

# Prevention of Wound Infection in Perforated Appendicitis: Experience with Delayed Primary Wound Closure

JAY L. GROSFELD,\* CAPT., MC, USAR, ROBERT W. SOLIT,\*\* CAPT., MC, USAR

*From the Department of Surgery, U. S. Army Hospital, Fort Jackson,  
South Carolina*

WOUND infection is the most common complication following operation for perforated appendicitis.<sup>2, 8, 9, 10</sup> Drainage and systemic antibiotic agents have not altered the incidence of wound sepsis in instances of perforated appendicitis with primary wound closure.<sup>4, 8, 11</sup>

Prevention of wound infection by utilization of delayed closure of contaminated operative wounds has been advocated since 1940.<sup>5</sup> Recent reports have renewed interest in this method of therapy, however, supporting statistical data is lacking in regard to its use in perforated appendicitis.<sup>8, 11</sup> The present report studies the efficacy of delayed primary wound closure in preventing wound infection in instances of perforated appendicitis.

## Materials and Methods

Three hundred and sixty patients with appendicitis who underwent operation at the U. S. Army Hospital, Fort Jackson, South Carolina from January 1964–February 1968 are presented. Negative explorations and incidental appendectomies performed during other operative procedures are not included. The series includes both civilian dependents and military personnel.

---

Submitted for publication April 22, 1968.

\* Assistant Chief, General Surgical Service. Present address (for reprint requests): Dept. of Pediatric Surgery, Childrens Hospital, Columbus, Ohio 43205.

\*\* Chief, General Surgical Service. Present address: Department of Surgery, Jefferson Medical College, Philadelphia, Pa.

Presented at The Gary P. Wratten Surgical Symposium, Walter Reed Army Medical Center, Washington, D. C., April 2, 1968.

There were 276 males and 84 females. The average age was 19.0 years with a range of one to 54 years (Fig. 1). For comparison purposes the patients were divided into three groups:

### Group I: Uncomplicated (Non-Perforated) Appendicitis

There were 275 patients with uncomplicated appendicitis who were treated by appendectomy and primary wound closure from January 1964–February 1968. There were 204 males and 71 females. The average age was 19.0 years with a range of two to 52 years.

### Group II: Perforated Appendicitis with Primary Wound Closure

Forty-one instances of perforated appendicitis were treated by appendectomy, drainage, and primary wound closure from January 1964–July 1966. Thirty-four males and seven females were included in this group. The average age was 18.0 years with a range of one to 54 years (Fig. 2). All patients received systemic antibiotic drugs.

### Group III: Perforated Appendicitis with Delayed Primary Wound Closure

Group III consisted of 44 patients with perforated appendicitis operated upon between August 1966 and February 1968. There were 38 males and six females. The average age was 20.8 years with a range of seven to 52 years (Fig. 2).

These patients were treated in the following manner: A transverse (Rockey-

TABLE 1. *Incidence of Postoperative Infection in 360 Patients with Appendicitis*

Group	No. Patients	No. Wound Infections	Incidence of Wound Infection	No. Pelvic Abscesses	Incidence of Pelvic Abscess
I Appendicitis (non-perforated)	275	13	4.7%	1	0.04%
II Perforated appendicitis with initial wound closure	41	14	34.1%	6	14.6%
III Perforated appendicitis with delayed primary wound closure	44	1	2.3%	1	2.3%
Totals	360	28	7.8%	8	2.2%

Davis) incision was utilized in the majority of instances. On entrance into the peritoneal cavity, free pus was aspirated after obtaining a specimen for culture and sensitivity. Appendectomy was performed in all but two patients. (Interval appendectomy was performed 2 months postoperatively in each instance.) Localized abscess was drained through a separate stab wound beneath the operative incision. In patients with generalized peritonitis, pus was aspirated as completely as possible but no drainage utilized. There were three such instances.

The peritoneum was closed with a continuous 2-0 chromic atraumatic catgut suture (Fig. 3A). The fascia of the oblique muscles was approximated with interrupted 2-0 chromic catgut sutures (Fig. 3B, 3C). The wound was irrigated with saline and then packed with fine mesh gauze. Interrupted fine 5-0 monofilament wire sutures were inserted from skin through the subcutaneous fascia but were left untied (Fig. 3D). A bulky, dry sterile dressing was applied. Postoperative systemic antibiotic agents were employed.

