ± 12.3 cc. LA group significantly had less operative blood loss (P .001).

	Open Appendectomy (n = 164)	Laparoscopic Appendectomy (n = 113)	P-value
Mean Duration	2.64 ± 2.15	1.87 ± 1.37	<.001
< 24 hours	0 (0)	2 (1.8)	
1 day	51 (31)	54 (47.8)	
2 days	55 (33.5)	36 (31.86)	
3-5 days	40 (24.5)	18 (15.93)	
>5 days	18 (11)	3 (2.65)	

Table 5. Length of hospital stay

In open appendectomy 51 cases had 1 day of stay, 55 cases had 2 days, 40 cases had 3 to 5 days and 18 cases had more than 5 days of postoperative stay in the hospital with mean duration of 2.64 ±2.15 days. In laparoscopic appendectomy, 2 cases had less than 24 hours of stay, 54 cases had 1 day of stay, 36 cases had 2 days, 18 cases had 3 to 5 days and 3 cases had more than 5 days of postoperative stay in the hospital with mean duration of 1.87±1.37 days. Laparoscopic appendectomy significantly reduced the hospital stay (P <.001).

	Open Appendectomy (n = 164)	Laparoscopic Appendectomy (n = 113)	P-value
Time before flatus (days)	0.71±0.95	0.345±0.68	<.001
< 24 hours	88 (53.66)	94 (83.2)	
>24 hours	48 (29.27)	16 (14.2)	
48 hours	20 (12.2)	2 (2)	
> 72 hours	5 (0.3)	1 (1)	
> 96 hours	3 (0.2)	0 (0)	

Table 6. Time before flatus

In open appendectomy, 88 cases had flatus within 24 hours of the surgery, 48 cases within 24 to 48 hours, 20 cases within 48 to 72 hours, 5 cases within 72 to 96 hours and 3 cases had flatus after 4 postoperative days with mean of 0.71±0.95 day. In lap appendectomy, 94 cases had flatus within 24 hours of the surgery, 16 cases within 24 to 48 hours, 2 cases within 48 to 72 hours, 1 case within 72 to 96 hours and no case had flatus after 4 postoperative days with mean of 0.345±0.68 day. Laparoscopic appendectomy significantly reduced time before flatus (P <.001).

	Open Appendectomy (n =164)	Laparoscopic Appendectomy (n =113)	P-value
	34 (20.7)	11 (9.7)	0.01
Vomiting	13	1	.008
Postoperative Fever	3	2	0.56
Postoperative Paralytic Ileus	8	1	.065
Surgical Site Infection	1	2	0.56
Wound Dehiscence	1	0	1
Intraabdominal Abscess	0	1	0.40
Intraabdominal Bleeding	0	0	1
Others	6	1	0.24
Death	1	0	1
Surgical reintervention	1	3	0.30
Readmission	1	3	0.30

Table 7. Post-operative complications

A greater overall incidence of complications is observed in OA than in LA. A total of 33 (20.7%) complications occurred in the OA group, while 11 (9.7%) complications occurred in the LA group, as summarized in Table 7. The difference is statistically significant with P value of 0.01. We did not observe a significant difference between

groups in terms of postoperative fever, postoperative ileus, surgical site infection, intrabdominal abscess and hemoperitoneum. Difference in postoperative vomiting is significant (P .008). One surgical reintervention for OA group was due to wound dehiscence. Three surgical interventions for the LA group were accounted for repair of umbilical hernia, wound debridement for surgical site infection and drainage of intraabdominal abscess. One patient with SSI was managed conservatively.

		B	Sig.	Exp (B)	Lower	Upper
(a)	TypeofSurgery(1)	.136	.797	1.145	.407	3.223
	Age	.053	.003	1.055	1.018	1.093
	Gender(1)	.471	.375	1.601	.566	4.528
	Co-morbidity(1)	.317	.579	1.374	.448	4.214
	Constant	-5.426	.000	.004		

At 95% C.I. for EXP (B)
a. Variable(s) entered on step 1: type of surgery, age, gender, co-morbidity

Table 8. Logistic regression for post-operative complications
Variables in the equation

The data in table 8 shows that factors concerning the type of surgery, gender and presence of comorbidity do not have statistically significant effect on the presence of postoperative complications, however, the age does have significant effect. For every 1-year increase in age, there is 6% probability of postoperative complications.

