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Original Article

Appendectomy: Outcomes at Suratthani Hospital

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Abstract

Background: **Appendectomy is commonly encountered by general surgeon. Also quite common are perforated appendicitis and negative appendectomy, which are undesirable outcomes of appendectomy.**

Objective: **To evaluate the outcomes of appendectomy at Suratthani Hospital and summarize atypical pathological results with discussion of appropriate management.**

Material and Methods: **A retrospective review was performed of patients who underwent appendectomy for appendicitis form January 2013 to December 2013. Patient demographics, operative characteristic, pathologic diagnosis and surgical outcomes were analyzed.**

Result: **The overall negative appendectomy rate was 20.5%. Female patients conferred an independent risk for a higher negative appendectomy rate than male (26.4% vs 13.7%; $p < 0.001$). The overall perforation rate was 19.9% (male 23.2% vs female 16.5%; $p = 0.013$). Preoperative imaging was associated with rate for perforated appendicitis ($p < 0.001$) and was not associated with lower negative appendectomy ($p = 0.344$). Multivariate analysis suggested that WBC count and PMN percentage associated of negative appendectomy. The duration of symptom, the body temperature and PMN percentage of patients with perforated appendicitis were higher than in those without perforation. Only 3.1% of the appendectomy specimens contained other appendiceal pathologies. Neoplastic appendiceal lesion was 0.37%.**

Conclusion: **Advances in diagnosis and surgical technique may be altering traditionally accepted rate of perforated appendicitis and negative appendectomy. Lower WBC count and lower PMN percentage shown are related to the rate of negative appendectomy. Duration of symptom, body temperature and higher PMN percentage are associated with perforated appendicitis.**

Keywords: **Appendectomy, appendicitis**

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Introduction

Appendectomy is the most common emergency condition in general surgical operation. In Suratthani Regional Hospital alone, there are approximately three cases per day. Worldwide lifetime rate of appendectomy is 12% for men and 25% for women, with approximately 7% of all people undergoing appendectomy for acute appendicitis during their lifetime[1]. Despite the increased use of imaging modalities, biochemical marker, and scoring system, the rate of misdiagnosis and appendiceal rupture remained constant[1]. Since typical presentations are only encountered in about 60% of the patients, accurate preoperative diagnosis has long been a great challenge, even to experienced surgeons. While studies are still ongoing to investigate how to improve the diagnostic accuracy, certain unexpected or unusual lesions of the appendix may warrant further clinical attention or follow-up. This study reviewed appendectomies for presumed acute appendicitis over one year period of Suratthani Regional Hospital. We set out to determine the incidences and relationships of various pathological findings of appendectomy to different demographic characteris-tics. A review of various studies of appendectomies was also performed.

Objectives

To study the appendectomies at Suratthani Regional Hospital, categorize and summarizethe symptoms, laboratory results, atypical pathological results with discussion of appropriate management and to improve current management of suspected acute appendicitis patients.

Patients and Methods

Patients in this retrospective study were recruited from Suratthani hospital which is a regional hospital as well as a tertiary referral center. The records of all those who underwent open appendectomy from one January 2013 to 31 December 2013 for presumed acute appendicitis were retrieved from the hospital database. All those who had appendectomy performed on non-emergency basis or as a part of other surgical procedures (e.g. right hemicolectomy for carcinoma of the caecum and incidental appendectomy) were excluded. The records of 1,079 patients were retrieved and medical notes, operative records, and pathology reports were reviewed. The diagnosis of acute appendicitis was done by infiltration of polymorphs in the muscularispropria of the appendix. Perforation was defined either intra-operatively by surgeon, or described in the pathology report. Periappendicitis, fibrous obliteration and serositis were regarded as negative appendectomies. We define the reproductive age-group as female aged 11 to 50 years, and the extreme age as being younger than 10 years or older than 70 years. Categorical variables were compared using the Chi-square test while continuous variables were compared using t-test. We defined the significance level of statistical analysis as $p < 0.05$.

