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Negative appendectomy rate in King Chulalongkorn Memorial Hospital

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Introduction : *Acute appendicitis is the most common acute abdominal condition that needs surgical intervention. Two primary adverse outcomes which are perforated appendicitis and negative appendectomy must be balanced in management of presumed appendicitis.*

Objective : *To determine negative appendectomy rate, diagnostic accuracy and perforation rate in King Chulalongkorn Memorial Hospital (KCMH); and to find out the factors influencing negative appendectomy rate.*

Setting : *King Chulalongkorn Memorial Hospital*

Research design : *Retrospective descriptive study*

Patients : *All adult patients (age $\geq$ 15 years) underwent appendectomy from January 2004 to March 2005 at KCMH. Incidental appendectomy and interval appendectomy were excluded.*

Methods : *Medical records, operative notes, imaging records and pathologic reports of 541 patients (238 males, 303 females) were reviewed. Factors that might influence the negative appendectomy rate were recorded and analyzed.*

Results : *Overall negative appendectomy rate was 8.5 %, diagnostic accuracy was 91.1 % and 20.3 % had perforated appendices. Female gender, absence of migratory pain and leukocyte count < 15,000/mm^3 are factors influencing negative appendectomy.*

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Conclusions : *Negative appendectomy rate and perforation rate in KCMH were acceptable. Physicians of patients who were at risk of negative appendectomy must be cautious while making the diagnosis. Clinical judgment bases on clinical information and basic laboratory data is still an essential and valuable role in the management of patients with suspected appendicitis.*

Keywords : *Appendicitis, Appendectomy, Negative appendectomy.*

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พิเชษฐ์ วัฒนไพโรจน์รัตน์, ศุภฤกษ์ ปรีชายุทธ. อัตราการผ่าตัดไส้ติ่งแล้วไม่พบพยาธิสภาพของไส้ติ่งในโรงพยาบาลจุฬาลงกรณ์. จุฬาลงกรณ์เวชสาร 2550 เม.ย; 51(4): 217 - 28

วัตถุประสงค์ : *เพื่อหาอัตราการผ่าตัดไส้ติ่งแล้วไม่พบพยาธิสภาพของไส้ติ่งในโรงพยาบาลจุฬาลงกรณ์ อัตราการแตกของไส้ติ่งอักเสบ รวมถึงหาปัจจัยต่าง ๆ ที่มีผลต่ออัตราการผ่าตัดไส้ติ่งแล้วไม่พบพยาธิสภาพของไส้ติ่ง*

วัสดุและวิธีการ : *เป็นการศึกษาย้อนหลังจากเวชระเบียนผู้ป่วยที่ได้รับการวินิจฉัยว่าเป็นไส้ติ่งอักเสบ และเข้ารับการผ่าตัดไส้ติ่งที่โรงพยาบาลจุฬาลงกรณ์ ระหว่างเดือนมกราคม 2547 ถึงเดือนมีนาคม 2548*

ผลการรักษา : *อัตราการผ่าตัดไส้ติ่งแล้วไม่พบพยาธิสภาพของไส้ติ่งเท่ากับร้อยละ 8.5 ความแม่นยำในการวินิจฉัยภาวะไส้ติ่งอักเสบเท่ากับร้อยละ 91.1 อัตราการแตกของไส้ติ่งอักเสบเท่ากับร้อยละ 20.3 ปัจจัยที่มีผลต่ออัตราการผ่าตัดไส้ติ่งแล้วไม่พบพยาธิสภาพของไส้ติ่ง ได้แก่ ผู้ป่วยเพศหญิง การไม่มีการย้ายที่ของอาการปวดท้องและระดับเม็ดเลือดขาวในเลือดน้อยกว่าหรือเท่ากับ 15,000/ลูกบาศก์มิลลิเมตร*