Analysis of hospital costs are presented in Table 3. The open appendectomy group has a mean cost of Php109191.81 ± 2.11 while the laparoscopic appendectomy group has a mean cost of Php151664.19 ± 3.07 which includes the costs accumulated due to eoperations caused by debridement of surgical site infections and repair of umbilical hernia. The difference in costs was statistically significant with p value < .001.

DISCUSSION

The development of minimally invasive techniques represents one of the most important advances in surgery during recent decades. Comparable results of laparoscopic appendectomy with open appendectomy and with increasing accessibility for laparoscopic instruments paved way for its use for both simple and complicated cases of acute appendicitis. Although the rate of laparoscopic appendectomy has been increasing, open appendectomy is still the conventional technique. Various studies have shown that laparoscopic appendectomy is safe, results in shorter hospital stay hence earlier return to routine activities and with less wound complications. These findings, however, are in conflict with other literatures. Their results show no significant difference in the outcome between the two procedures and even noted higher costs with the laparoscopic approach.

Notwithstanding the additional benefit described, favoring laparoscopic appendectomy still remains a matter of debate because of concerns of longer operative time,

higher rate of postoperative intraabdominal abscesses and higher costs compared to open appendectomy. The difference in operative time in this study is statistically insignificant due to the increasing experience of surgeons in the laparoscopic approach. There is statistically significant difference in terms of operative blood loss with higher volume in the open appendectomy group. The magnified view afforded by laparoscopy enhances the surgeon's view of the structures surrounding the specimen. With the help of laparoscopic instruments, surgeons could achieve precise dissection along appropriate planes.

Subjective assessment of postoperative pain was done with visual analogue scale and objectively with the tabulation of analgesic use. The amount of analgesics used, (oral and parenteral) by the patients were compared. Intravenous and oral analgesic uses were less in the laparoscopic than in the open group, showing a statistical significance difference (P <.001). This is at par with other studies (15-17) that reported less pain in the laparoscopic group. Smaller trocar incision, minimal tissue handling and lower peritoneal injury from pneumoperitoneum may be the reason for decreased postoperative pain perception in laparoscopic appendectomy.

Overall complication rates were 20.7 % and 9.7 % for open and laparoscopic group respectively, with no statistically significant difference in the dehiscence and wound infection rate . Antibiotics used in the perioperative period, however, were not mentioned which can play a role in surgical site infections. Surgical site infection was more prevalent in complicated appendicitis and can affect the recovery and quality of life of patients. No difference was observed in the intraoperative findings between the two groups as shown in Table 2. Previous studies show a lower rate of wound infection in laparoscopic group which can be due to placement of the appendix into an endobag before being removed from the abdominal cavity, lessening contact with the fascial surfaces hence decreased contamination. There is one case of intraabdominal abscess formation in the laparoscopic group and none in the open group. This finding is consistent with other studies which showed an increased risk of intra-abdominal abscess after laparoscopic appendectomy (18- 20). Several hypotheses suggest insufficient learning curve, spread of bacteria in the peritoneal cavity during gas insufflation especially in case of ruptured appendix and copious irrigation and suctioning of the infected area in severe peritonitis that leads to contamination of the entire abdominal cavity which is inadequately aspirated after. However, in the study this finding was not statistically significant. There is one mortality case in the open appendectomy group which is due to septic shock. The low mortality rates reported in previous researches, 0.03 % and 0.05 % in open and laparoscopy groups, respectively indicate that appendectomy, especially in absence of complicated disease, is a safe procedure regardless of the technique used.

Presence of ileus, pain and wound infection impedes the mobility of the patient, in turn lengthening the hospital stay and increasing the overall cost. In the study, hospital stay was significantly shorter with concomitant earlier return of bowel movement in patients managed laparoscopically, leading to earlier discharge from hospital. Although the cost of laparoscopic appendectomy is higher than open appendectomy, the difference in total cost between the two procedures is decreased by shorter length of stay. The findings are in agreement with several studies that demonstrated a significantly shorter hospital stay for the laparoscopic approach (21-24).

