Clinical Outcome and Cost Comparison Between Laparoscopic and Open Appendicectomy

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Abstract

Introduction: Local data comparing laparoscopic appendicectomy (LA) and open appendicectomy (OA) is lacking. We perform a cost and outcome comparison between LA and OA. Materials and Methods: A retrospective review of all appendicectomies performed for suspected appendicitis from July 2010 to December 2010 was conducted. Patient demographics, duration of surgery, complication rates, total cost of stay (COS) and length of stay (LOS) were compared between LA and OA. Results: A total of 198 patients underwent appendicectomy during the duration of study; 82 LA and 116 OA. There were 115 males (58.1%) and 83 females (41.9%). Median age was 33 years. Patients who underwent LA were significantly younger (*P* <0.001) with a greater proportion of females (*P* <0.0001) and were more likely to be negative appendicectomies (18.3% vs. 6.9%, *P* = 0.023). Duration of surgery was significantly longer in LA patients (86 min vs. 74 min, *P* = 0.003). LOS in the LA group was shorter by 1.3 days compared to OA (2.0 days vs. 3.3 days, *P* <0.0001). The differences in operative duration and LOS between LA and OA remained significant on multivariate analysis (*P* = 0.001 and *P* = 0.008, respectively). The COS (*P* = 0.359), wound infection rates (*P* = 0.528) and complication rates (*P* = 0.131) were not significantly different between the 2 groups. Conclusion: LA is associated with a shorter LOS while its cost is equivalent to OA. From the perspective of utilisation of healthcare resources, LA appears to be superior.

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Introduction

Acute appendicitis is one of the most common causes of acute abdominal pain requiring surgical intervention.[1,2] The traditional operation of choice was the open appendicectomy (OA) pioneered by McBurney in 1894.[3] In 1981, the laparoscopic technique was introduced by Kurt Semm and since then, laparoscopic appendicectomy (LA) is increasingly being performed in place of OA.[4,5] While there is an abundance of published data comparing the pros and cons of LA and OA from overseas, local data is lacking. To the best of our knowledge, there has only been one local publication specifically comparing outcomes between LA and OA. However, this paper was published close to 20 years ago when LA was still a relatively new procedure.[6] In particular, there is no data comparing the cost difference between LA and OA in the local context. This is important as cost analysis from foreign publications may not be applicable in our local setting as healthcare economics vary between countries. In the current era where healthcare resources are spread thinly nationwide, such data is crucial for us to determine the more cost-effective technique for the treatment of a common surgical pathology. We thus aim to perform a cost analysis and compare the clinical outcomes between LA and OA in the local setting.

Materials and Methods

We conducted a retrospective review of medical records of all consecutive cases of appendicectomies performed for

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suspected appendicitis from July 2010 to December 2010 in a 1500-bed tertiary hospital. Cases with pathologies which eventually required a formal laparotomy with bowel resection were excluded from the analysis.

Patient demographics, the type of appendicectomy (laparoscopic or open) performed, the use of computed tomography (CT) during evaluation, perforation status, the duration of surgery, final histology, cost of stay (COS) and length of stay (LOS) were recorded in a standardised data collection sheet. Medical records were reviewed up to 12 months from discharge and postoperative complications were recorded when applicable.

The choice of procedure (LA or OA) was decided based on patient preference and clinical factors. OA was performed via a right lower quadrant Lanz or gridiron incision, even in patients with previous laparotomy. LA was performed via 3 laparoscopic ports. A 10 mm umbilical camera port was first inserted using the open Hasson technique. Pneumoperitoneum was achieved to a pressure of 10 to 12 mm Hg using carbon dioxide. Two 5 mm working ports were next inserted under direct vision in the left lower quadrant and the suprapubic region. The appendix was dissected free and the appendicular artery ligated using 3 Hem-o-lok® clips (2 proximal and 1 distal) and divided. The appendicular base was secured using 3 Endoloop® (2 proximal and 1 distal) and divided. The appendix specimen was retrieved using the Endo Catch™ pouch via the umbilical port. Operative time was defined as the time from skin incision to skin closure. LOS was defined as the duration (days) from time of surgery completion to discharge. COS was defined as the total hospitalisation bill incurred by the patient in Singapore dollars during admission before government subsidies were taken into consideration. The presence of appendicitis was defined based on final histology. Negative appendicectomy was defined as patients who underwent surgery with the clinical impression of acute appendicitis but with no features of appendicitis on histology. In our institution, patients who underwent diagnostic laparoscopy were also consented preoperatively for LA. These patients will have a LA performed even in the presence of a normal-appearing appendix. These patients were included during the analysis of negative appendicectomies. Perforation status was defined based on histological findings. Complications were defined as any deviation from the normal postoperative course for an appendicectomy.[7] These include wound infections, postoperative ileus, postoperative intestinal obstruction, intra-abdominal abscesses, pulmonary complications and incisional hernias.

