Comparison of Outcomes between Laparoscopic Appendectomy Versus Open Appendectomy in Children

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บทคัดย่อ: การศึกษาเปรียบเทียบผลการรักษาไส้ติ่งอักเสบ ระหว่างการผ่าตัดส่องกล้องกับการผ่าเปิดหน้าท้องในเด็ก

มนทินี สัปจาตุระ พ.บ.
กลุ่มงานศัลยศาสตร์ โรงพยาบาลตรัง อำเภอเมือง จังหวัดตรัง 9200

ความเป็นมา: ไส้ติ่งอักเสบ เป็นโรคที่พบบ่อยที่สุดทางศัลยกรรมในเด็ก การผ่าตัดไส้ติ่งโดยการผ่าตัดส่องกล้อง เป็นอีกหนึ่งทางเลือกที่ได้รับความนิยมอย่างมาก และมีการทำอย่างแพร่หลายเพิ่มมากขึ้น แต่อย่างไรก็ตาม ในประเทศไทย โรงพยาบาลส่วนใหญ่ยังนิยมทำการผ่าตัดไส้ติ่งโดยผ่าเปิดทางหน้าท้อง มีวัตถุประสงค์เพื่อศึกษาถึงผลการรักษาโรคไส้ติ่งอักเสบในเด็ก โดยการเปรียบเทียบระหว่างการผ่าตัดโดยการผ่าตัดส่องกล้องและผ่าตัดเปิดทางหน้าท้อง หลังจากที่เริ่มทำการผ่าตัดส่องกล้องในเด็ก ตั้งแต่ปีพ.ศ. 2559 ที่โรงพยาบาลตรัง โรงพยาบาลศูนย์ในภาคใต้ของประเทศไทย **วิธีการ:** ทำการศึกษาในผู้ป่วยเด็กที่อายุต่ำกว่า 15 ปีทุกราย ที่เข้ารับการผ่าตัดรักษาไส้ติ่งอักเสบระหว่างเดือนมกราคม พ.ศ. 2559 ถึงเดือนธันวาคม พ.ศ. 2560 โดยเป็นการศึกษาย้อนหลังผู้ป่วยถูกแบ่งเป็น 2 กลุ่มตามผลการวินิจฉัยหลังผ่าตัด เป็นกลุ่มไส้ติ่งอักเสบ (Acute Appendicitis) หรือ AA และกลุ่มไส้ติ่งแตก (Perforated Appendicitis) หรือ PA ผลการรักษาของทั้งสองกลุ่ม นำมาเปรียบเทียบกันโดยใช้ Chi-square test หากค่า p น้อยกว่า 0.05 แสดงว่ามีความแตกต่างอย่างมีนัยสำคัญทางสถิติ งานวิจัยนี้ได้ผ่านการเห็นชอบจากคณะกรรมการวิจัยของโรงพยาบาลตรัง **ผล:** ในช่วงเวลาดังกล่าวมีผู้ป่วยเด็กเป็นโรคไส้ติ่งอักเสบ 256 ราย แบ่งเป็นกลุ่มไส้ติ่งอักเสบ 224 ราย เข้ารับการผ่าตัดส่องกล้อง 30 ราย ผ่าเปิดหน้าท้อง 194 ราย และกลุ่มไส้ติ่งแตก 32 ราย เข้ารับการผ่าตัดส่องกล้อง 5 ราย และผ่าเปิดหน้าท้อง 27 ราย ผลการศึกษาพบว่า ในทั้งสองกลุ่มไส้ติ่งอักเสบและไส้ติ่งแตก การผ่าตัดเปิดหน้าท้องใช้เวลาผ่าตัดน้อยกว่าการผ่าตัดส่องกล้อง (41.2 ± 21.7 นาที เทียบกับ 86.2 ± 27.3 นาที; p-value = 0.001 และ 64.1 ± 31.8 นาที เทียบกับ 100.4 ± 19.4 นาที; p-value = 0.011) นอกจากนี้ทั้ง 2 กลุ่ม มีค่ารักษาพยาบาลในกลุ่มผ่าตัดส่องกล้องแพงกว่ากลุ่มผ่าตัดเปิดหน้าท้อง (17,006.8 ± 7,304.5 เทียบกับ 7,913 ± 1,332 บาท และ 19,310 ± 6,167 เทียบกับ 8,155 ± 2,476 บาท p-value = 0.001) แต่อย่างไรก็ตาม เฉพาะในกลุ่มไส้ติ่งแตก ผู้ป่วยที่ผ่าตัดส่องกล้องมีระยะเวลานอนโรงพยาบาลน้อยกว่ากลุ่มผ่าตัดเปิดหน้าท้อง (6.6 ± 1.3 วัน เทียบกับ 10.4 ± 7.2 วัน; p-value = 0.037) ส่วนเรื่องภาวะแทรกซ้อนหลังผ่าตัด ไม่พบความแตกต่างกันระหว่างการผ่าตัดส่องกล้องและผ่าตัดเปิดหน้าท้องในทั้งสองกลุ่ม แต่แผลผ่าตัดจากการผ่าตัดส่องกล้องมีแผลเป็นที่เรียบเนียน สวยกว่าแผลเป็นจากการผ่าตัดเปิดหน้าท้อง โดยเฉพาะในกลุ่มไส้ติ่งแตก **สรุป:** การผ่าตัดไส้ติ่งโดยวิธีผ่าตัดส่องกล้องมีความปลอดภัย และได้ผลดีโดยเฉพาะในกลุ่มไส้ติ่งแตก จึงควรมีการสนับสนุนและส่งเสริมให้การผ่าตัดไส้ติ่งผ่านการส่องกล้อง เป็นมาตรฐานการรักษาผู้ป่วยเด็กในประเทศไทย