Results

Study population

During 1 year period, there were 1,079 emergency appendectomies. There were 503 males and 576 females in the study population (Figure 1 and 2). The most common age group at appendectomy was 10 to<20

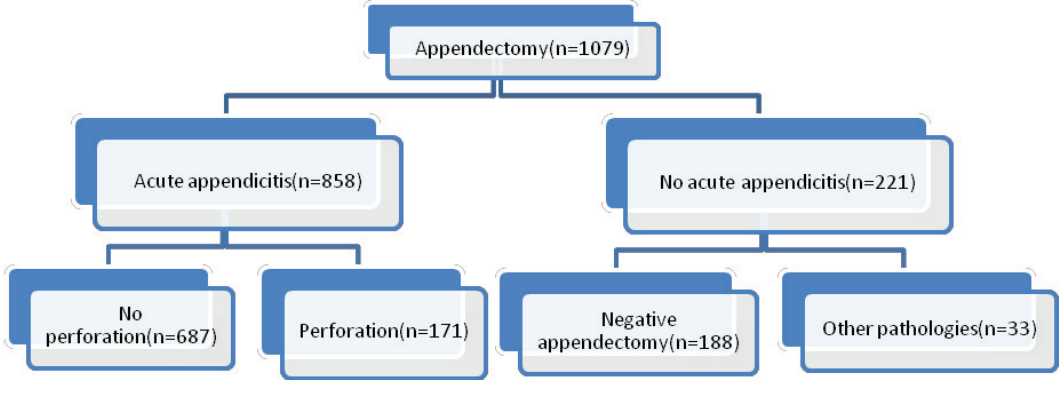

Figure 1 Categorization of the patients

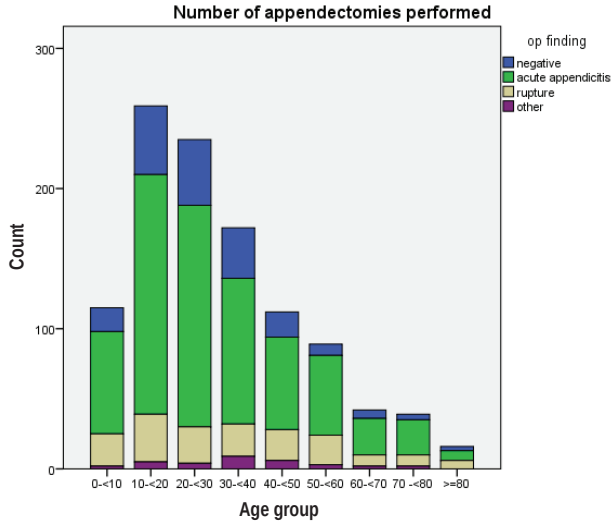

Figure 2 Number appendectomy performed according to age group

years (24%). This was followed by patients in their third and fourth decades of life, accounting for 21.8% and 15.9%, respectively (Table 1).

Acute appendicitis

There were 858 patients (79.5%) with pathologically confirmed acute appendicitis; 434 were male and 424 were female, giving sex ratio of 1 to 0.97. The mean age of the patients with acute appendicitis was 31.24 ± 19.41 (standard deviation) years,which is composed of: male 28.9 ± 19.28, female 33.64 ± 19.28. The age ranged from 1 month to 91 years. The histopathological finding of acute appendicitis was highest in the sixth decade of life, followed by those in their eighth and first decades of life, at 87.6%, 84.6%, and 83.5%, respectively (Table 1).