On the fifth postoperative day delayed primary wound closure was performed at the bedside. The dressing and fine mesh gauze were removed and the wound irrigated with saline. The previously inserted monofilament wire sutures were loosely

tied. The intra-abdominal penrose drain was then mobilized following the closure. Forty-eight hours later the drain was removed. If afebrile at this time civilian patients were discharged, leaving the hospital one week from the day of operation. Sutures were removed 5 days later as an outpatient. Military personnel remained hospitalized until suture removal (12 days postoperatively).

### Results

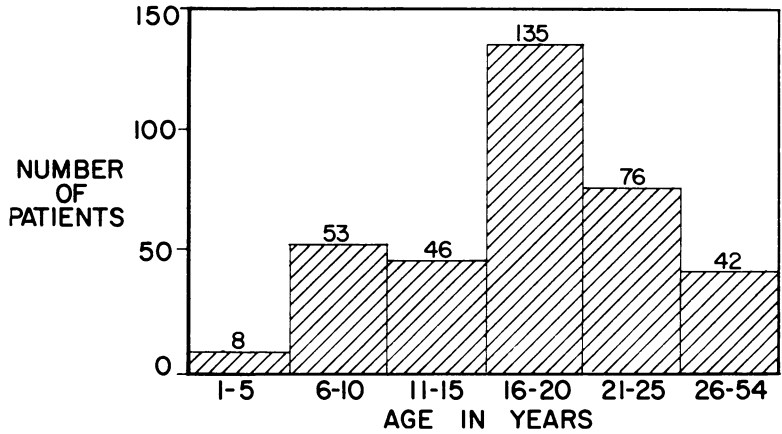
(Table 1.) There were no deaths encountered in the series of 360 patients. Wound infection was defined as a collection of purulent exudate in the wound requiring incision and drainage.

**Group I:** Wound infection occurred in 13 of 275 instances of uncomplicated appendicitis, an incidence of 4.7 per cent. Seven of these patients had gangrenous changes in the appendix without perforation. Pelvic abscess occurred in one patient (0.04%).

**Group II:** Wound infection was noted in 14 of 41 patients with perforated appendicitis and primary wound closure, an incidence of 34.1 per cent. Pelvic abscess occurred in six patients (14.6%).

**Group III:** Wound infection occurred in one of 44 patients with perforated appendicitis treated by delayed primary clo-

FIG. 1. Age distribution of 360 patients with appendicitis.



sure, an incidence of 2.3 per cent. Pelvic abscess occurred in one instance (2.3%).

*Comments.* Fort Jackson is a basic training center with 20,000 to 25,000 young recruits stationed there most of the time. This explains the preponderance of males and large number of patients in the 18-25 year age grouping in this study. The duration of hospitalization for military personnel is difficult to evaluate, and was omitted from the study. The new recruit remains hospitalized until removal of skin sutures and is then sent on a convalescent leave until he is able to resume the vigorous physical requirements of basic training.

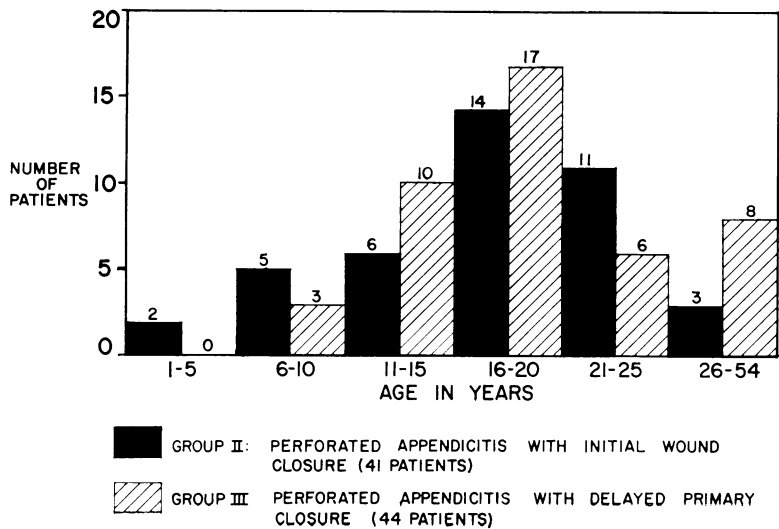
The convalescent leave is counted as time assigned to the hospital unit.