COST ANALYSIS

The higher cost of laparoscopic instruments represents an obstacle to its greater use. In a study by Moore et al., they have shown that laparoscopic appendectomy is of much benefit to the younger population and to the patients who lead a productive life. The laparoscopic approach contributes to the economic gain from the perspective of an earlier return to daily activities means earlier return to work. The cost analysis remains the most controversial issue concerning laparoscopic appendectomy because it relies entirely on the

health system of the country. Even though laparoscopic appendectomy has reduced length of hospital stay, it cannot offset the higher cost of laparoscopic instruments. As previous studies have shown, the cost generally still remains higher with the laparoscopic approach. On the basis of the current pricing system in the Philippines, the mean net cost, excluding the medications used, is by far less in the open appendectomy group than the laparoscopic appendectomy group. The mean hospital stay is already very low in both groups (<3 days), therefore, it is highly unlikely that a longer hospital stay in the open appendectomy group would outweigh the higher cost of laparoscopic appendectomy. Based from the current pricing, patients should stay in the hospital for at least another 13 days for that to happen. From this point of view, laparoscopic appendectomy remains an expensive procedure compared with the open approach in our current setting and this can primarily be attributed to the pricing system of the hospital.

CONCLUSIONS

The advantage of the laparoscopic over open appendectomy include shorter hospital stays, decrease in postoperative analgesia, lower complication rates, against a slightly higher hospital cost. In a setting with adequate equipment surgical experience, laparoscopy could be considered safe and equally efficient compared to open and should be given as the initial procedure of choice for most cases. In addition to the clinical benefits described in several studies, the laparoscopic approach allows a full exploration of the peritoneal cavity thus representing an important diagnostic tool in case there is only suspicion of acute appendicitis. Several diseases like PID, endometriosis, ovarian cysts, ectopic pregnancy, cholecystitis, colonic perforation may mimic appendicitis. Since there is no unanimity yet to the best approach, both procedures are still being practiced actively leaving the choice to the preference of surgeon and patients. In the future, laparoscopic appendectomy could represent the standard treatment for patients with appendicitis and undiagnosed abdominal pain.

We acknowledge there are limitations in our study such as its retrospective nature. Despite absence of randomization of patients, there was good matching between the two study groups. Another limitation is the lack of evaluation of laparoscopic surgery in obese patients as body mass indexes were not noted. In a different study, the laparoscopic approach has been proposed as the preferred technique in obese and elderly patients (25). Early return to work or normal activity was not assessed due to its retrospective nature, hence another limitation. Early return to full activity is accepted as an obvious advantage of laparoscopic appendectomy which was supported by a large-scale metanalyses conducted by the Cochrane group review. We could only emphasize on immediate and primary outcomes and could not measure the long-term complications such as obstruction and incisional hernias, and their effect on health care costs.

Taking our results into account with that of the current Philippine health care system, it is evident that laparoscopic appendectomy is still not cost-effective. Nonetheless, some other benefits may justify the cost. We suggest laparoscopic appendectomy in cases of equivocal diagnosis and, cosmesis is emphasized. Cases involving obese patients, young women with vague lower quadrant pain and patients with diabetes mellitu that increases the chances of wound infection are factors to consider laparoscopic appendectomy. This is where the procedure is advantageous regardless of a higher cost. We also consider alteration of the current cost system used in our health care system for better adaptation to the needs of our patients.

ACKNOWLEDGEMENT

None

DISCLOSURE

No conflict of interest. This manuscript has not been published previously and is not under consideration for publication elsewhere.

References

1. Brunicardi F, Andersen DK, Billiar TR, Dunn DL, Kao LS, Hunter JG, Matthews JB, Pollock RE. Schwartz's principles of surgery.11th ed. McGraw Hill, New York; 2019.

2. Galarido, MF, Margallo, RD. Health services outcome report appendectomy data quality management yearend report 2018. QC. SLMC HSOR unit, 2019. 12p.

