

A Prospective Randomized Trial Comparing Open *Versus* Laparoscopic Appendectomy

Richard C. Frazee, M.D., John W. Roberts, M.D., Richard E. Symmonds, M.D.,
Samuel K. Snyder, M.D., John C. Hendricks, M.D., Randall W. Smith, M.D.,
Monford D. Custer III, M.D., and J. Blake Harrison, M.D.

*From the Departments of General and Pediatric Surgery, Scott and White Memorial Hospital,
Scott, Sherwood, and Brindley Foundation, Texas A&M Health Science Center,
College of Medicine, Temple, Texas*

Objective

The authors determined whether there was an advantage to laparoscopic appendectomy when compared with open appendectomy.

Summary/Background Data

The advantages of laparoscopic appendectomy *versus* open appendectomy were questioned because the recovery from open appendectomy is brief.

Methods

From January 15, 1992 through January 15, 1993, 75 patients older than 9 years were entered into a study randomizing the choice of operation to either the open or the laparoscopic technique. Statistical comparisons were performed using the Wilcoxon test.

Results

Thirty-seven patients were assigned to the open appendectomy group and 38 patients were assigned to the laparoscopic appendectomy group. Two patients were converted intraoperatively from laparoscopic appendectomies to open procedures. Thirty-one patients (81%) in the open group had acute appendicitis, as did 32 patients (84%) in the laparoscopic group. Mean duration of surgery was 65 minutes for open appendectomy and 87 minutes for laparoscopic appendectomy ($p < 0.001$). There were no statistically significant differences in length of hospitalization, interval until resumption of a regular diet, or morbidity. Duration of both parenteral and oral analgesic use favored laparoscopic appendectomy (2.0 days *versus* 1.2 days, and 8.0 days *versus* 5.4 days, $p < 0.05$). All patients were instructed to return to full activities by 2 weeks postoperatively. This occurred at an average of 25 days for the open appendectomy group *versus* 14 days for the laparoscopic appendectomy group ($p < 0.001$).

Conclusions

Patients who underwent laparoscopic appendectomies have a shorter duration of analgesic use and return to full activities sooner postoperatively when compared with patients who underwent open appendectomies. The authors consider laparoscopic appendectomy to be the procedure of choice in patients with acute appendicitis.

Recently, laparoscopic techniques have been applied to a variety of abdominal procedures that were performed traditionally via an open technique. Laparoscopic cholecystectomy has gained wide acceptance since it has been shown to be as safe as open cholecystectomy, but with the advantage of a shorter hospitalization and an earlier return to work.¹⁻⁵ Laparoscopic techniques have been described for appendectomy, colon resection, adrenalectomy, and splenectomy.

Laparoscopic appendectomy was first described by Semm⁶ in 1983 and initially was performed incidental to other pelvic procedures. As the operative techniques were refined, the indications were extended to patients with suspected appendicitis.^{7,8}

Early series of laparoscopic appendectomies have reported minimal morbidity and a shortened recovery. However, many surgeons have questioned the advantages of laparoscopic appendectomy because the recovery from open appendectomy is brief. This study determined whether the laparoscopic procedure is an advantage, compared with the open technique.

METHODS

From January 15, 1992, through January 15, 1993, all patients older than 9 years with a preoperative diagnosis of acute appendicitis were offered entry into the study protocol. Interval appendectomies and appendectomies performed incidental to other procedures were not included in the study. Patients were assigned randomly to receive either open or laparoscopic appendectomies.

Open appendectomies were performed through a right lower quadrant, muscle-splitting incision. Laparoscopic appendectomies were performed using a 10-mm periumbilical Hasson trocar, a 10-mm trocar in the right lower quadrant, and a 5-mm suprapubic trocar. The mesentery of the appendix was divided using endoclips, and the base of the appendix was ligated with chromic endoloops. The appendix was placed in a sterile latex receptacle for retrieval from the abdomen. Patients were converted from laparoscopic to open appendectomies at the discretion of the surgeon; however, postoperative results for the two converted patients were calculated in the laparoscopic group.

The two groups were compared with regard to patient demographics, pathologic findings, operative time (skin incision to skin closure), and postoperative course. Patients were instructed to return to full activities 2 weeks postoperatively. Patients were observed by clinic visit or

Table 1. COMPARISON OF OPEN AND LAPAROSCOPIC APPENDECTOMY

	Open	Laparoscopic
Average age (yrs)	30 (10-68)	28 (10-70)
Male:female ratio	20:17	16:22
Acute appendicitis percent	81	84
Mean operating time (min)	65 (20-210)	87 (45-150)
$p < 0.001$		
Regular diet (days)	2.5	1.7
$p = \text{NS}$		
Hospitalization (days)	2.8	2.0
$p = \text{NS}$		
Morbidity	5%	8%
$p = \text{NS}$		
Parental analgesic use (days)	2.0	1.2
$p < 0.02$		
Oral analgesic use (days)	8.0	5.4
$p < 0.02$		
Return to full activities (days)	25	14
$p < 0.001$		

telephone interview at 2, 4, and 8 weeks postoperatively, and follow-up was complete for all patients.

Statistical comparisons were made using the Wilcoxon test. The study protocol was reviewed and approved by the hospital research committee and the institutional review board. All patients signed informed consent in accordance with institution and state guidelines.