### Discussion

Complications of perforated appendicitis continue to represent a significant postoperative problem. Early diagnosis of acute appendicitis and operation prior to perforation remains the best form of prevention of complications.

In instances of perforation the appendix should be removed whenever possible at the time of operation. This reduces morbidity by obviating the necessity for a second operation. There is little subjective

FIG. 2. A comparison of the age distribution in instances of perforated appendicitis in Groups II and III.



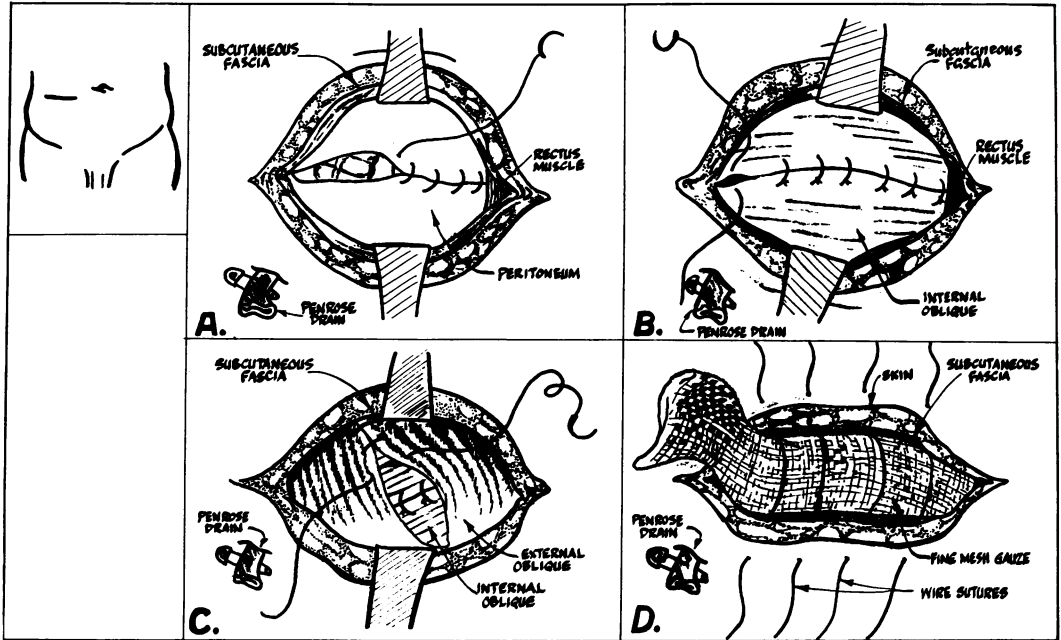


FIG. 3. Technic of delayed primary wound closure. Appendectomy is performed through a transverse incision (upper left). (3A). The peritoneum is closed with a continuous 2-0 chromic atraumatic catgut suture. (3B and 3C). The fascial layers are approximated with interrupted 2-0 chromic catgut sutures. (3D). The wound is then packed with fine mesh gauze. 5-0 monofilament wire sutures are inserted from skin through the subcutaneous fascia and left untied. A dry sterile dressing is applied. Delayed primary wound closure is performed 5 days later at the bedside.

evidence to support drainage of the free peritoneal cavity in the presence of generalized peritonitis.<sup>8, 11, 12</sup> The few instances of generalized peritonitis in this study were therefore not drained. On the other hand, unanimity exists in the efficacy of drainage of localized collections of pus which occur in the majority of perforated instances. The drain is brought out through a separate stab wound site to prevent contamination of the operative wound in the postoperative period.

The wound becomes contaminated during operation for perforated appendix by manipulation and seepage of purulent exudate into the wound. Primary closure of such a wound creates a potential closed space infection. The high incidence (34.1%) of superficial wound infection occurring in instances of perforated appendicitis with closure of the wound at initial operation bears out this observation.

Close attention should be paid to the type of suture utilized. Good evidence exists that suture material itself may contribute to the origin of wound infection.<sup>7</sup> Avoidance of multifilament nonabsorbable suture materials and plain catgut in grossly contaminated wounds has recently been stressed.<sup>1</sup> The use of chromic catgut to repair the fascial layers of the abdominal wall and fine monofilament wire for skin has been satisfactory in the present series.