3. Alejandro RP, Samuel R, Molina G. Cost-effectiveness of laparoscopic versus open appendectomy in developing nations: a Colombian analysis [Internet] . J Surg Res. 2018 Apr [cited 2020 August];224:33-37. Available from: https://pubmed.ncbi.nlm.nih.gov/29506848/ DOI: 10.1016/j.jss.2017.11.007

4. Haas L, Stargardt T, Schreyoegg J. Cost-effectiveness of open versus laparoscopic appendectomy: a multilevel approach with propensity score matching. [Internet]. Eur J Health Econ. 2012 Oct [cited 2020 August] ;13(5):549-60. Available from https://pubmed.ncbi.nlm.nih.gov/21984223/ DOI: 10.1007/s10198-011-0355-6

5. Ortega AE, Hunter JG, Peters JH, Swanstrom LL, Schirmer B. A prospective, randomized comparison of laparoscopic appendectomy with open appendectomy. Laparoscopic Appendectomy Study Group. [Internet]. Am J Surg. 1995 Feb [cited 2020 August] ;169(2):208-12; discussion 212-3. Available from: https://pubmed.ncbi.nlm.nih.gov/7840381/ DOI:10.1016/s0002-9610(99)80138-x. 1995.

6. Milewczyk M, Michalik M, Ciesielski M. A prospective, randomized, unicenter study comparing laparoscopic and open treatments of acute appendicitis. [Internet]. Surg Endosc. 2003 Jul [cited 2020 August];17(7):1023-8. Available from: https://pubmed.ncbi.nlm.nih.gov/12728377/ DOI: 10.1007/s00464-002-9112-3

7. Bresciani C, Perez RO, Habr-Gama A, Jacob CE, Ozaki A, Batagello C,Proscurshim I, Gama-Rodrigues J .Laparoscopic versus standard appendectomy outcomes and cost comparisons in the private sector. [Internet]. J Gastrointest Surg, 2005 Nov [cited 2020 August] ; 9(8):1174-80; discussion 1180-1. Available from: https://pubmed.ncbi.nlm.nih.gov/16269389/ DOI:10.1016/j.gassur.2005.06.001

8. Ignacio RC, Burke R, Spencer D, Bissell C, Dorsainvil C, Lucha PA. Laparoscopic versus open appendectomy: what is the real difference? Results of a prospective randomized double-blinded trial. [Internet]. Surg Endosc, 2004 Feb [cited 2020 August];18(2):334-7. Available from: https://pubmed.ncbi.nlm.nih.gov/14691696/ DOI: 10.1007/s00464-003-8927-x

9. Olmi S, Magnone S, Bertolini A, Croce E. Laparoscopic versus open appendectomy in acute appendicitis: a randomized prospective study. [Internet]. Surg Endosc. 2005 Sep [cited 2020 August];19(9):1193-5. Available from: https://pubmed.ncbi.nlm.nih.gov/16132334/ DOI: 10.1007/s00464-004-2165-8

10. Katkhouda N, Mason RJ, Towfigh S, Gevorgyan A, Essani R. Laparoscopic versus open appendectomy: a prospective randomized double-blind study. [Internet]. Ann Surg. 2005 Sep [cited 2020 August] ;242(3):439-48;discussion448-50. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1357752/ DOI: 10.1097/01.sla.0000179648.75373.2f.

11. Golub R, Siddiqui F, Pohl D. Laparoscopic versus open appendectomy: a metaanalysis. [Internet]. J Am Coll Surg. 1998 May [cited 2020 August] ;186(5):545-53. Available from: https://pubmed.ncbi.nlm.nih.gov/9583695/ DOI: org/10.1016/S1072-7515(98)00080-5

12. Chung RS, Rowland DY, Li P, Diaz J. A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy. [Internet]. Am J Surg. 1999 Mar [cited 2020 August] ;177(3):250-6. Available from: https://pubmed.ncbi.nlm.nih.gov/10219865/ DOI: 10.1016/s0002-9610(99)00017-3

13. Hart R, Rajgopal C, Plewes A, Sweeney J, Davies W, Gray D, Taylor B. Laparoscopic versus open appendectomy: a prospective randomized trial of 81 patient. [Internet]. Can J Surg. 1996 Dec. [cited 2020 August] ;39(6):457-62. Available from: https://pubmed.ncbi.nlm.nih.gov/8956810/

14. Garbutt JM, Soper NJ, Shannon WD, Botero A, Littenberg B. Meta-analysis of randomized controlled trials comparing laparoscopic and open appendectomy. [Internet]. Surg Laparosc Endosc. 1999 Jan. [cited 2020 August] ;9(1):17-26. Available from: https://pubmed.ncbi.nlm.nih.gov/9950122/