Table 1 Incidence of acute appendicitis according to age

			Acute appendicitis		Total
			No	Yes	
Age group	0-<10	Count	19	96	115
		% within age group	16.5	83.5	100.0
		% within Acute appendicitis	8.6	11.2	10.7
	10-<20	Count	54	205	259
		% within age group	20.8	79.2	100.0
		% within Acute appendicitis	24.4	23.9	24.0
	20-<30	Count	51	184	235
		% within age group	21.7	78.3	100.0
		% within Acute appendicitis	23.1	21.4	21.8
	30-<40	Count	45	127	172
		% within age group	26.2	73.8	100.0
		% within Acute appendicitis	20.4	14.8	15.9
	40-<50	Count	24	88	112
		% within age group	21.4	78.6	100.0
		% within Acute appendicitis	10.9	10.3	10.4
	50-<60	Count	11	78	89
		% within age group	12.4	87.6	100.0
		% within Acute appendicitis	5.0	9.1	8.2
	60-<70	Count	8	34	42
		% within age group	19.0	81.0	100.0
		% within Acute appendicitis	3.6	4.0	3.9
	70 -<80	Count	6	33	39
		% within age group	15.4	84.6	100.0
		% within Acute appendicitis	2.7	3.8	3.6
	≥ 80	Count	3	13	16
		% within age group	18.8	81.3	100.0
		% within Acute appendicitis	1.4	1.5	1.5
Total		Count	221	858	1079
		% within age group	20.5	79.5	100.0
		% within Acute appendicitis or rupture	100.0	100.0	100.0

Perforation rate

In the 858 patients with confirmed acute appendicitis, the overall perforation rate was 19.9% (23.2% in male vs. 16.5% in female; $p = 0.013$). When comparing the perforation rate in different age groups, patients in extreme age group were more likely to have perforation (26.1% vs. 18.7%; $p = 0.051$).

Negative appendectomy rate (NAR)

Overall, 221 appendixes were normal, making the overall NAR 20.5%; 13.7% in male and 26.4% in female ($p < 0.001$). The age group with highest NAR is 30 to <40 years. This age group has NAR = 26.5%, followed by the 20 to < 30 age group (21.7%) and then the 40 to < 50 group (21.4%). Notably, female patients of reproductive age (11-50 years) had a higher NAR than those in the non-reproductive age group (28.8% vs. 19.6%; $p = 0.032$).

Lengths of hospital stay (LOS)

The median LOS was 3 (range: 1-27) days. The mean LOS of perforated and non-perforated appendicitis was 5.17 ± 3.64(standard deviation) days and 2.16 ± 1.30 days($p < 0.001$). The mean LOS of negative appendectomy and acute appendicitis was 2.94 ± 2.15 and 3.12 ± 2.24 days ($p = 0.086$).

Preoperative imaging

Preoperative imaging was performed in 6% of the patients (4.5% in NAR and 6.4% in acute appendicitis; $p = 0.344$). A total of 6.4% of patients received preoperative imaging (4.1% in non-perforated and 15.8% in perforated appendicitis; $p < 0.001$).

Table 2 Characteristics of the patients according to negative and positive appendectomy status

	Positive appendicitis or not	N	Mean	Std. Deviation	Std. Error Mean	Sig.
Duration of symptom (days)	Negative	188	1.436	0.9708	0.0708	
	Appendicitis + perforated	858	1.403	0.9701	0.0331	0.674
Preoperative imaging or not	Negative	188	0.03	0.161	0.012	
	Appendicitis + perforated	858	0.06	0.245	0.008	0.010
WBC (*10^9/L)	Negative	188	12.5179	4.62148	0.33706	
	Appendicitis + perforated	858	15.4442	5.56074	0.18984	<0.001
PMN (%)	Negative	188	69.649	14.1936	1.0352	
	Appendicitis + perforated	858	78.332	10.9137	0.3726	<0.001
TEMP(°C)	Negative	188	37.207	0.7324	0.0534	
	Appendicitis + perforated	858	37.450	0.8311	0.0284	<0.001
PULSE (beats/min)	Negative	188	90.670	18.2867	1.3337	
	Appendicitis + perforated	858	93.033	39.2676	1.3406	0.212