Maddox *et al.* suggested leaving the wound open for a 24-48 hour period followed by delayed closure.<sup>8</sup> Statistical data did not accompany this suggestion. The usual patient with perforation remains febrile and ill for a 3- to 4-day period postoperatively. Closure of the wound before 5 days and prior to the presence of an afebrile state probably represents an inadequate duration of drainage of a wound po-

tentially contaminated by aerobic and anaerobic organisms.

Delayed primary closure of contaminated extremity war wounds has successfully prevented wound infection when closed 5 days after initial debridement. In the present series the resultant scar following delayed primary closure appeared quite similar to that of a primary wound and did not present a cosmetic problem.

Intravenous antibiotic drugs are administered to combat infection due to both gram negative and gram positive organisms. While systemic antibiotic agents have no effect on the incidence of wound infection, they do decrease morbidity and mortality by preventing the sequelae of the septicemic complications of peritonitis.<sup>4</sup> Reports that use of intraperitoneal antibiotic treatment reduces wound complications have been encouraging.<sup>3, 6, 10</sup> Noon *et al.*, however, reported an incidence of 22% wound infection in perforated appendicitis despite the use of such adjuncts.<sup>10</sup>

Delayed primary wound closure in instances of perforated appendicitis has significantly reduced the incidence of superficial wound infection when compared to a similar, although unrandomized, group of perforated cases with closure of the wound primarily. The incidence of wound infection in the delayed primary closure group was actually lower than that for instances of uncomplicated appendicitis. It is of interest that seven of 13 instances of wound infection in the uncomplicated (non-perforated) group occurred in patients with gangrenous appendicitis. Delayed primary wound closure should probably be utilized in these instances as well as in patients with perforation.

Delayed primary closure may assume an important role in the pediatric age group where the highest incidence of perforated appendicitis is encountered.

## Summary

Delayed primary wound closure was performed in 44 instances of perforated appendicitis. Wound infection occurred in one patient, an incidence of 2.3 per cent. The incidence of wound infection in 41 instances of perforated appendicitis with wound closure at initial operation was 34.1 per cent. Delayed primary wound closure significantly reduces the incidence of wound infection in instances of perforated appendicitis. Further experience with this technic is warranted.

## References

1. Alexander, J. W., Kaplan, J. Z. and Altmeier, W. A.: Role of Suture Materials in the Development of Wound Infection. *Ann. Surg.*, 165:192, 1967.
2. Boles, E. R., Jr., Ireton, R. J. and Clatworthy, H. W., Jr.: Acute Appendicitis in Children. *Arch. Surg.*, 79:447, 1959.
3. Brickman, I. D. and Leon, W.: Acute Appendicitis in Childhood. *Surgery*, 60:1083, 1966.
4. Cole, W. R. and Bernard, H. R.: A Reappraisal of the Effects of Antimicrobial Therapy on the Course of Appendicitis in Children. *Amer. Surg.*, 27:29, 1961.
5. Coller, F. A. and Valk, W. L.: Delayed Closure of Contaminated Wounds: Preliminary Report. *Ann. Surg.*, 112:256, 1940.
6. DiVicenti, F. and Cohn, I., Jr.: Intraperitoneal Kanamycin in Advanced Peritonitis. A Preliminary Report. *Amer. J. Surg.*, 111:147, 1966.
7. Elek, S. D. and Conen, P. E.: The Virulence of *Staphylococcus Pyogenes* for Man. A Study of the Problems of Wound Infection. *Brit. J. Exp. Path.*, 38:573, 1957.
8. Maddox, J. R., Johnson, W. W. and Sergeant, C. K.: Appendectomies in a Children's Hospital. *Arch. Surg.*, 89:223, 1964.
9. Magee, R. B., Stowell, J. M. and MacDuffee, R. C.: Appendicitis—A Twenty Year Study of 2,117 Cases Treated Surgically. Clinical Display at American College of Surgeons Conv. 1965, Atlantic City, N. J.
10. Noon, G. P., Beall, A. C., Jr., Jordan, G. L., Jr., Riggs, S. and DeBaakey, M. E.: Clinical Evaluation of Peritoneal Irrigation with Antibiotic Solution. *Surgery*, 62:73, 1967.
11. Talbert, J. L. and Zuidema, G.: Appendicitis—A Reappraisal of an Old Problem. *Surg. Clin. N. Amer.*, 46:1101, 1966.
12. Vinnicombe, J.: Appendectomy, Wound Infection, Drainage, and Antibiotics. *Brit. J. Surg.*, 41:328, 1964.