15. Ortega AE, Hunter JG, Peters JH, Swanstrom LL, Schirmer B. A prospective, randomized comparison of laparoscopic appendectomy with open appendectomy . Laparoscopic Appendectomy Study Group. [Internet]. Am J Surg. 1995 Feb [cited 2020 August] ;169(2):208-12; discussion 212-3. Available from: https://pubmed.ncbi.nlm.nih.gov/7840381/ DOI: 10.1016/s0002-9610(99)80138-x

16. Moore DE, Speroff T, Grogan E, Poulose B, Holzman MD. Cost perspectives of laparoscopic and open appendectomy. [Internet]. Surg Endosc, 2005 Mar [cited 2020 August] ;19(3):374-8. Available from: https://pubmed.ncbi.nlm.nih.gov/15624056/ DOI: 10.1007/s00464-004-8724-1

17. Frazee RC, Roberts JW, Symmonds RE. A prospective randomized trial comparing open versus laparoscopic appendectomy. [Internet]. Ann Surg. 1994 Jun [cited 2020 August] ;219(6):725-8; discussion 728-31. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1243232/ DOI:10.1097/00000658-199406000-00017

18. Shaikh AR, Sangrasi AK, Shaikh GA. Clinical Outcomes of laparoscopic versus open Appendectomy. [Internet]. JSLS, 2009 Oct-Dec [cited 2020 August] ;13(4):574-80. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3030794/ DOI: 10.4293/108680809X1258998404524

19. Agresta F, De Simone P, Leone L, Arezzo A, Biondi A, Bottero L, et al. Italian Society Of Young Surgeons (SPIGC). Laparoscopic appendectomy in Italy: an appraisal of 26,863 cases. [Internet]. J Laparoendosc Adv Surg Tech A, 2004 Feb [cited 2020 August] ;14(1):1-8. Available from: https://pubmed.ncbi.nlm.nih.gov/15035836/ DOI: 10.1089/109264204322862270

20. Biondi, A, Di Stefano C. Laparoscopic versus open appendectomy: a retrospective cohort study assessing outcomes and cost- effectiveness. [Internet]. World J Emerg Surg. 2016 Aug 30. [cited 2020 August] ;11(1):44. Available from: https://pubmed.ncbi.nlm.nih.gov/27582784/ DOI: 10.1186/s13017-016-0102-5.

21. Guller U, Hervey S, Purves H, Muhlbaier LH, Peterson ED, Eubanks S, Pietrobon R. Laparoscopic versus open appendectomy: outcomes. Biondi et al. [Internet]. Ann Surg. 2004 Jan [cited 2020 August] ;239(1):43-52. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1356191/ DOI: 10.1007/s13126-016-0277-y

22. Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. [Internet]. Cochrane Database Syst Rev. 2002 [cited 2020 August] ;(1):CD001546. Available from: https://pubmed.ncbi.nlm.nih.gov/11869603/ DOI: 10.1002/14651858.CD001546.pub3

23. Shaikh AR, Sangrasi AK, Shaikh GA. Clinical Outcomes of laparoscopic versus open Appendectomy. [Internet]. JSLS. 2009 Oct-Dec [cited 2020 August] ;13(4):574-80. Available from: https://pubmed.ncbi.nlm.nih.gov/20202400/ DOI: 10.4293/108680809X1258998404524

24. Merhoff AM, Merhoff GC, Franklin ME. Laparoscopic versus open appendectomy. [Internet]. Am J Surg. 2000 May [cited 2020 August] ;179(5):375-8. Available from: https://pubmed.ncbi.nlm.nih.gov/10930483/ DOI: 10.1016/s0002-9610(00)00373-1, 2000.

25. Varela JE, Hinojosa MW, Nguyen NT. Laparascopy should be the approach of choice for acute appendicitis in the morbidly obese. [Internet]. Am J Surg. 2008 Aug [cited 2020 August] ;196(2):218-22. Available from: https://pubmed.ncbi.nlm.nih.gov/18519131/ DOI: 10.1016/j.amjsurg.2007.08.067

Cite this article as: Cabel MFJ, Adora JJD. Clinical Outcomes and Cost-Analysis of Laparoscopic versus Open Appendectomy for Treatment of Acute Appendicitis in St. Luke's Medical Center Quezon City. PJELS 2021;1(2):12-21.