สรุป : *อัตราการผ่าตัดไส้ติ่งแล้วไม่พบพยาธิสภาพของไส้ติ่ง และอัตราการแตกของไส้ติ่งอักเสบในโรงพยาบาลจุฬาลงกรณ์อยู่ในเกณฑ์ที่ยอมรับได้ แพทย์ควรใช้ความระมัดระวังในการวินิจฉัยไส้ติ่งอักเสบในผู้ป่วยบางกลุ่ม ที่มีความเสี่ยงต่อการวินิจฉัยไส้ติ่งอักเสบผิดพลาด*

คำสำคัญ : *ไส้ติ่งอักเสบ, การตัดไส้ติ่ง, อัตราการผ่าตัดไส้ติ่ง.*

Acute appendicitis is the most common acute abdominal condition that needs surgical intervention, the crude annual incidence of acute appendicitis is about 11 per 10,000 people per year.[1,2] Despite a lifetime cumulative risk of developing acute appendicitis is nearly 7 %[1] , the diagnosis remains a challenge. The risk of two primary adverse outcomes must be balanced in the management of presumed appendicitis: perforation or ruptured appendix, and misdiagnosis or negative appendectomy. Acceptable negative appendectomy rate is around 10 - 15 %.[3] In general, the less the negative appendectomy rate is, the more the ruptured rate will be due to late diagnosis. The use of investigation (ultrasonography and CT scan) has lowered the negative appendectomy rate in some series. This study is designed to determine negative appendectomy rate, diagnostic accuracy and perforation rate at King Chulalongkorn Memorial Hospital (KCMH) and to find out factors influencing negative appendectomy rate.

Materials and Methods

Study design

Retrospective descriptive study.

Patients

During a 15-month period from January 2004 to March 2005, all adult patients (age > 15 years) who underwent appendectomy due to preoperative diagnosis of acute appendicitis at KCMH were included. Incidental appendectomy and interval appendectomy cases were excluded. Also, pediatric patients (age < 15 years) were not included in this study. Medical records, operative notes, imaging records and pathologic reports were retrospectively reviewed. Conventionally, the preoperative diagnosis of appendicitis at KCMH was made by surgical residents and staff according to clinical assessments and laboratory data. The imaging studies (ultrasonography and CT scan) were used in equivocal cases. The factors that might influence negative appendectomy rate which included age, sex, underlying disease of the patients, presence of pregnancy, duration of pain, atypical presentations (defined as no migratory pain, no anorexia, no fever or no leukocytosis) were recorded and analyzed in this study. The atypical presentations used in this study were taken from parameters used in Alvarado's score.

Definitions

Diagnostic accuracy (DA) was defined as the percentage of removed appendices with a histologic diagnosis of acute appendicitis from the total number of performed appendectomies.

Negative appendectomy rate was defined as the percentage of removed appendices without diagnosis of acute appendicitis from the total number of performed appendectomies.

Perforation rate was defined as the proportion of perforated appendices of all patients with diagnosis of acute appendicitis.

Histology

All specimens were routinely examined morphologically, and intraoperative findings were recorded in operative notes. Definite diagnosis of acute appendicitis was confirmed by pathologic report. Perforated appendicitis was diagnosed according to intraoperative findings by the surgeon. Nonperforated appendicitis was defined as an inflamed

appendix without evidence of macroscopic perforation.

Statistical methods

Statistical analysis was carried out with SPSS for Windows version 12.0. Data were reported as diagnostic accuracy, negative appendectomy rate and perforation rate. Categorical variables were assessed for a significant association with negative appendectomy and perforation for the entire cohort. For demographic subgroups considered to be at higher risk were calculated and compared using Chi square test.

Multivariable analysis was performed by using binary logistic regression model. This model considered negative appendectomy and perforation as response variables; and sex, age group, duration of abdominal pain, atypical presentations (no migratory pain, no fever, no anorexia and no leucocytosis) as predictor variables when other variables are controlled. P-values less than 0.05 were considered significant. Adjusted odd ratios were calculated from this model to express the predictive power of a variable. The adjusted odd ratio of a negative result indicates the decrease in the odds of appendicitis that is associated with a negative result. Also, adjusted odd ratio of perforation result indicates how much a perforation result will increase the odds of ruptured appendicitis.