คำสำคัญ: โรคไส้ติ่งอักเสบ โรคไส้ติ่งแตก การผ่าตัดไส้ติ่งแบบเปิดหน้าท้อง การผ่าตัดไส้ติ่งแบบผ่าตัดส่องกล้อง ผลการรักษา ภาวะแทรกซ้อนหลังผ่าตัด

Abstract

Background: Appendicitis is one of the most common surgical emergencies in children. Laparoscopic appendectomy (LA) is an alternative treatment to the classical open appendectomy (OA). Laparoscopy has increased its popularity. However, in Thailand, most hospitals performed only OA. The aim of this study is to compare the outcomes of treatment between LA and OA in children after initialization of pediatric minimally invasive surgery since 2016 at Trang Hospital, a regional hospital in the southern of Thailand. **Methods:** All children under 15 years of age, whom underwent appendectomy at Trang Hospital during Jan 2016 to Dec 2017, were included in this retrospective cohort study. The patients were divided into 2 groups according to their post-operative diagnosis; acute appendicitis (AA) and perforated appendicitis (PA). In each group, the outcome between patients that underwent LA or OA was compared. The outcomes of two groups were compared using the Chi-square test. A p-value less than 0.05 were considered statistically significant. Institutional research board approval was obtained for this study. Results: During the study period, 256 patients underwent appendectomy, 224 patients were classified into AA group, 194 underwent OA and 30 underwent LA. Thirty-two patients were classified into PA group, 27 underwent OA and 5 underwent LA. OA had a shorter operative time than LA in both AA and PA groups (41.2 ± 21.7 vs 86.2±27.3min, p-value = 0.001 and 64.1 ± 31.8 vs 100.4±19.4 min, p-value = 0.011). LA was more expensive than OA in both groups (17,006.8 ± 7,304.5 vs 7,913 ± 1,332 THB and 19,310 ± 6,167 vs 8,155 ± 2,476 THB p-value = 0.001). However for PA, LA had a shorter length of stay than OA (6.6 ± 1.3 days vs 10.4 ± 7.2 days, p-value = 0.037). Both groups had no differences of complications. LA obviously had a more acceptable surgical scar than OA, especially in PA. **Conclusion:** Laparoscopic appendectomy is a safe and effective procedure

for appendicitis especially perforated appendicitis in children. There should be an effort to support and promote laparoscopic appendectomy as standard of care, in order to optimize the pediatric healthcare in Thailand.

