Laparoscopy in Children With Complicated Appendicitis

By Hannu Lintula, Hannu Kokki, Kari Vanamo, Pentti Antila, and Matti Eskelinen
Kuopio, Finland and Joensuu, Finland

Background/Purpose: Laparoscopic appendectomy is an accepted way of dealing with suspected uncomplicated appendicitis in children. The role of laparoscopy in complicated acute appendicitis is more controversial. The purpose of this trial was to compare laparoscopic appendectomy with open appendectomy in children with complicated appendicitis.

Methods: A total of 102 children with suspected acute appendicitis were selected randomly to undergo either a laparoscopic or an open appendectomy. The outcomes of 25 children with complicated appendicitis, 13 in the laparoscopic group and 12 in the open appendectomy group, were analyzed. Children, their parents, and research nurses were blinded to which procedure had been performed and remained blinded until the control visit 7 days after the operation. All 25 children completed a 30-day follow-up.

Results: There were no differences in terms of patients' age, sex, weight, height, and appendiceal histology between the 2 groups. All laparoscopic procedures were completed without conversion. The mean (±SD) operating time was 63 (±31) minutes in the laparoscopic group and 37 (±18) minutes in the open appendectomy group (mean difference 26 minutes, 95% CI 5 to 47 minutes, $P = .02$). There were 2 major complications in the laparoscopic group in children with appendiceal masses. One child had an entero-cutaneous fistula of the residual appendiceal tip that needed open reoperation. Another child had a pelvic abscess that resolved with antibiotic treatment. Superficial wound infections were encountered in 2 patients in the open appendectomy group.

Conclusions: Laparoscopic appendectomy is an alternative to open procedure in children with complicated appendicitis. Good surgical judgement is necessary in patients with an established appendiceal abscess.
J Pediatr Surg 37:1317-1320. Copyright 2002, Elsevier Science (USA). All rights reserved.

INDEX WORDS: Laparoscopic appendectomy, complicated appendicitis.

LAPAROSCOPIC APPENDECTOMY is an established approach to simple appendicitis also in children.[1] The role of laparoscopic surgery in the treatment of complicated appendicitis has been more controversial. Some investigators have advocated that laparoscopy should not be used in children with complicated disease because of increased postoperative morbidity.[2] However, we are unaware of any prospective trials comparing conventional versus laparoscopic procedure in children with complicated appendicitis. The purpose of this study was to compare laparoscopic with open appendectomy in the treatment of gangrenous, ruptured, or abscessed appendix.

MATERIALS AND METHODS

The trial was conducted at the Kuopio University Hospital and the North Karelian Central Hospital over a 24-month period ending April 30, 2000. The trial was approved by the Local Ethics Committees and was conducted in accordance with the latest revision of the Declaration of Helsinki. Inclusion criteria were ASA physical status I or II, age between 4 and 15 years, weight between 15 and 75 kg, and a decision to operate for suspected acute appendicitis. Children with a history of pain of more than one week's duration were excluded from the study, as were children with previous abdominal operations, bleeding diathesis, kidney or liver dysfunction, and neurologic disease. Patients with radiologically confirmed masses were selected randomly to undergo either laparoscopic or open appendectomy only if their clinical conditions were not improved by antibiotics.

After obtaining written informed consent, the patients were assigned to either a laparoscopic (LA group) or an open procedure (OA group). Randomization was performed with consequtively numbered sealed envelopes containing a random number. A blinded study protocol was followed: children, parents, research nurses, and pediatric surgeons, except the principal investigator, remained unaware of the exact procedure until a control visit scheduled 7 days after the operation. After surgery each child had a similar wound dressing.[3] The trial documents were kept separate from the patient's medical records.

Children with operative findings of periappendicular abscess and children with a histologically confirmed gangrenous or ruptured appendix were included in the subgroup of complicated appendicitis.