Results

From January 2004 to March 2005, a total of 541 patients underwent appendectomy for presumed acute appendicitis at KCMH (238 males; 303 females) which median age was 28 years (average age 32.5 years, ranged 15 - 89 years old) with male to female ratio of 1:1.3. The demographic data are shown in table 1. Most patients (79.3 %) were 15-40 years old. Pathologic confirmation of the presence or absence of appendicitis was available in 539 cases (99.6 %). Incomplete medical records were found in 25 cases (3 %). In female patients, 9 cases were pregnant during the treatment period.

The diagnosis of acute appendicitis was confirmed in 91.1 % (493/541) of the patients, negative appendectomy rate was 8.5 % (46/541), 79.7 % (393/493) had acute non-ruptured appendicitis and 20.3 % (100/493) had ruptured appendicitis (Table 2). Women were significantly more likely to have negative appendectomy than men (12.5 % vs. 3.4 %; $p < 0.001$). Negative appendectomy rate was no significantly different among women of reproductive age (15 - 50 years) and non reproductive age (>50 years) (12.8 % vs. 10.9 %; p= 0.37). Also, perforation rate of male and female patients were comparable (19.1% vs. 21.3 %; p= 0.5). Highest negative appendectomy rate (18.2 %) was found in women older than 70 years. Patients whose age was between 51 to 60 years had the highest perforation rate (33.3 %). Age-specific distribution of patients with acute appendicitis and perforated appendicitis are shown in table 3. Perforation rate was low in the younger age group (15 - 40 years) and higher in the older age group (> 40 years) (Fig.1). Diagnostic accuracy and perforation rate of appendicitis in different gender and age groups are presented in figure 2.

Of the negative appendectomy patients, 56.5 % (26/46) had specific diagnoses, including Meckel's diverticulitis, hematologic malignancy, perforated duodenal ulcer, infected VP shunt, pneumatosis cystoides intestinalis, cecal diverticulitis, enteritis, acute pancreatitis and gynecological diseases (Table 4), whereas the remaining 43.5 % (20/46) had no specific diagnosis.

Table 1. Demographic data of patients undergoing appendectomy.

	Male	Female	Overall
Total, n (%)	238 (44 %)	303 (56 %)	541
Age (years)			
Mean	33.3	31.4	32.5
Age groups, n			
15-20	57	59	116
21-30	74	106	180
31-40	66	67	133
41-50	18	25	43
51-60	12	20	32
61-70	6	15	21
>70	5	11	16
Underlying diseases			
• Diabetes mellitus	4	7	11
• Hypertension	13	17	30
• Cardiovascular disease	3	6	9
• Respiratory disease	6	2	8
• Neurological disease	5	5	10
• GI disease	4	5	9
• KUB disease	5	5	10
• Gynecological disease	-	9	9
• HIV infection	5	-	5
• Others	7	22	29
Pregnancy	-	9	9
Imaging			
• Ultrasound	2	8	10
• CT-scan	3	1	4
No pathology report	-	2	2
Incomplete medical records	1	7	8

Table 2. Diagnostic accuracy, negative appendectomy rate and perforation rate of patients underwent appendectomy at KCMH.

Parameters, *n* (%)	**Male**	**Female**	**Overall**
Diagnostic accuracy	230 (96.6 %)	263 (86.8 %)	493 (91.1 %)
Negative appendectomy	8 (3.4 %)	38 (12.5 %)	46 (8.5 %)
Perforation rate	44 (19.1 %)	56 (21.3 %)	100 (20.3 %)

Table 3. Age-specific distribution of patients with acute appendicitis by grading of perforation and no perforation (n = 493).