The main outcome measures, namely, operative duration, LOS, COS, wound infection rate and complication rates, between the LA and OA groups were compared. These were adjusted for differences in demographic characteristics, previous abdominal surgery, American Society of Anesthesiologists (ASA) status, CT evaluation status, presence of appendicitis and perforation status using multivariate analysis. Patients with intraoperative conversion from LA to OA were analysed under the LA group based on intention to treat analysis.

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 17. Categorical variables were compared using Chi-square analysis. Parametric variables were compared using t-test while non-parametric variables were compared using Mann-Whitney U test. Linear and logistic regression analyses were used for multivariate analysis of continuous and categorical variables, respectively. A P value <0.05 was regarded as statistically significant.

Results

A total of 204 patients underwent appendicectomy during the duration of study. Six patients were found intraoperatively to have pathologies which warranted a formal laparotomy. Five patients had a right hemicolectomy performed due to caecal tumour (1 patient), perforated caecal diverticulitis (1 patient) and unhealthy base of appendix (3 patients). The remaining patient had a concomitant small bowel resection for Meckel's diverticulitis noted intraoperatively. These 6 cases were excluded from analysis. Excluding these 6 patients, there were 198 patients who underwent routine appendicectomy. Eighty-two were LA (41.4%) and 116 were OA (58.6%). Comparison of demographic characteristics between the groups with LA and OA is shown in Table 1.

Twelve cases out of 82 attempted LA were converted to OA (14.6%). The reasons for conversion include dense adhesions (3 patients), difficulty in maintaining pneumoperitoneum (3 patients), impaired visibility due to bleeding from the appendicular artery (2 patients) and concerns regarding the integrity of the appendiceal stump (4 patients).

A comparison of outcomes between LA and OA is shown in Table 2. Laparoscopic appendicectomy was associated with an increased operative duration (86 min vs. 74 min, P = 0.003) and a shorter postoperative LOS of 1.3 days compared with OA (2.0 days vs. 3.3 days, P <0.001). The differences in duration of surgery (P = 0.001) and LOS (P = 0.008) remained significant on multivariate analysis. COS, wound infection and complication rates were not significantly different between the 2 groups.

Complications developed in 17 patients (8.6%), none of which occurred intraoperatively. Majority of these were due to superficial wound infections (10 patients). Intra-abdominal abscesses developed in 3 patients, 2 in OA

Table 1. Comparison of Demographic Characteristics Between Laparoscopic and Open Appendicectomy

	Overall (n = 198)	**Laparoscopic Appendicectomy (n = 82)**	**Open Appendicectomy (n = 116)**	***P* Value**
Median age				
Years	33	30	37	<0.001*
Range	13 – 83	15 – 67	13 – 83	
Gender (%)				
Male	58.1	40.2	70.7	<0.001*
Female	41.9	59.8	39.3	
Previous abdominal surgery (%)	8.6	2.4	12.9	0.009*
ASA status (%)				
ASA 1	66	72	62	0.173
ASA 2	30	27	33	
ASA 3	3	0	4	
ASA 4	1	1	1	
CT evaluation (%)	42.9	30.5	51.7	0.004*
Negative appendicectomy rate (%)	11.6	18.3	6.9	0.023*
Perforated appendicitis (%)	9.1	6.1	11.2	0.316

*Denotes statistically significant results
ASA: American Society of Anesthesiologists; Computed tomography