Keywords: Acute appendicitis, Perforated appendicitis, Open appendectomy, Laparoscopic appendectomy, Outcomes of treatment, Postoperative complication

Introduction

Appendicitis is one of the most common surgical emergencies in children.[1] Laparoscopic appendectomy (LA) is an alternative treatment to the classical open appendectomy (OA). LA was first described in 1983.[2] The use of laparoscopy has increased popularity from about 20% in 1998 to 70% in 2007.[3-5] At the present, LA in children is worldwide, feasible and safe.[6] However, in Thailand, most hospitals performed only OA. The aim of this study is to compare the outcomes of treatment between LA and OA in children after initialization of pediatric minimally invasive surgery since 2016 at Trang Hospital, a regional hospital in the southern of Thailand.

Materials and Methods

All children under 15 years of age, whom underwent appendectomy at Trang Hospital during January 2016 to December 2017, were included in this retrospective cohort study. The patients were divided into 2 groups according to their post-operative diagnosis; acute appendicitis (AA) and perforated appendicitis (PA). In each group, the outcome between patients that underwent LA or OA was compared. The followings patient data were collected for analysis: demographic data, operative time, length of stay, cost, cosmetics (surgical scar) and complications. The complications were defined as early postoperative complications that meant complication during admission, and late postoperative complications which meant complication within 2-4 weeks after discharge. The outcomes of both groups were compared using the Chi-square test. A p-value less than 0.05 are considered statistically significant. Institutional research board approval was obtained for this study.

Surgical technique

OA was typically performed using transverse right lower quadrant incision. The appendix was delivered through the incision, mesoappendix was divided, and appendix was double ligated using two 2-0 silk sutures then removed. In perforated appendicitis, a Penrose drain was left through the incision for drainage and all layers of the incision were closed. The drain was shortened and removed within 5-7 days post operation.

LA was performed using three-port technique. The patient was positioned supine. After insertion of a 10-12 mm umbilical cannula via open technique, pneumoperitoneum was established using 8-12 mmHg of insufflation pressure. Two 5 mm ports were placed at the left lower quadrant and the suprapubic area (Fig 1). The mesoappendix was divided using electrocautery. The appendiceal stump was secured with two 2-0 Polypropylene suture (Prolene® ETHICON) ligatures and cauterized (Fig 2). The appendix was removed through the umbilical port. In perforated appendicitis, abdominal washing was thoroughly done and no drain was required.

Figure1 Laparoscopic approach

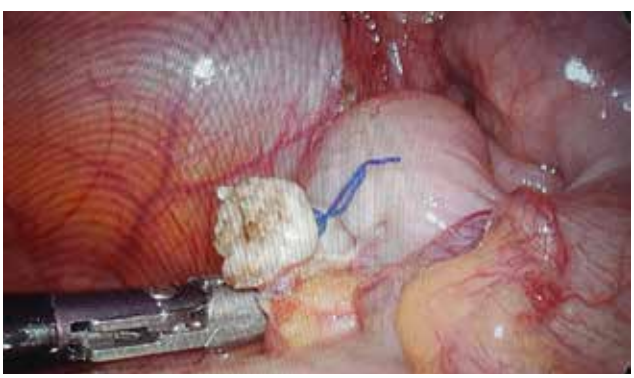

Figure 2 The stump was secured, appendix was cut and then the stump was cauterized

Results

Demographic data

During the study period, 256 patients underwent appendectomy which 224 patients were classified into acute appendicitis (AA) group and 32 patients were classified into perforated appendicitis (PA) group. In AA group, 194 underwent OA and 30 underwent LA. As for PA group, 27 underwent OA and 5 underwent LA (Fig.3). There were no cases of LA that required conversion to OA.

According to patient age (Table1), in AA group, the mean age of OA and LA were 9.8 ± 3.0 years (range 2-14 years) and 10 ± 2.4 years (range 6 - 14 years). In PA group, mean age of OA

and LA were 8.0 ± 3.6 years (range 1-14 years) and 9.4 ± 1.5 years (range 7 - 11 years). There was no significant difference between patient age in both groups (p-value 0.331 VS 0.326).

There was also no significant difference between the genders of both groups (p-value 0.811 VS 0.900).

Most of all patients had no underlying diseases. Except in AA group, 1 patient had asthma and 2 had morbid obesity. There was no significant difference between both groups.