Age	Non-perforated		Perforated		Total	
(years)	No.	%	No.	%	No.	%
15-20	93	84.5	17	15.5	110	100
21-30	137	86.2	22	13.8	159	100
31-40	99	81.1	23	18.9	122	100
41-50	29	70.7	12	29.3	41	100
51-60	18	66.7	9	33.3	27	100
61-70	10	50	10	50	20	100
>70	7	50	7	50	14	100
Total	393	79.7	100	20.3	493	100

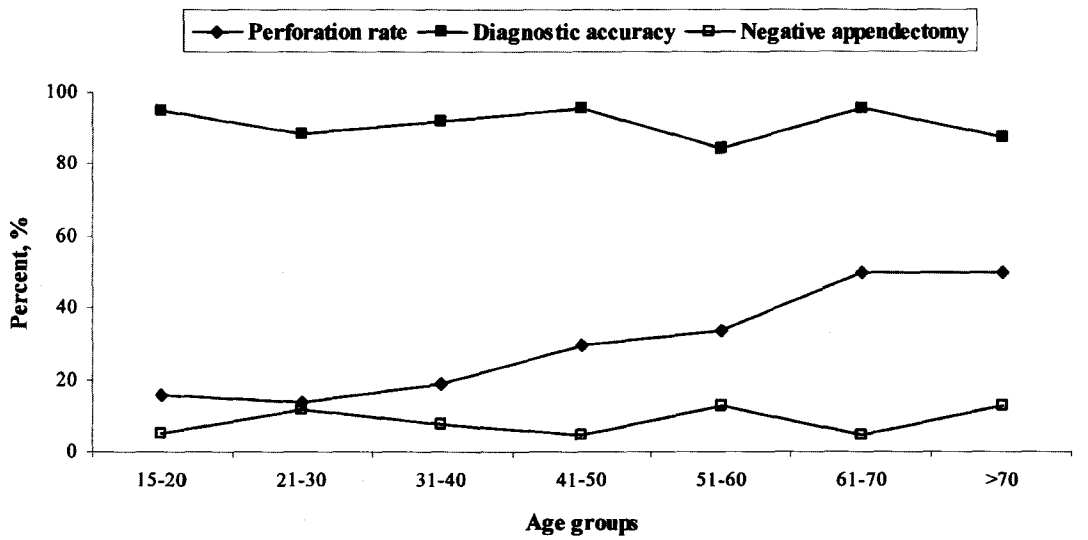

Figure 1. Perforation rate, diagnostic accuracy and negative appendectomy rate in different age groups.

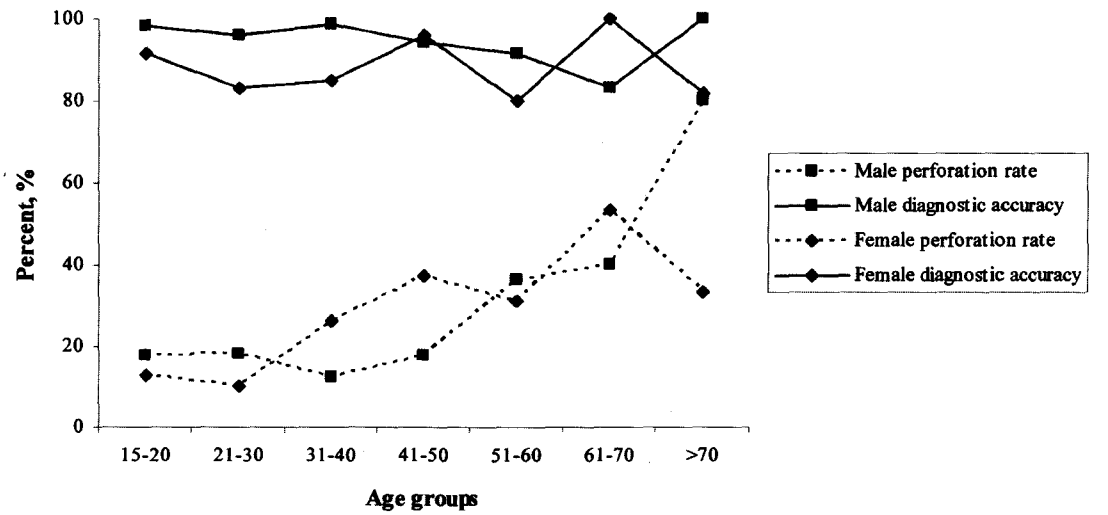

Figure 2. Diagnostic accuracy and perforation rate of appendicitis performed in KCMH by different gender and age groups.

