Vigorous Wound Irrigation Followed by Subcuticular Skin Closure in Children with Perforated Appendicitis

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Background: *Although various protocols for the treatment of children with perforated appendicitis have been established, no one has cited incisional wound irrigation in detail.*
Material and Method: *The records of 69 children undergoing appendectomy for perforated appendicitis between 2004 and 2006 were reviewed. Wound irrigation prior to skin closure using 1-2 liters of normal saline was routinely performed in every case. The treatment protocol includes preoperative and postoperative antibiotic, early appendectomy, copious intraabdominal swab, vigorous wound irrigation and subcuticular skin closure. Either peritoneal lavage or transperitoneal drainage is omitted.*
Results: *Mean patients' age was 8.7 years, 47.8% were girls and there was no death. Subcutaneous fat thickness averaged 1.3 cm. Mean duration of hospitalization was 5.8 days. Of 69 appendectomies, 47 had simple perforation and 22 developed complicated perforation. There were four post-op complications (5.8%). Two patients had very small seroma at the lateral margin of incision, which resolved without additional treatment. One boy developed adhesion obstruction and enterocutaneous fistula, postoperatively. The patient required reoperation and recovered uneventfully. Only one child had wound infection.*
Conclusion: *Vigorous wound irrigation followed by subcuticular skin closure for perforated appendicitis yields an acceptable outcome with low rate of wound complications.*

Keywords: *Perforated appendicitis, Wound irrigation, Wound infection*

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Presently, the protocolization for the treatment of perforated appendicitis from most series reported in literature has nearly reached the conclusion. They have agreed that intravenous antibiotics should be given at the time the diagnosis is made and continue until the temperature declination[1,2]. Pediatric surgeons generally perform emergency appendectomy. However, a few surgeons perform the operation later when phlegmon or mass is palpable on examination[3-6]. Appendectomy is carried out at right lower transverse skin crease incision with or without inversion of appendiceal stump. Although transperitoneal drainage with silicones or penrose drains are helpful, they are not routine practice[7,8]. In case of patients with generalized pus or intraperitoneal reaction fluid, most surgeons are likely to perform copious lavage of the peritoneal cavity[6,9-12]. Some series included an implementation of wound irrigation into their treatment protocols but without details[9,10]. After operation, abdominal skin is closed primarily with various techniques of suture, particularly subcuticular suture with absorbable materials[6,9,10,13]. With these protocols, the authors have reported the rates of wound infection between 1.8-11%.

According to the authors experience of performing vigorous wound irrigation with normal saline and followed by primary subcuticular wound closure in cases with perforated appendicitis, the authors have a compelling result. The protocol is

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devoid of either peritoneal drainage or lavage. The aim of the present study was to review the surgical outcomes in the treatment of the presented pediatric patients with perforated appendicitis under this treatment protocol.

Material and Method

From June 2004 to date, the authors established a treatment protocol for emergency appendectomy at Buddhachinaraj Hospital, School of Medicine, Phitsanulok. Between June 2004 and July 2006, 208 children with acute appendicitis had been treated under the protocol. Of these patients, 69 had perforated appendicitis. Data were collected on demographic information, present illness, physical examination, laboratory findings, operative records, hospital course, pathologic results and development and treatment of complications. All technical terms of symptoms and signs, macroscopic pathology and wound complications were well defined. The details of treatment protocol were described as follows.

When diagnosis of acute appendicitis was made, the patients were treated by emergency appendectomy. A single dose of 10 mg/kg metronidazole and 5 mg/kg gentamicin were given intravenously, preoperatively. In the operating theatre, the patients were laid on the table in the recumbent position undergoing general anesthesia. The operation site was scrubbed with povidone-iodine followed by painting with povidone-iodine solution without shaving. Sterile cloth towels were utilized as usual. Transverse skin crease incision at McBurney point and appendix removal by doubly ligated technique with 2-0 silk suture without inversion of appendiceal stump were performed in all cases. In case of patients with non-perforated appendicitis, appendectomy was done with a scalpel and the appendiceal stump was cleaned with pure phenol and 70% alcohol solution, respectively. At this point, special care must be taken to avoid incisional contamination by the appendiceal stump. Peritonization and muscular sheath approximation with 3-0 polyglactin suture were then performed. One or two stitches of subcutaneous fat with 5-0 polyglactin suture and subcuticular skin closure with the remaining 5-0 polyglactin suture were completed respectively.