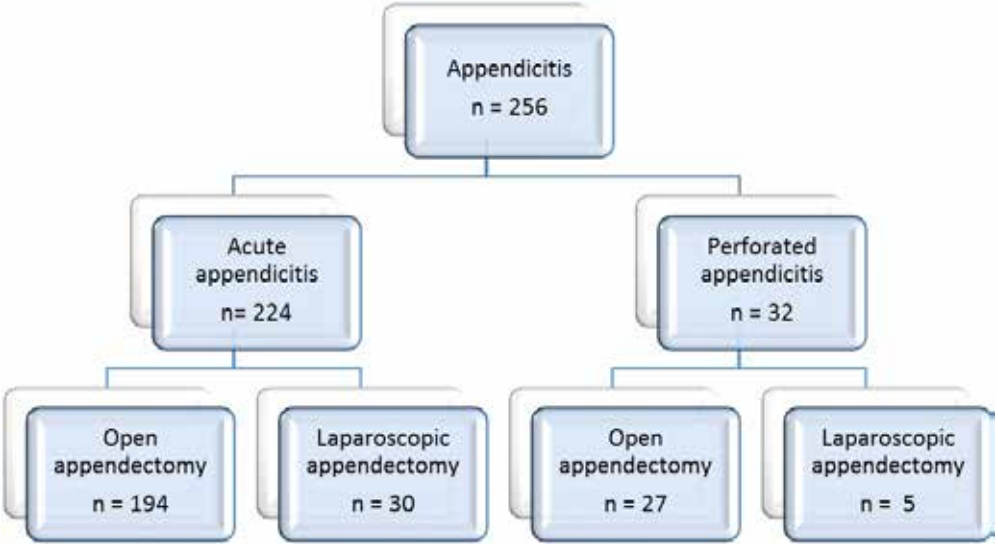

Figure 3 Schematics for treatment of 256 patients with appendicitis.

Table 1 Demographic data

	AA (n = 224)		p-value	PA (n = 32)		p-value
	OA (n = 194)	LA (n = 30)		OA (n = 27)	LA (n = 5)	
Gender						
male : female	108 : 86	16 : 14	0.811	17 : 10	3 : 2	0.900
ratio	1.3 : 1	1.1 : 1		1.7 : 1	1.5 : 1	
Age						
< 8 years	41 (21.1%)	4 (13.3%)		12 (44.4%)	1 (20%)	
8 - 12 years	108 (55.7%)	21 (70%)		12 (44.4%)	4 (80%)	
> 12 years	45 (23.2%)	5 (16.7%)		3 (11.2%)	0	
Mean	9.8 ± 3	10 ± 2.4	0.331	8.0 ± 3.6	9.4 ± 1.5	0.326
Underlying disease						
No	191 (98.5%)	30 (100%)		27 (100%)	5 (100%)	
Yes	3 (1.5%)	0	0.790	0	0	N/A

Operative time

The mean operative time in AA group for OA and LA were 41.2 ± 21.7 min and 86.2 ± 27.3 min (Table2). The OA had a significant shorter operative time than LA (p-value 0.001). As for PA group, the mean operative time for OA and LA were 64.1 ± 31.8 min and 100.4 ± 19.4 min. The OA also had a significant shorter operative time than LA (p-value 0.011).

Table 2 Operative time

Operative time	AA (n = 224)		p-value	PA (n = 32)		p-value
	OA (n = 194)	LA (n = 30)		OA (n = 27)	LA (n = 5)	
< 30 min.	74 (38.1%)	0		0	0	
30 - 60 min.	90 (46.4%)	5 (16.6%)		15(55.6%)	0	
61 - 90 min.	19 (9.8%)	10 (33.4%)		8(29.6%)	1 (20%)	
91 - 120 min.	7 (3.6%)	8 (26.6%)		2 (7.4%)	3 (60%)	
> 120 min.	4 (2.1%)	7 (23.4%)		2 (7.4%)	1 (20%)	
Min - Max	15 - 140	45 - 150		32 - 167	70 - 124	
Mean	41.2 ± 21.7	86.2 ± 27.3	0.001	64.1 ± 31.9	100.4 ± 19.4	0.011

Length of Stay (LOS)

In AA group, the mean LOS for OA and LA were 3.1 ± 1.6 days and 3.33 ± 1.5 days (Table3). There was no significant difference between both groups (p-value 0.133). In contrast with the PA group, the mean LOS for LA (6.6 ± 1.3 days) was significantly shorter than OA (10.4 ± 7.2 days) (p-value 0.037) (Fig 4).