Table 3 Group Statistics in non-perforated and perforated appendicitis

	Op finding	N	Mean	Std. Deviation	Std. Error Mean	Sig.
Duration of symptom (days)	Acute appendicitis	687	1.239	0.6166	0.0235	
	Perforated	171	2.064	1.6311	0.1247	<0.001
Preoperative imaging or not	Acute appendicitis	687	0.04	0.198	0.008	
	Perforated	171	0.16	0.366	0.028	<0.001
WBC (*10^9/L)	Acute appendicitis	687	15.2689	5.56139	0.21218	
	Perforated	171	16.1488	5.51825	0.42199	0.064
PMN (%)	Acute appendicitis	687	77.495	11.2408	0.4289	
	Perforated	171	81.695	8.7386	0.6683	<0.001
TEMP (°C)	Acute appendicitis	687	37.359	0.7719	0.0294	
	Perforated	171	37.816	0.9537	0.0729	<0.001
PULSE (beats/min)	Acute appendicitis	687	90.651	18.0371	0.6882	
	Perforated	171	102.602	79.6576	6.0916	<0.001

Clinical factors and laboratory findings

Table 2 and 3 summarize clinical factors and laboratory findings of patients. From Table 2, the negative appendectomy group had lower white blood cell count (WBC*10^9/Litre), percentage of neutrophils (PMN %), and body temperature on admission (TEMP °C) than the acute appendicitis group ($p < 0.001$). Table 3 showed that in the perforated appendicitis group, duration of symptom, preoperative imaging, PMN (%), TEMP (°C) and pulse rate on admission (PULSE beats/min) was higher than the non-perforated appendicitis group ($p < 0.001$).

Table 4 Univariate analysis of factors associated with negative appendectomy rate

		Sig.	Odds ratio	95% C.I. for Odds ratio	
				Lower	Upper
Step 1	Age	0.138	1.007	0.998	1.015
	Sex	0.000	2.131	1.527	2.974
	Duration of symptom (day)	0.674	0.967	0.827	1.131
	Preoperative imaging	0.053	2.507	0.990	6.350
	WBC (*10^9/L)	<0.001	1.150	1.105	1.197
	PMN (%)	<0.010	1.056	1.042	1.069
	TEMP (°C)	<0.001	1.495	1.206	1.853
	PULSE (beats/min)	0.390	1.004	0.995	1.012

Variables entered on step 1: age, sex, duration of symptom, preoperative imaging, WBC, PMN, TEMP, and PULSE.

Table 5 Univariate analysis of factors associated with perforated appendicitis

		Sig.	Odd ratio	95% CI for Odds ratio	
				Lower	Uppe
Step 1	Age	0.022	1.010	1.001	1.018
	Sex	0.014	1.534	1.092	2.154
	Duration of symptom (day)	<0.001	2.232	1.836	2.714
	Preoperative imaging	<0.001	4.413	2.524	7.714
	WBC (*10^9/L)	0.070	1.026	0.998	1.056
	PMN (%)	<0.001	1.044	1.024	1.064
	TEMP (°C)	<0.001	1.867	1.531	2.276
	PULSE (beats/min)	<0.001	1.017	1.008	1.026

Variables entered on step 1: age, sex, duration of symptom, preoperative imaging, WBC, PMN, TEMP, and PULSE.

Table 6 Multivariate analysis of different factors associated with negative appendectomy

		Sig.	Odd ratio	95% CIfor Odds ratio	
				Lower	Upper
Step 1[a]	Age	0.040	1.010	1.000	1.020
	Sex	0.000	1.886	1.324	2.687
	Duration of symptom (day)	0.662	0.959	0.795	1.157
	Preoperative imaging	0.164	2.016	0.752	5.403
	WBC (*10^9/L)	<0.001	1.087	1.039	1.137
	PMN (%)	<0.001	1.033	1.018	1.049
	TEMP (°C)	0.060	1.254	0.990	1.587
	PULSE (beats/min)	0.647	0.999	0.994	1.004
	Constant	0.012	0.000		

a. Variables entered on step 1: age, sex, duration, preoperative imaging, WBC, PMN, TEMP, and PULSE.