If perforated appendicitis was encountered, appendiceal stump cleansing was unnecessary. Intra-abdominal swabbing using 4 x 4 sterile gauzes was performed copiously until the last gauze was devoid of debris or purulent discharge. After muscular sheath approximation with 3-0 polyglactin suture, subcutaneous fat thickness was measured by measuring distance between sheath surface and incisional skin using sterile ruler. Vigorous wound irrigation using 60 mL bulb syringe with approximately 1,000 mL for subcutaneous fat thickness below 1.5 cm and 2,000 mL for thickness above 1.5 cm was then carried out. From that time, all contaminated instruments and gloves were discarded and new cloth towels were used to cover the surgical field. In addition, new instruments including a sterile needle holder, Adson's tooth-forceps, scissors, 5-0 polyglactin and gloves were utilized for abdominal skin closure. Subcutaneous fat and skin management were the same as the technique for non-perforated appendicitis. Transperitoneal drainage and peritoneal lavage were not used in the present study. Either purulent collection or intraabdominal reaction fluid was managed by suction and swabbing with dry gauzes until satisfactory without sending for culture and sensitivity as routinely performed by some authors[14,15].

Postoperatively, the patients were hospitalized for at least four days or until the temperature declined. Trophic feeding was gradually stepped up. After declination of temperature, antibiotics were switched into oral route for take-home medication for seven days. Any complications were detected at the ward and again at the time of follow-up (approximately 2 weeks after discharge). All data are expressed as mean and SD.

Results

Two hundred and eight pediatric patients with appendicitis underwent emergency appendectomy during this period. All of them had pathological proof. In cases in which the pathology report revealed normal were excluded from the present study. Of these, 69 had appendicitis with perforation. There were 36 (52.2%) females and 33 (47.8%) males with an average age of 8.7 $\pm$ 2.9 years (range, 3 to 14 years) and weight of 26.2 $\pm$ 12.5 kg (range, 11 to 64 kg). The average duration of abdominal pain prior to admission was 2.1 $\pm$ 1.6 days (range, 1 to 10 days). The demographic characteristics with respect to present illness and physical examination are summarized in Table 1. All of the children had right lower quadrant (RLQ) pain. Fever, nausea or vomiting, and anorexia were common, except for diarrhea, which represented only 42.0% of all cases. One hundred per cent did have McBurney sign and the second most frequency was rebound tenderness. The mean white blood cell count was 18,487 $\pm$ 5,560 WBC/mL (range, 5,630 to 31,900 WBC/mL) with an average neutrophil

Table 1. Demographic information with respect to patients' present illness and physical examination

	Number (n = 69)	Percentage
Present illness		
RLQ pain	69	100
Fever	67	97.1
Nausea or vomiting	62	89.9
Anorexia	56	81.2
Diarrhea	29	42
Physical examination		
McBurney sign	69	100
Rebound tenderness	65	94.2
Guarding	52	75.4
Cutaneous hyperesthesia	48	69.6
Rovsing sign	40	57.9
Psoas sign	29	42
Obturator sign	27	39.1
Palpable mass	11	15.9

RLQ = right lower quandrant

percentage of 85.9 $\pm$ 5.6 (range, 71 to 96). The average subcutaneous fat thickness was 1.3 $\pm$ 0.9 cm (range, 0.4 to 5.0 cm). The time from admission to appendectomy averaged 12.3 $\pm$ 33.6 hours (range, 2 to 240 hours). Should a case in which the diagnosis was delayed by empirical anti-biotic and the operation was performed on day 10 of admission be excluded, this average time would decline to 7.6 $\pm$ 5.6 hours (range, 2 to 27 hours). The mean operative time was 62.3 $\pm$ 14.8 minutes (range, 30 to 105 minutes) and average duration of hospitalization was 5.8 $\pm$ 3 days (range, 4 to 29 days).

Of the 69 perforated appendicitis, 47 had simple perforation (inflammatory in 2, suppurative in 15 and gangrenous in 30) and 22 developed complicated perforation (13 phlegmons and 9 abscesses) at the time of operation. There were four complications and no mortality in the present study. The complications included two incisional seromas, one wound infection, and one adhesion obstruction. Both cases of seromas developed a small lesion at the lateral margin of incision on the twelfth and fourteenth postoperative day, respectively. They both had more fat thickness (2.5 and 5 cm) than its mean value. None of these, however, required further treatment. In a boy who developed wound infection, had a fat thickness of 3 cm. The purulent discharge emanated from a small vent at the lateral margin of the incision on the post-operative day 10. Only oral antibiotics and daily dressing were required for resolution. During the present study, a 7-year-old boy presented to us with a serious problem. He was thin with a fat thickness of 1.3 cm at the first operative period. The patient developed adhesion obstruction following appendectomy on the second week. The initial symptoms comprised abdominal distension and vomiting. Radiography revealed typical patterns of intestinal obstruction. The boy was then admitted. Clinically, he did not improve by nasogastric decompression. Subsequently, entero-cutaneous fistula was present on day 2. Therefore, he was transferred to the operating room. At celiotomy, there was an adhesion band at the ascending colon just below the hepatic flexure and perforation of appendiceal stump. Adhesiolysis and primary repair with placement of penrose drainage at the appendectomy wound were performed. On day 5, enterocutaneous fistula developed again. However, with the administration of total parenteral nutrition and intravenous antibiotics, the patient had an uneventful recovery and was discharged on day 29. All patients with these complications experienced complicated perforation at the time of appendectomy.