Table 3 Length of stay

Length of stay	AA (n = 224)		p-value	PA (n = 32)		p-value
	OA (n = 194)	LA (n = 30)		OA (n = 27)	LA (n = 5)	
< 4 day	153 (78.9%)	20 (66.7%)		0	0	
4 - 7 days	36 (18.6%)	10 (33.3%)		6 (22.2%)	4(80%)	
8 - 14 days	5 (2.5%)	0		18 (66.7%)	1 (20%)	
>14 days	0	0		3 (11.1%)	0	
Min - Max	2 - 12	2 - 7		5 - 38	6 - 9	
Mean	3.1 ± 1.6	3.3 ± 1.5	0.113	10.4 ± 7.2	6.6 ± 1.3	0.037

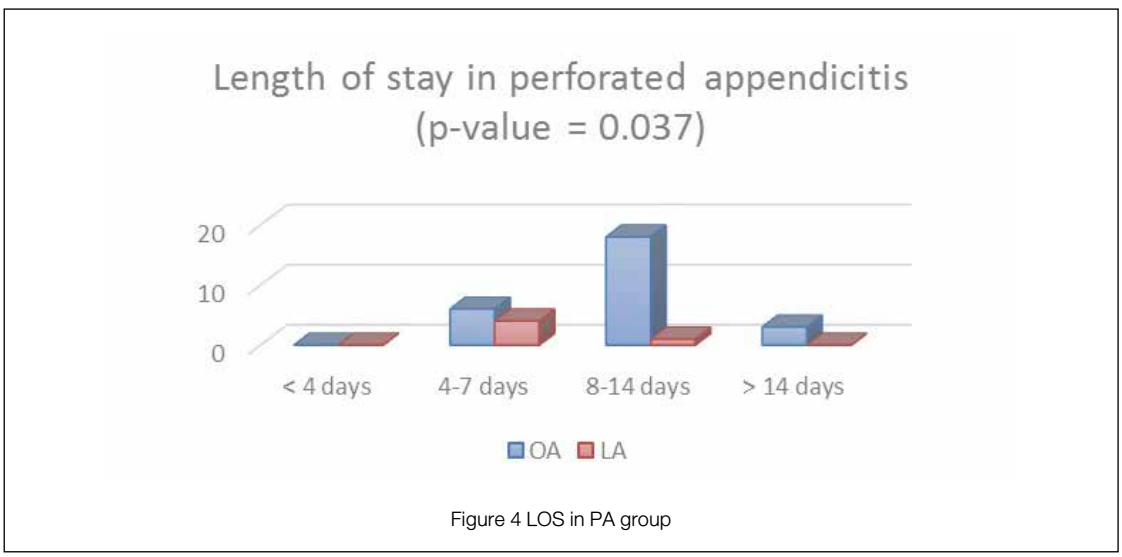

Figure 4 LOS in PA group

Hospital cost (Thai baht THB)

In AA group, OA had the mean hospital cost at 7,913 ± 1,332 THB compared to 17,006 ± 7,304 THB (Table 4) for LA. As for PA group, OA had the mean hospital cost at 8,155 ± 2,476 THB compared to 19,310 ± 6,167 THB for LA. Both groups had significantly lower hospital cost for OA than LA (p-value 0.001).

Table 4 Hospital cost

Hospital cost (THB)	AA (n = 224)		p-value	PA (n = 32)		p-value
	OA (n = 194)	LA (n = 30)		OA (n = 27)	LA (n = 5)	
< 8,000	122 (62.9%)	4 (13.3%)		17 (63%)	1 (20%)	
8,000 - 15,000	68 (35.1%)	3 (10%)		10 (37%)	1 (20%)	
15,001 - 20,000	1 (0.5%)	4 (13.3%)		0	1 (20%)	
>20,000	3 (1.5%)	19 (63.4%)		0	2 (40%)	
Min - Max	5,286-10,287	6,900-24,338		5,277-24,772	6,900-28,273	
Mean	7,913.6 ± 1,332.4	17,006.8 ± 7,304.5	0.001	8,155.6 ± 2,476.1	19,310 ± 6,167	0.001

Complications

The overall complication rate was 10% for AA group and up to 40% for PA group. Surgical site infection (SSI) was the most common complication. Three patients in PA group required postoperative ICU care due to septicemia prior admission. There were no deaths in either groups.