Table 4. Definitive diagnosis in negative appendectomy by different genders.

Etiology in male group	Total
Meckel's diverticulitis	1
Perforated duodenal ulcer	1
Infected VP shunt	1
Hematologic malignancy	1
No specific diagnosis	4
Total	8(3.4 %)

Etiology in female group	Total
Gynecological causes	17
Enteritis	2
Cecal diverticulitis	1
Pneumatosisi cystoids intestinalis	1
Acute pancreatitis	1
No specific diagnosis	6
Total	38(12.5 %)

Negative appendectomy was more likely in female patients, with adjusted odd ratio of 1.506 to 7.487 ($p = 0.003$). Appendicitis was unlikely when migratory pain was absent, with adjusted odd ratio of 1.218 to 4.515 ($p = 0.011$). White blood cell count was also an important predictor, as shown by adjusted odd ratio 1.729 to 12.514 ($p = 0.002$) for low white blood cell count. Details are presented in table 5.

In the positive appendectomy group, perforated appendicitis was more likely in patients who presented with high grade fever (> 38.5 ^{o}C), with adjusted odd ratio 3.090 to 12.721 ($p < 0.001$). Also, presentation with an onset of abdominal pain more than 72 hours before admission was an important predictor of perforated appendicitis, with adjusted odd ratio 2.099 to 18.434 ($p = 0.001$). Advanced age (> 50 years) was relatively a strong predictor of perforated appendicitis, with adjusted odd ratio 2.631 to 10.652 ($p < 0.001$). Anorexia was also a significant predictor of perforated appendicitis, with adjusted odd ratio 1.108 to 4.021 ($p = 0.02$). Adjusted odd ratio of each significant variable was presented in table 6.

In equivocal cases, imaging studies were performed in 14 of 541 total patients (2.6 %). Four patients were investigated with CT-scan (3 males and 1 female). Ten patients were investigated with ultrasonography (2 males and 8 females). In CT-scan group, all male patients had true positive results (3/3). In contrast, 1 female patient had false negative result.

Table 5. Factors influencing the negative appendectomy.

	Adjusted OR	*P*
Female sex	3.357(1.506, 7.487)	0.003
No migratory pain	2.345(1.218, 4.515)	0.011
WBC (x 10^3/ml)		
10-15	4.652(1.729, 12.514)	0.002
> 15	2.114(0.821, 5.444)	0.121

Values in parentheses are 95 percent confidence intervals. OR, odd ratio; WBC, white blood cell count.

Table 6. Factors influencing the perforated appendicitis.

	Adjusted OR	*P*
Body temperature (°C)		
37.8-38.5	2.447 (1.368, 4.377)	0.003
>38.5	6.269 (3.090, 12.721)	<0.001
Duration (hours)		
12-24	1.192 (0.619, 2.297)	0.600
25-48	3.870 (1.808, 8.281)	<0.001
49-72	2.302 (0.845, 6.275)	0.103
>72	6.220 (2.099, 18.434)	0.001
Anorexia	2.111 (1.108, 4.021)	0.023
Age (years)		
31-50	1.686 (0.968, 2.937)	0.065
>50	5.294 (2.631, 10.652)	<0.001

Values in parentheses are 95 percent confidence intervals. OR, odd ratio.

In the ultrasound group, all male patients had true positive result (2/2). In contrast, 3 female patients had false negative result. All equivocal 14 patients who were investigated with imaging studies and underwent appendectomy were diagnosed appendicitis histologically.

Discussion

The acceptable negative appendectomy rate in the literatures is around 10 - 15 %. However, debate continues concerning the acceptable negative appendectomy rate and whether an inverse relationship exists between negative appendectomy rate and perforation rate. [3] In our study, the overall negative appendectomy rate of 8.5 % was lower than previous studies, and overall perforation rate of 20.3 % which was comparable. [4-7] (Table 7) The diagnosis of appendicitis in KCMH was generally made by clinical information which included history, physical examination and laboratory data.