Discussion

Appendectomies are still one of the most commonly performed operations for emergency intra-abdominal surgery. At present with a new era of modern surgery, antibiotic therapy and anesthetic knowledge have resulted in a decrease in morbidity and mortality. Even so, infectious complications continue to be a great concern among postoperative problems in pediatric appendicitis especially with perforation. In order to cope with these problematic concerns, various protocols for the treatment of perforated appendicitis in children have been postulated in the literature (Table 2).

It seems that transperitoneal drainage and peritoneal lavage play an important role in the management of children with perforated appendicitis. The former using routine penrose drainage will facilitate the removal of contaminated fluid from the intraperitoneal cavity. The surgical drainage is probably the most beneficial in patients with a well-developed abscess cavity[16]. While the purpose of peritoneal lavage is to dilute the bacterial contamination to levels that host defense mechanisms can overcome, thereby reducing intraabdominal abscess rate[17,18]. The technique of peritoneal lavage can be achieved by using either normal saline or antibiotic solutions. However, there was no significant difference in

Table 2. Review of the incidence of postoperative complications according to various protocols

Reference	Year	n	Protocolization				IA (%)	AO (%)	IW (%)
			PL	PD	WI	PSC			
Karp et al[6]	1979-1985	88	Yes	No	No	Yes	1 (1.1%)	1 (1.1%)	3 (3.4%)
Neilson et al[9]	1986-1988	90	Yes	No	Yes	Yes	2 (2.2%)	-	2 (2.2%)
Burnweit et al[20]	1985-1989	181	No	No	No	Yes	11 (6%)	-	20 (11%)
Lund et al[13]	1981-1991	373	Yes	Yes	No	Yes	5 (1.3%)	6 (1.6%)	7 (1.8%)
Serour et al[10]	1994-1995	70	Yes	No	Yes	Yes	4 (5.7%)	1 (1.4%)	4 (5.7%)
Fishman et al[12]	1995-1999	150	Yes	Yes	No	Yes	5 (3.3%)	2 (1.3%)	4 (2.7%)
Present study	2004-2006	69	No	No	Yes	Yes	0 (0%)	1 (1.45%)	1 (1.45%)

n, number of perforated appendicitis; IA, intraabdominal abscess; AO, adhesion obstruction; IW, infected wound; PL, peritoneal lavage; PD, peritoneal drainage; WI, wound irrigation; PSC, primary skin closure

infectious complication rates between normal saline and antibiotic lavage[19]. Although, in the past, there were attempts to compare both techniques and the results revealed that peritoneal drainage appeared to be inferior to peritoneal lavage, they are both still popular as an adjunct to the appendectomy[7,8]. Interestingly, with the authors' protocol, which was devoid of peritoneal drainage and lavage, a compelling outcome was obtained. Perhaps the authors' technique using copious amounts of gauze swabs may confer advantages comparable to the aforementioned techniques. In a series by Burnweit et al, which was similar to the present study, the authors demonstrated higher rates of infectious complications (31/181)[20]. Such a result may be explained by inadequate peritoneal swabbing. In fact, they did not describe any detail about management of generalized intraperitoneal fluid. In addition, their severity categorization was very different from the present study. Therefore, it would not be appropriate to compare the outcome of the present study to their result.

Subcutaneous fat, an excellent food for bacteria, constitutes the almost entire layer of incisional wound. Thus, vigorous irrigation of the incisional wound will help reduce the bacterial loading into harmless levels. Although the technique of wound irrigation has been mentioned in the literature, there is a lack of details[9,10]. Nevertheless, the amount of normal saline used in the present study was arbitrarily defined according to the fat thickness. In order to achieve the purpose of this technique, approximately 5-10 minutes was used prior to skin closure. There were very small seromas at the lateral margin of the incision in two patients in which additional treatment was not required. This minor complication would result from residual saline left in the surrounding fat, which in turn accumulated as a small pocket later. At the second half of the authors' experience, when dry gauzes were used to absorb the residual saline for a while prior to wound closure, this complication was absent. There was one (1.45%) wound infection developed in the present series. Only oral anti-biotic and daily dressings were required for resolution. Nevertheless, the number of the presented patients was relatively small and there was a difference in classification of patient's severity among the series. Unfortunately, a patient was debilitated by obstruction at an unusual intestinal location causing enterocutaneous fistula. The explanation for the occurrence was unknown because the patient presented with appendiceal abscess, similar to the other patients. Despite the absence of intraabdominal abscess in the present study, the presence of this serious complication would indicate that the presented treatment was not without deleterious consequence.