Early postoperative complications

In AA group, the complications after OA were 1% bowel ileus, 0.5% intraabdominal collection and 0.5% minor small bowel injury that was repaired intraoperatively (Table 5), in opposition to LA which had no complications. There was no statistical difference. As for PA group, there were more complications after OA; 11.8% SSI, 8.8% intraabdominal collection, and 5.9% bowel ileus, differ than LA which had no complications. However, there also was no statistical difference.

Only one patient required re-operation. An underlying morbid obesity patient from the PA group which underwent OA, developed SSI then had wound dehiscent which had a re-operation for facial closure and another minor operation for wound re-suturing. He was discharge later uneventfully.

Late postoperative complications

In AA group, patients whom underwent OA 8.2% had SSI, 3.7% had abdominal discomfort and 1.5% had intestinal obstruction. There was a slight higher SSI rate at 11.5% for patients whom underwent LA. The umbilical area was the only site that was infected. However, there was no statistical difference. In PA group, there were more complications after OA as well, 18.5% SSI, 6% intestinal obstruction and granulation tissue at the incision compared to LA which was found to have only minor abdominal discomfort. However there also was no statistical difference. For all cases of intestinal obstruction required re-admission, it was managed conservatively and all patients were discharged home uneventfully. None of the remaining patients with late complications required re-admission.

Table 5 Complications

Complications	AA group		p-value	PA group		p-value
	OA	LA		OA	LA	
Early Complications	N = 194	N = 30		N = 27	N = 5	
Surgical site infection	0	0	N/A	4 (11.8%)	0	0.358
Bowel ileus	2 (1%)	0	0.576	2 (5.9%)	0	0.530
Intraabdominal collection	1 (0.5%)	0	0.693	3 (8.8%)	0	0.434
Small bowel injury	1 (0.5%)	0	0.693	0	0	N/A
UTI	0	0	N/A	1 (2.9%)	0	0.662
HAP	0	0	N/A	1 (2.9%)	0	0.662
	N = 135	N = 26		N = 27	N = 5	
Late Complications	11 (8.2%)	3 (11.5%)	0.494	5 (18.5%)	0	0.284
Surgical site infection	1 (0.7%)	0	0.657	0	0	N/A
Bowel ileus	2 (1.5%)	0	0.529	2 (7.4%)	0	0.521
Intestinal obstruction	1 (0. 7%)	0	0.657	2 (7.4%)	0	0.521
Granulation tissue at incision	5 (3.7%)	0	0.315	1 (3.7%)	1 (20%)	0.178
Abdominal discomfort						

Remark: UTI - Urinary tract infection, HAP - Hospital Acquired Pneumonia

Cosmetics

Laparoscopic appendectomy obviously had a more acceptable surgical scar than open appendectomy especially in perforated appendicitis. (Fig 5)

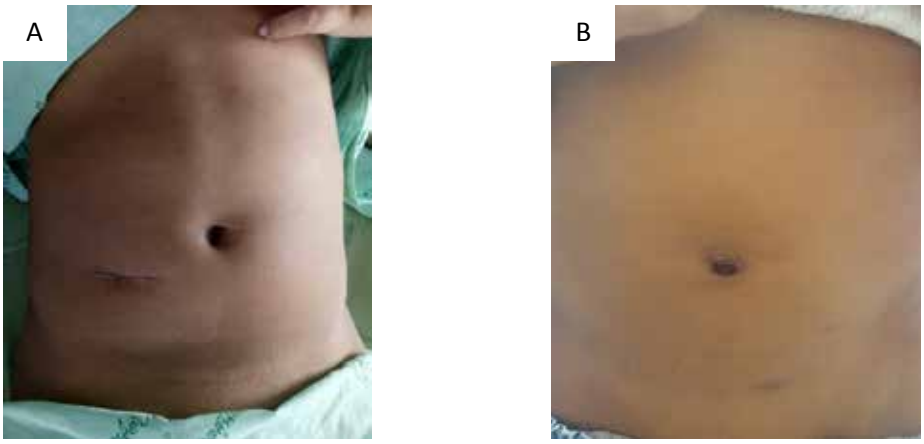

Figure 5 Surgical scar, open approach in PA group (A) and laparoscopic approach in PA group (B)