"Alvarado's score" in diagnosis of acute appendicitis was impressive. The scoring system based on three symptoms (migratory pain, anorexia, vomiting), three signs (RLQ tenderness, rebound tenderness, elevation of temperature) and two laboratory findings (leukocytosis, shift to the left of neutrophils). Although this scoring system provides a high degree of sensitivity and specificity (sensitivity 95.2 % and specificity 81.3 %)[8], but it had false positive rate (negative appendectomy) 12.6 % that still be higher than clinical diagnosis in this study. The factors influencing the negative appendectomy rate in this study were female patient, no migratory pain and leukocyte count $\leq$ 15,000/mm^3.

The perforation rate was known to increase in extreme age patients, HIV infected patients and pregnancy. In this study, the factors influencing the perforation rate were fever, prolonged abdominal pain, anorexia and patients age > 50 years.

Table 7. Studies analyzing the clinical and laboratory diagnosis of appendicitis in patients with suspected appendicitis.

References	Year	No. of patients	Perforation (%)
Albu et al.[10]	1994	56	6 (23.1)
Andersson et al.[11]	1999	496	28 (14.4)
Bolton et al.[12]	1975	100	8 (17.4)
Dueholm et al.[13]	1989	204	8 (13.6)
Fenyo et al.[14]	1997	1167	65 (16.6)
Hallan et al.[15]	1997	257	25 (25.5)
Izbicki et al.[16]	1992	150	2 (3.7)
Jahn et al.[17]	1997	222	15 (16)
John et al.[18]	1993	111	11 (20)
Thimsen et al.[19]	1989	70	8 (28.6)
Colson et al.[6]	1997	659	185 (30.9)
Present study	2007	541	100 (20.3)

Anorexia nearly always accompanies appendicitis, but in this study, patients with true appendicitis had anorexia 75 % (366/488). Surprisingly, we found that anorexia was a factor that associated with perforated appendicitis.

Sensitivity, specificity of imaging studies were not presented in this study due to too small number of patients underwent imaging study. Recently, Flum[9] reported low sensitivity of CT/US (74.2 %), and although a positive test was highly predictive of appendicitis (positive predictive value 95.1 %), the tests were frequently negative in the setting of an early appendicitis (11.7 % for CT and 30.5 % for US). The tests were also frequently positive when no appendicitis was found at appendectomy.

Despite the rapid growth of CT/US in general practice, there has been no improvement in diagnostic accuracy. Flum suggested that decisions on the use of CT/US for presumed appendicitis should be individualized based on the test performance at that center. He also questioned the routine use of CT/US for diagnosis of appendicitis and emphasized the need of test benchmarking before establishing protocols of diagnostic management.

Although many imaging studies are now available, good history taking and physical examination still remain the basis for diagnosing the patients with suspected appendicitis.[20,21] All clinical and laboratory variables are weak discriminators individually, but Andersson[22] demonstrated that they achieved a high discriminatory power for appendicitis when the variables were combined. The challenge to the surgeon is to prevent appendiceal perforation by early operation in cases of true appendicitis. However, at the same time they should make diagnosis with sufficient specificity to avoid unnecessary negative appendectomy that rather had significant clinical and cost implications. Recently, Flum showed that an

estimated $741.5 million per year in total hospital charges were resulted from admissions in the USA which negative appendectomy was performed. [23]

Conclusion

In our hospital where the diagnosis of appendicitis was made by clinical evaluation, negative appendectomy rate and ruptured rate were acceptable. In certain groups of patients who were at risk of negative appendectomy, including female gender, no migratory pain and leucocyte count $\leq$ 15,000/mm^3, the physicians must be cautious in making the diagnosis of appendicitis, and imaging studies may be helpful. Clinical judgment based on clinical information and basic laboratory data are more important than imaging study results; they still have essential and valuable roles in the management of patients with suspected appendicitis.

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