Operative Procedures

General anesthesia with endotracheal intubation was used in all cases. Induction was performed with thiopental, fentanyl and cisatracurium, and maintenance with sevoflurane in oxygen and air. All children had a nasogastric tube during the procedure, and metronidazole, 7 mg kg^{-1}, was given intravenously at induction for prophylaxis. The urinary bladder was not catheterized routinely.

Laparoscopic appendectomy was performed with reusable instruments in a standardized manner using 2 5-mm working ports and one

From the Departments of Pediatric Surgery, Surgery, and Anaesthesiology and Intensive Care, Kuopio University Hospital, Kuopio, Finland, and the Department of Surgery, North Karelian Central Hospital, Joensuu, Finland.

Address reprint requests to Hannu Lintula, MD, Department of Paediatric Surgery, Kuopio University Hospital, PO Box 1777, FIN-70211 Kuopio, Finland.

Copyright 2002, Elsevier Science (USA). All rights reserved.
0022-3468/02/3709-0013$35.00/0
doi:10.1053/jpsu.2002.34998

5- or 10-mm sheath for the camera. The peritoneal cavity was opened under direct vision. After visualization of the entire intraperitoneal space via a 5-mm telescope, the right upper and the midline lower quadrant ports were inserted. The appendix was removed, and its stump was secured with 2 2-0 polydioxanone ligatures (EndoLoop; Ethicon, Sommerville, NJ). The stump was neither inverted nor cauterized. A plastic bag (Endocatch; USSC, Norwalk, CT) was utilized for removal of the appendix. In the case of peritonitis, abdominal irrigation with saline solution was performed until the aspirated liquid became clear. No drains were left in the abdominal cavity. Open appendectomy was performed through a McBurney incision.

After surgery each child was given cefuroxime, 80 mg kg^{-1} 24 h^{-1}, and metronidazole, 20 mg kg^{-1} 24 h^{-1}, intravenously until they tolerated a normal oral diet. Analgesic use was standardized and recorded.[3] The nasogastric tube was left in place until bowel function returned. All appendices were examined histologically. Children were discharged when the set criteria were met.[3]

Follow-Up

A follow-up visit took place 7 days postoperatively. Recovery at home was assessed by a structured questionnaire. Physical status, subjective recovery, and complications were evaluated. The wound dressings were removed and the blinding opened. Intraabdominal infection was defined as clinical symptoms plus laboratory findings of inflammation plus a positive ultrasound examination. Wound infection was defined as local signs of inflammation plus positive bacterial culture. A follow-up phone call was scheduled 30 days after surgery to determine when the patients were able to return to their normal activities and to record complications and other adverse events. Patients who completed 30 days of follow-up were included in the final analysis.

RESULTS

Patients

One hundred two patients entered the study. One child in the OA group was withdrawn because a possible allergic reaction developed toward ketoprofen the first day after the operation, and the wound dressings were removed. Of the remaining 101 patients, 25 children (13 in the LA group and 12 in the OA group) met the inclusion criteria for complicated appendicitis (Fig 1). The LA and OA groups with complicated appendicitis were similar in respect to age, sex, weight, and height. In the LA group there were more children with perforated and abscessed appendices compared with the OA group (Table 1). Results in patients with uncomplicated appendicitis have been reported elsewhere.[3]

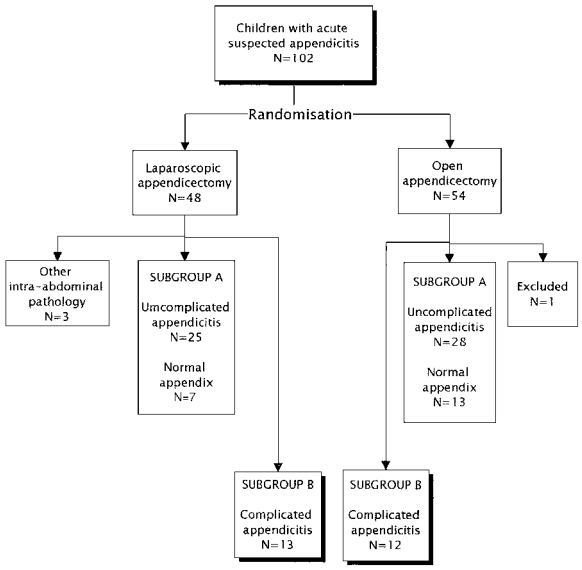

Fig 1. Study groups. Schematic representation of randomization in children with suspected simple or complicated appendicitis.