Table 7 Multivariate analysis of different factors associated with perforated appendicitis

		Sig.	Odd ratio	95% C.I.for Odd ratio	
				Lower	Upper
Step 1[a]	Age	0.002	1.016	1.006	1.027
	Sex	0.007	1.706	1.157	2.515
	Duration of symptom (day)	<0.001	2.236	1.774	2.818
	preoperative imaging	0.149	1.669	0.832	3.351
	WBC (*10^9/L)	0.331	1.018	0.982	1.055
	PMN (%)	0.000	1.041	1.018	1.065
	TEMP (°C)	0.000	1.535	1.209	1.948
	PULSE (beats/min)	0.136	1.009	0.997	1.021
	Constant	<0.001	0.000		

a. Variables entered on step 1: age, sex, duration, preoperative imaging, WBC, PMN, TEMP, and PULSE

Univariate analyses of different factors

The patients with normal appendix had significant lower mean WBC, PMN, and TEMP ($p < 0.001$). The patients with perforated appendicitis had significant higher mean duration of symptom, PMN, TEMP, PULSE, and percentage of preoperative imaging ($p < 0.001$) (Table 4 and 5).

Multivariate analyses of different factors

Patients with negative appendectomy had lower mean WBC and PMN ($p < 0.001$). Patients with perforated appendicitis had a higher mean duration of symptom, PMN and TEMP ($p < 0.001$) (Table 6, 7).

Table 8 Final diagnosis other than acute appendicitis

Mucinous adenocarcinoma	2
Neuroendocrine tumor (NET G1)	2
Ruptured corpus luteal cyst	9
Pelvic inflammatory disease	3
Renal calculi with hydronephrosis	2
Acute pancreatitis	1
Xanthogranulomatous inflammation	1
Remnant of Omphalomesenteric duct	1
Acute pyelonephritis	1
Ectopic pregnancy	1
Cecal diverticulitis	2
Gall stone, common bile duct stone	1
Diverticulitis of appendix	1
Lymphoma	1
Pneumonia	1
Urinary tract infection	1
Dysmenorrhea	1
Endometriosis	1
Spontaneous bacterial peritonitis	1

Table 9 Post-operative complication

Surgical site infection	50
Intra-abdominal collection	8
Pulmonary complication	7
Small bowel obstruction	4
DKA	1
Sepsis	1
Wound dehiscence	1
Acute MI	1
Hematoma	1

Final diagnosis other than acute appendicitis

Appendiceal pathology other than acute appendicitis was found in 33 patients, making an overall percentage of 3.1%. The majority of these were gynecologic condition. There were 4 neoplastic appendiceal lesions (2 carcinoid tumor and 2 adenocarcinoma), making an overall percentage of 0.37% (Table 8).

Post-operative complications

Complication rate in this study was 6.5% (NAR =3.2%, acute appendicitis =7.2%; $p = 0.049$). A total of 24% of patients with perforated appendicitis had complications compared to only 3.1% of those with non-perforated appendicitis ($p < 0.001$). Most common post-operative complication was surgical site infection. One patient (0.09%) died from sepsis (Table 9).

Discussion

The current study showed that the incidence of acute appendicitis was highest in the 10-30 year-old patients. This result is similar to the result of a study by

Addis DG et al.[2]. The mean age of patients with appendicitis from this study is 31.24 years, with male-female ratio of 1:0.97, similar to results of a study by Flum DR et al.[3]. Negative appendectomy and perforation of an inflamed appendix are the two main adverse outcomes in management of suspected acute appendicitis, having an impact on both length of stay in the hospital and cost of treatment. The patients with perforated appendicitis have significantly longer length of stay than the patients with non-perforated appendicitis. Although this is simple logic, the decision to operate or not is always a challenge even for a senior surgeon.