Table 2. Comparison of Outcomes Between Laparoscopic and Open Appendicectomy

	Overall (n = 198)	**Laparoscopic Appendectomy (n = 82)**	**Open Appendectomy (n = 116)**	**Univariate Analysis *P* Value**	**Multivariate Analysis *P* Value**
Mean duration of surgery					
Minimum	79	86	74	0.003*	0.001*
Range	30 – 170	30 – 170	30 – 143		
Mean postoperative length of stay					
Days	2.7	2.0	3.3	<0.001*	0.008*
Range	1 – 34	1 – 6	1 – 34		
Median cost of stay ($)					
Cost	4087	3893	4158	0.359	0.636
Range	2430 – 44,843	2646 – 7651	2430 – 44,843		
Wound infection rate (%)	5.1	3.7	6	0.528	0.958
Complication rate (%)	8.6	4.9	11.2	0.131	0.113

*Denotes statistically significant results

and 1 in LA. The patient with intra-abdominal abscess in the LA group was successfully managed conservatively with antibiotics. In the other 2 cases in the OA group, 1 resolved with conservative management while the other required percutaneous drainage. The remaining 4 patients had other complications such as intestinal obstruction or incisional hernias.

Discussion

In our study, LOS in LA was significantly shorter by 1.3 days compared with OA, with the difference remaining significant on multivariate analysis. This is similar to findings in other studies comparing LA and OA.[5,8-10] In terms of cost comparisons between the 2 techniques, findings in literature are mixed, with most demonstrating an increased

Table 3. Comparison of Cost of Stay Between Laparoscopic and Open Appendicectomy After Taking Into Consideration CT Evaluation Status

	Laparoscopic Appendicectomy	Open Appendicectomy	*P* Value
Median cost of stay in patients with preoperative CT evaluation (n = 85) ($)			
Cost	4794	4725	0.721
Range	3775 – 7651	2863 – 44,843	
Median cost of stay in patients without preoperative CT evaluation (n = 113) ($)			
Cost	3549	3368	0.170
Range	2646 – 6737	2430 – 10,474	

CT: Computed tomography

cost associated with LA.[9-15] The perceived higher cost incurred with LA is a major reason why the minimally-invasive approach is not preferred to conventional OA in many institutions. Contrary to this belief, our data actually shows that overall cost incurred was similar between the 2 techniques. One may argue that the increased use of preoperative CT evaluation in the OA group may have inflated overall hospitalisation cost and masked any cost differences between LA and OA. However, even after CT evaluation status was taken into consideration, the overall COS between LA and OA remained comparable (Table 3). This appears counterintuitive since the additional consumables incurred in LA increases overall operating cost when compared to OA. Our findings may be explained by the cost savings from reduction in LOS that could have offset the additional operating costs incurred in LA. Various publications have also revealed that the reduction of time spent away from work with LA may lead to further economic savings which were not assessed in our study.[16,17] Thus, from the perspective of cost analysis, LA appears to be superior to OA.

In terms of comparisons of other outcomes, duration of surgery was significantly longer in LA compared with OA, as is consistent with the findings in other studies.[8,14,18] Wound infection rates and complication rates were, however, similar between the 2 groups in our study. This differs from the data of 3 recent meta-analyses comparing LA and OA, which revealed a lower incidence of wound infection and postoperative complications among patients who received LA.[8,14,18] We acknowledge that, unlike these meta-analyses, our study is likely underpowered to detect these differences between the 2 groups of patients.

There are several limitations resulting from the retrospective nature of our study. Firstly, there were distinct differences in terms of demographic characteristics between the 2 groups of patients (Table 1) which may have confounded findings from comparisons of outcomes (Table 2). This was addressed by performing multivariate analysis, which showed that the outcomes that were significantly different between LA and OA (operative duration and LOS) remained significant after adjusting for these variables. Secondly, patients analysed in the LA group included clinically equivocal cases which were subjected to diagnostic laparoscopy. Ideally, these cases should be excluded from the study as they could have minimal disease which would translate to a shorter LOS. Unfortunately, due to inadequacies in documentation, it is often difficult to identify cases of LA which were performed with the original intent of diagnostic laparoscopy. Thirdly, our study may be underpowered to detect differences such as rates of wound infections and pelvic collections between LA and OA, which the other meta-analyses have managed to show. Nonetheless, we have managed to dispel the notion that LA costs significantly more than OA, as the cost comparison from our study was comparable between the 2 groups. In addition, LA offers the benefit of a shorter LOS compared to OA. Thus, from the perspective of utilisation of healthcare resources, LA appears to be the superior technique.

Conclusion

Compared to OA, LA was associated with a shorter LOS with equivalent cost. It appears superior from the perspective of utilisation of healthcare resources.

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