Table 1. Patient Characteristics

	Laparoscopic Group (n = 13)	Open Group (n = 12)
Gender (male/female)	9/4	9/3
Age (yrs)	10 (3)	11 (3)
Range	4-14	5-15
Height (cm)	146 (18)	151 (16)
Range	125-180	120-180
Weight (kg)	39 (13)	45 (15)
Range	15-55	21-62
Appendix (gangrenous/perforated/ abscessed)	2/9/2	7/4/1

NOTE. Data represent number of cases of mean (±SD) with range (n = 28).

Surgery

The mean operating time was significantly longer in the LA group, 63 (±31) minutes, compared with the OA group, 37 (±18) minutes, (mean difference, 26 minutes, 95% CI 5 to 47 minutes, $P = .02$). No conversion to an open procedure was necessary in the laparoscopic group.

Postoperative Recovery

There were no differences in postoperative recovery in terms of the length of hospital stay or return to normal activities between the 2 groups (Table 2). Hospitalization

Table 2. Recovery After Laparoscopic and Open Appendectomy in Children With Complicated Appendicitis

	Laparoscopic Group (n = 13)	Open Group (n = 12)
Length of hospital stay (d)	5.0 (1.9)	4.0 (1.2)
Range	3-9	3-6
Return to school (d)	10.0 (3.0)	9.0 (2.0)
Range	4-13	7-13
Return to sport activities (d)	14.0 (7.4)	19.0 (10.0)
Range	4-30	10-30
Children with major complications	2*	0
Children with minor complications	0	2†

NOTE. Data represent number of cases or mean (±SD) with range (n = 25).

*One cutanic fistula and one pelvic abscess in children with periappendicular abscesses.

†Two superficial wound infections.

of 6 days or longer was required for 2 children with perforated appendicitis and for 3 children with periappendicular abscess. Four of these children were in the LA group and one child in the OA group. At 4 weeks, all but one child in the LA group had returned to normal daily activities.

Outcome

There was no mortality, and all patients healed eventually. There were 2 major complications in children with periappendicular masses in the LA group. One child had an intrapelvic abscess after discharge, and she was readmitted 5 days after surgery because of protracted vomiting and diarrhea. The abscess resolved with antibiotic treatment (cefuroxime and metronidazole) in 2 weeks. In another child, the tip of the appendix remained in situ after laparoscopic appendectomy. One month after surgery he developed an entero-cutaneous fistula which was excised successfully by open laparotomy. Two patients in the OA group had wound infections, which were cured by local debridement. Postoperative imaging studies were performed in 3 patients in the LA group.

DISCUSSION

It seems that laparoscopy may be a therapeutic alternative to open apppendectomy also in children with complicated appendicitis. However, caution, good surgical judgement, and a low threshold for conversion to open procedure are advised, especially when dealing with an appendiceal abscess.

There exist several theoretical advantages of the laparoscopic approach in complicated appendicitis. It enables visualization of the whole abdominal cavity and thorough peritoneal lavage. In open surgery, atypical localization of the appendix or wrong diagnosis may require an extended or second incision. Laparoscopy may lessen the operative trauma and lead to earlier discharge and return to normal activities.