The quoted NAR was 15-25%, but could be as high as 40% in female patients[4-6]. The overall NAR from the study was 20.5%, which was in the expected range. Since the appendix is in close proximity to the reproductive organ in females, many common gynecological conditions can masquerade as acute appendicitis, this accounts for their higher NAR.

The overall rate of perforated appendicitis was 25.8%. Children and patients older than 70 years had the highest rate of perforation (45-51%)[4,7]. From our study, the overall perforation rate was 19.9% (23.2% in male vs 16.5% in female, $p=0.013$). Patients of extreme age (youngest or oldest) were more likely to have perforation, which may be because of a delayed diagnosis, due to atypical presentations and less efficient communication.

Preoperative imaging has been advocated to minimize the chance of a negative appendectomy. Some studies even suggested that routine preoperative imaging could reduce the NAR[8,9], but others showed in the contrary[10,11]. In this study, preoperative imaging was performed in 6% of all cases, and the fraction of cases with preoperative imaging conducted was similar for both the negative appendectomy patients and the acute appendicitis patients. But this study did not look into the group of patients that received preoperative imaging that discharged without an operation. So we cannot conclude that preoperative imaging helps reduce negative appendectomy rate. However, we found and were preoperative imaging was performed more frequently for the patients with perforated appendicitis than for the patients with non-perforated one. This may be because perforated appendicitis patients displayed symptoms and we wanted to discover whether they had perforated appendicitis or other diseases. The author of this study does not favor the practice of routine preoperative imaging because:

1) It could never replace taking thorough historical and physical examinations.

2) It may overload the Radiology department with abdominal pain patients, which may lead to delayed treatment and hence an increased chance of perforation.

We suggest that preoperative imaging be offered more liberally to female, reproductive (age-range) group and patients of extreme age.

In patients with acute appendicitis, we found that temperature elevation is rarely above 1 ˚C and pulse rate is normal or slightly elevated. Leukocytosis range from 10,000 - 18,000 cell/mm^3 is usually present in patients with acute appendicitis and is often accompanied by a PMN predominance[12,13]. But in the current study, only the values for WBC and PMN showed significant difference between the group of patients with negative appendectomy and the group with acute appendicitis. Comparing the perforated appendicitis group with the non-perforated group, we found that the duration of symptoms, PMN and temperature showed significance difference (Table 6, 7).

In our study, 3.1% of the patients had other pathologies, most of them are gynecological conditions. There were 4 cases (0.37%) with neoplastic appendiceal lesion, which is comparable to the rate quoted in the literature (0.3-0.9%)[14,15].

Mortality from appendicitis in the United States has steadily decreased from a rate of 9.9 per 100,000 in 1939 to 0.2 per 100,000 today. Overall mortality rate for acute appendicitis with rupture is approximately 1%. The mortality rate for elderly with ruptured appendicitis is higher (5%). Death is usually attributed to uncontrolled sepsis-peritonitis or intra-abdominal abscess.

The complication rates of acute appendicitis and ruptured appendicitis were 7.2 and 24%, respectively. There was 1 death from septicemia (0.09%). Complications occurred in 3% of the non-perforated appendicitis group, but were much more frequent in the perforated group (47%). Wound infection was the most common complication but most confined to the subcutaneous tissue and could be treated by prompt wound drainage[16].

Conclusion

Appendectomy continues to be a common surgical procedure. Precautions should be taken to prevent wrong diagnosis of appendicitis (i.e. negative appendectomy) especially in:

1) Females of reproductive age
2) Patients with no fever
3) Low WBC and low PMN percentage

For the patients in the following groups, we should suspect that they have a perforated appendicitis:

1) Patients of extreme age (young or old)
2) Patients with high fever and high PMN percentage
3) Patients with prolonged illness

Preoperative imaging is recommended for female patients of reproductive age and patients of extreme age.