Discussion

Since 1983 laparoscopic appendectomy has gain its popularity. It is now the standard treatment of appendicitis for both adults and children in many developed countries. For decades, there have been many studies comparing the outcomes of OA versus LA which concluded that LA is associated with shorter hospitalization and earlier return to routine activity.[3-5,7] Other studies have favored to LA because of improved decreased postoperative pain, shorter recovery time, and lower rate of SSI.[12-13,14-19] More recent studies proposed that LA in children is superior to OA about SSI, cosmetics and intestinal obstruction in the long term period.[3-5,8-10] Unfortunately, LA has not gained widespread acceptance in all pediatric surgery centers especially in Thailand. Only a few hospitals have the capability to perform the procedure due to lack of pediatric laparoscopic surgeons, proper pediatric size equipment and health insurance coverage.

In this study, for acute appendicitis, OA significantly had different outcomes compared to LA. A shorter operative time and lower cost same as previous studies. However, for perforated appendicitis, LA is significantly superior to OA in terms of shorter LOS. This is the result of a smaller wound with no drain which reduced post operative pain and contributed to an easier and earlier ambulation. The shorter LOS and faster recovery helps decrease the risk of hospital acquired pneumonia (HAP) and urinary tract infection (UTI) despite there was no statistical difference of the complications post OA and LA in this group. Also the shorter LOS has impact on the hospital bed turnover rate and bed occupancy which is vital for Trang Hospital since the bed occupancy is over 100%.

All the patients that underwent surgery for both acute and perforated appendicitis were discharged home safely. There was no conversion from LA to OA. As for the complications, this study showed a higher rate of overall complications, 10% in acute appendicitis and 40% in perforated appendicitis. Compared to 3% and 25% from a study conducted in Japan by Hitochi et al.[20] The higher rate of overall complications was the result from the higher rate of SSI in late postoperative complications. Even though SSI was the most common complication, the overall SSI rates were 6% in acute appendicitis and 26% in perforated appendicitis which were within standard guidelines of SSI rate according to wound types.[21] There was no significant difference of SSI between OA and LA in both groups. The key factor contributing to SSI in late postoperation, was the improper wound care and poor hygiene as most of these patients live in remote areas with low socioeconomic status which was quite challenging to access medical services. There was 30% loss to follow-up in the acute appendicitis group which also affects the results.

For laparoscopic appendectomy, the overall complication rate was 11% for acute appendicitis and 20% for perforated appendicitis which was quite high compared to 3% and 16% from Masoomi et al in 2012.[5] However, there were no early postoperative complications found in this study. The complications were late postoperative complications, only SSI was found in the AA group and minor abdominal discomfort was found in the PA group. This was different than other studies that found SSI less than 1% for AA group and up to 16% for PA group, postoperative intraabdominal collection less than 1% for AA group and 15-20% for PA group[22] and intestinal obstruction developed 1% for AA group and 2-3% in PA group.[9] There were no cases of intraabdominal collection or intestinal obstruction in this study, despite of no statistical difference between OA and LA. This is the result of lower numbers of laparoscopic appendectomy cases and a 12% lost to follow-up rate in the AA group.

About cost and effectiveness, although laparoscopic appendectomy was 2.5 times significantly more expensive than OA, the operative cost could be reduced with reusable laparoscopic equipment in the future. The cosmetics results were great in all cases of laparoscopic appendectomy especially in perforated

appendicitis cases compared to open appendectomy scars. This was one of most appreciable issue to all parents of these children.

Limitation of this study is small sample size especially patients whom underwent laparoscopic appendectomy. This is because of the lack of laparoscopic equipment. Larger study with longer follow-up should be conducted.

Conclusion

Laparoscopic appendectomy is a safe and effective procedure for appendicitis especially perforated appendicitis in children. There should be an effort to support and promote laparoscopic appendectomy as standard of care, in order to optimize the pediatric healthcare in Thailand.

Acknowledgement

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