Randomized clinical trials of large series in children with complicated appendicitis comparing the 2 techniques have not been published. Ure et al[4] have reported a considerablly high conversion rate after laparoscopic operation for an advanced appendicitis.[4] Horwitz et al[2] even suggest that the laparoscopic technique should be avoided in children who have complicated disease because of the increased risk for postoperative intraabdominal abscesses. Valla et al[5] regard open surgery as preferable in cases of appendiceal masses, because the dissection of the mass without manual palpation may lead to bleeding and visceral injuries. In contrast to these opinions, some retrospective studies have shown that laparoscopic appendectomy may be as safe and effective as open appendectomy for perforated appendicitis.[5,6]

In this study, laparoscopic appendectomy provided definitive cure for all except one patient. No primary operation needed to be converted into an open procedure. However, the operating time was significantly longer in the laparoscopic group, with a mean difference of 26 minutes compared with the open procedure. Manipulation of inflammated tissue appeared to be difficult with the laparoscopic instrumentation. There is no sensation at the tip of the forceps, and the importance of avoiding visceral injury makes dissection slow. Therefore intraoperative complications related to the laparoscopic technique may occur frequently in patients with appendiceal masses. Improvements in dissecting technique and equipment may overcome these problems in the future. No difference was found between the groups in hospital stay or return to normal activities. This may reflect the fact that postoperative morbidity in complicated appendicitis is related more to the complication itself than to the operative procedure.

Morbidity rates have varied from 10% to 45% in large surveys of children with complicated appendicitis; thus, our complication rate was well in the range of previous studies.[7-9] Both major complications occurred in patients with periappendicular abscesses in the LA group. One patient initially had an intrapelvic abscess surrounded by adhesive bowel loops, and the perforated appendix was attached to the floor of the pelvis. A 2-cm-long remnant of the appendix was left in place after the laparoscopic operation resulting later in a fistula. It remains open to speculation whether conversion to an open procedure would have allowed us to notice the remaining appendiceal tip and avoid the reoperation 4 weeks later. Another child with diarrhea and vomiting was unable to take antibiotics by mouth, and later had a pelvic abscess. She was treated first by intravenous and then by oral antibiotics for 2 weeks with eventual cure. There were no major complications in the OA group, but this may result from the fact that there were fewer children with perforated or abscessed appendices in this group. Both minor complications, 2 superficial wound infections, occurred in the open appendectomy group. Prior studies have shown laparoscopic appendectomies to be associated with lower wound infection rates as well.[10,11]

REFERENCES

1. Kokoska ER, Murayama KM, Silen ML, et al: A state-wide evaluation of appendectomy in children. Am J Surg 178:537-540, 1999

2. Horwitz JR, Custer MD, May BH, et al: Should laparoscopic appendectomy be avoided for complicated appendicitis in children? J Pediatr Surg 32:1601-1603, 1997

3. Lintula H, Kokki H, Vanamo K: Single-blind randomized clinical

trial of laparoscopic versus open appendectomy in children. Br J Surg 88:510-514, 2001

4. Ure BM, Spangenberger W, Hebebrand D, et al: Laparoscopic surgery in children and adolescents with suspected appendicitis: Results of medical technology assessment. Eur J Pediatr Surg 2:336-340, 1992

5. Valla JS, Steyaert H, Alain JL, et al: Management of appendicular peritonitis in children: Traditional surgery vs. laparoscopy. Retrospective comparative study of pediatric videosurgery group. Int J Ped Surg Sci 10:13-16, 1996

6. Canty TG Sr, Collins D, Losasso B, et al: Laparoscopic appendectomy for simple and perforated appendicitis in children: The procedure of choice? J Pediatr Surg 35:1582-1585, 2000

7. Stone HH, Sanders SL, Martin JD: Perforated appendicitis in children. Surgery 69:673-679, 1971

8. Samelson SL, Reyes HM: Management of perforated appendicitis in children—revisited. Arch Surg 122:691-696, 1987

9. Pearl RH, Hale DA, Molloy M, et al: Pediatric appendectomy. J Pediatr Surg 30:173-181, 1995

10. Pedersen AG, Petersen OB, Wara P, et al: Randomised clinical trial of laparoscopic versus open appendectomy. Br J Surg 88:200-205, 2001

11. Piskun G, Kozik D, Kajpal S, et al: Comparison of laparoscopic, open, and converted appendectomy for perforated appendicitis. Surg Endosc 15:660-662, 2001