In this study, we have looked into a significant number of cases of appendectomy at Suratthani Regional Hospital, and investigated the different outcomes of appendectomy (acute, perforated, negative, etc. and associated complications) and the patient groups most vulnerable to these conditions. We expect this study will be helpful to surgeons, providing them with the knowledge to solve problems they may encounter, especially perforation in certain patient groups. We also suggest the recommendations that will likely reduce the number of costly negative appendectomies.

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บทคัดย่อ **ผลการผ่าตัดไส้ติ่ง ของโรงพยาบาลสุราษฎร์ธานี**

ปณิธาน สื่อมโนธรรม, พ.บ.

กลุ่มงานศัลยกรรม โรงพยาบาลสุราษฎร์ธานี จังหวัดสุราษฎร์ธานี

ที่มาและความสำคัญ: การผ่าตัดไส้ติ่ง เป็นการผ่าตัดที่พบบ่อยของศัลยกรรม แต่ปัญหาที่สำคัญในการผ่าตัดไส้ติ่ง คือผลการผ่าตัด พบว่าไส้ติ่งปกติ และ ไส้ติ่งอักเสบที่แตกแล้ว จึงเป็นที่มาของการศึกษานี้

วัตถุประสงค์: ทบทวนการรักษา และผลการรักษาไส้ติ่งอักเสบที่ได้รับการผ่าตัด ในโรงพยาบาลสุราษฎร์ธานี โดยเปรียบเทียบดูปัจจัยต่าง ๆ ของผู้ป่วย

วัสดุและวิธีการ: เป็นการศึกษาย้อนหลัง โดยศึกษาในผู้ป่วยทุกรายที่ได้รับการผ่าตัดไส้ติ่ง และมีผลชิ้นเนื้อร่วมด้วยทุกราย ระหว่าง เดือนมกราคม ค.ศ. 2013 ถึง เดือนธันวาคม ค.ศ. 2013 โดยเก็บข้อมูลตั้งแต่ก่อนผ่าตัด ระหว่างผ่าตัด และหลังผ่าตัด รวมทั้งผลการรักษา

ผลการศึกษา: จำนวนผู้ป่วยที่ผ่าตัดไส้ติ่งแล้วพบว่าไส้ติ่งปกติ 20.5% ผู้ป่วยเพศหญิงพบว่าว่าไส้ติ่งปกติมากกว่าเพศชาย (26.4% กับ 26.4%; $p = 0.001$) จำนวนผู้ป่วยที่พบว่าไส้ติ่งอักเสบและแตก พบ 19.9% (ชาย 23.2%, หญิง 16.5%; $p = 0.01$) การตรวจทางรังสีวิทยาก่อนผ่าตัดสัมพันธ์กับการพบภาวะไส้ติ่งอักเสบแตก ($p < 0.001$) แต่ไม่สัมพันธ์กับการพบว่าไส้ติ่งปกติ ($p = 0.344$) ความสัมพันธ์ที่พบว่าผ่าตัดแล้วไส้ติ่งปกติ คือ เม็ดเลือดขาวและ ร้อยละนิวโทรฟิลต่ำ ความสัมพันธ์ที่พบภาวะผ่าตัดแล้วไส้ติ่งแตก คือ ระยะเวลาอาการนาน มีไข้ และร้อยละนิวโทรฟิลสูง ($p < 0.001$) พบผลชิ้นเนื้อและโรคที่ไม่เกี่ยวข้องกับไส้ติ่ง 3.1% พบภาวะที่เป็นเนื้องอกบริเวณไส้ติ่ง 0.37%

สรุป: การศึกษานี้ ปัจจัยที่พบว่าเกี่ยวข้องกับภาวะไส้ติ่งปกติ คือ เม็ดเลือดขาว และร้อยละ นิวโทรฟิลต่ำ ปัจจัยที่พบว่าเกี่ยวข้องกับภาวะไส้ติ่งอักเสบแตก คือ ระยะเวลาอาการนาน มีไข้ และร้อยละนิวโทรฟิลสูง