Over the past two decades, many surgeons have shifted the open wound management to primary wound closure because of its superior cosmetic results. Unlike adult patients, delayed primary wound closure is more problematic in pediatric patients because of the distressing dressing changes and subsequent tying of the sutures. Psychic trauma is inflicted on the children as reflected by their parents or medical staffs. With the authors' technique of using absorbable sutures, the majority of patients achieved good skin approximation and fewer scars. In conclusion, vigorous wound irrigation followed by subcuticular skin closure yields an acceptable outcome with low infectious complication rates in children with perforated appendicitis. This treatment protocol may

be an alternative to the other proposed protocols in the literature.

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การล้างแผลด้วยน้ำเกลือปริมาณมากก่อนเย็บปิดแผลในผู้ป่วยเด็กที่เป็นไส้ติ่งอักเสบแตก

ไพบูลย์ สุขโพธารมณ์, วาสนา คำผิวมา, ธนพร เติมวัฒนภักดี

วัตถุประสงค์: *แม้ว่าในปัจจุบันจะมีการเสนอแนวทางปฏิบัติในการรักษาผู้ป่วยเด็กที่เป็นไส้ติ่งอักเสบแตกมาแล้วหลายแนวทาง แต่ก็ยังไม่มีแนวทางปฏิบัติใดที่กล่าวถึงการล้างแผลด้วยน้ำเกลือปริมาณมากมาก่อนเลย*

วัสดุและวิธีการ: *สำรวจบันทึกรายงานผู้ป่วยเด็กที่เป็นไส้ติ่งอักเสบแตกตั้งแต่ปี พ.ศ. 2547 ถึง พ.ศ. 2549 จำนวนทั้งสิ้น 69 ราย ทุกรายได้ทำการล้างแผลด้วยน้ำเกลือปริมาณมาก ในการศึกษาครั้งนี้แนวทางปฏิบัติในการรักษาผู้ป่วยประกอบด้วย การผ่าตัดไส้ติ่งในทันทีที่ทำได้ การให้ยาปฏิชีวนะก่อนและหลังการผ่าตัด การเช็ดซับภายในช่องท้องอย่างเพียงพอการล้างแผลด้วยน้ำเกลือปริมาณมาก และการเย็บปิดผนังหน้าท้องแบบซ่อนไหมด้วยไหมละลาย*

ผลการศึกษา: *ผู้ป่วยทั้งหมดมีอายุเฉลี่ย 8.7 ปี โดยร้อยละ 47.8 เป็นเพศหญิง และไม่มีผู้ใดเลยที่เสียชีวิตจากการรักษาผู้ป่วยมีความหนาของชั้นไขมันผนังหน้าท้องโดยเฉลี่ย 1.3 เซนติเมตร มีระยะเวลาที่นอนโรงพยาบาลโดยเฉลี่ยนาน 5.8 วัน จากจำนวนผู้ป่วยเด็กที่ไส้ติ่งอักเสบแตกทั้งสิ้น 69 ราย พบว่าเป็นชนิดไม่ซับซ้อน 47 ราย และชนิดซับซ้อน 22 ราย เกิดภาวะแทรกซ้อนหลังการผ่าตัด 4 ราย โดยในจำนวนนี้ 2 ราย เกิดเป็นน้ำเหลืองขังใต้ชั้นผิวหนังขนาดเล็กซึ่งพบว่าหายเอง มี 1 ราย เกิดภาวะพังผืดรัดลำไส้จนกระทั่งต่อมาเกิดรูรั่วของลำไส้ออกมาที่ผนังหน้าท้อง ซึ่งหลังจากการผ่าตัดแก้ไขผู้ป่วยก็มีอาการดีขึ้นและหายดี และอีก 1 ราย เกิดภาวะแผลผ่าตัดติดเชื้อ*

สรุป: *จากผลการศึกษาพบว่าการล้างแผลด้วยน้ำเกลือปริมาณมากก่อนการเย็บปิดผนังหน้าท้องได้ผลดี และเกิดภาวะแผลผ่าตัดติดเชื้อน้อย*