RESULTS

During the 1-year study period, 77 patients had signs and symptoms of acute appendicitis and were offered entry into the study. Seventy-five patients agreed to participate; 37 patients were assigned to the open appendectomy group and 38 patients were assigned to the laparoscopic appendectomy group. Two patients were converted from laparoscopic to open appendectomies during surgery, and their results remain in the laparoscopic group. Average age and male:female ratio were similar in both groups. Thirty patients (81%) in the open group and 32 patients (84%) in the laparoscopic group had acute appendicitis. Six patients who had open appendectomies and seven patients who had laparoscopic appendectomies had free appendiceal perforation. Mean duration of surgery was 65 minutes for the open appendectomy group and 87 minutes for the laparoscopic appendectomy group ($p < 0.001$, Wilcoxon test). No statistically significant differences were noted in the length of hospitalization, interval until the resumption of a regular diet, or morbidity (Table 1). Patients who underwent laparoscopic appendectomies had a shorter duration of parenteral and oral analgesic use (2.0 days *versus* 1.2

days, and 8.0 days *versus* 5.4 days, $p < 0.05$, Wilcoxon test). Patients who had laparoscopic appendectomies returned to full activities 14 days postoperatively *versus* 25 days for patients who underwent open appendectomies ($p < 0.001$, Wilcoxon test).

DISCUSSION

Early reports on the use of laparoscopy for appendicitis center around its use as a diagnostic tool. The negative appendectomy rate in most series of open appendectomies ranges from 20% to 30%.^{9,10} This rate has become accepted because as the diagnostic accuracy increases, so does the rate of perforation. In the early 1980s, laparoscopy was advocated as a means of decreasing the rate of negative appendectomy without increasing the rate of complications.¹¹⁻¹³ In one series, however, the appendix could only be visualized directly during single trocar diagnostic laparoscopy in 4 of 46 patients. They used indirect signs of appendicitis, such as adherence of the omentum to the right lower quadrant, cecal inflammation, or the presence of turbid fluid in the pelvis, to assist in the operative decision-making process. Since that time, operative laparoscopy has become more commonplace, with advances in both equipment and operative techniques. The surgical technique for laparoscopic appendectomy is now well described, and several different methods have been developed.¹⁴⁻¹⁶ Both three- and four-trocar techniques have been described. The base of the appendix can be ligated by intracorporeal or extracorporeal suturing, endoloop placement, clip application, or stapling device. All laparoscopic appendectomies in our series were performed using three trocars and chromic endoloops to ligate the appendiceal stump.

Several retrospective reviews have reported the advantages of laparoscopic appendectomy when compared with historical controls for open appendectomy. Scott-Conner et al.¹⁷ reported that for 16 patients undergoing laparoscopies for suspected appendicitis, laparoscopic appendectomies were performed successfully in 12 patients. Two patients (12.5%) were converted to celiotomy for bleeding or a perforated appendix. Hospital stay averaged 2.5 days, and all patients returned to full activities between 1 and 2 weeks after surgery. The authors concluded that laparoscopic appendectomy can be performed safely with comparable results to open appendectomy.

Nowzaraden et al.¹⁸ retrospectively reviewed 43 patients with right lower quadrant pain and a preoperative diagnosis of acute appendicitis who underwent laparoscopic appendectomies. Patients with perforation by either preoperative examination or operative findings automatically underwent open appendectomies. Nowzaraden et al. claimed that laparoscopic appendectomies

resulted in less postoperative pain, a shorter hospital stay, earlier return to normal activities, fewer long-term sequelae, lower morbidity, and a better cosmetic result. Pier et al.¹⁹ studied 625 laparoscopic appendectomies performed in 678 patients with suspected appendicitis. Two percent of the patients required conversion to open appendectomies. Morbidity was low and included three patients who developed bleeding problems and three patients with postoperative intra-abdominal abscesses. Their average operating time 15 to 20 minutes, which is significantly shorter than our experience and other reports in the literature. The average operating time in our series favored open appendectomy. Laparoscopic appendectomies took an average of 87 minutes, whereas open appendectomies required 65 minutes. It is questionable, however, whether the additional 22 minutes of average operating time is clinically significant.

Schirmer et al.²⁰ reviewed 122 patients who underwent either open appendectomies, diagnostic laparoscopies with or without open appendectomies, or laparoscopic appendectomies during a 3-year period. Their patients were not randomized, and the selection criteria is undefined for the choice of surgery. They showed no difference in hospital stay, mortality, complications, or cost when comparing the open and laparoscopic techniques. The authors stated that their results are evidence that a controlled randomized trial comparing these two treatments is indicated. They emphasized the need for surgeons sufficiently skilled in laparoscopic appendectomy to perform such a study so that potential biases introduced by the learning process would be avoided. Our study was initiated after 2 years of experience with laparoscopic appendectomy. Although each of the cases involved surgical resident participation, they were performed under the supervision of experienced laparoscopic surgeons.

In a summary of a presentation made by Richards et al.²¹ at the 1992 American College of Surgeons meeting on laparoscopic appendectomy, Fitzgibbons stated that comparisons between different patient groups or historical controls can lead to a selection bias, and, without a randomized clinical trial, this limitation cannot be overcome. Because of these concerns about selection bias and patient selection, we devised the current prospective randomized trial. All patients older than 9 years were offered entry into the study. Both patient groups were comparable with respect to age, male:female ratio, and percentage of patients with acute inflammation. No statistically significant differences were seen in length of hospital stay, interval until resumption of a regular diet, and morbidity. Operating times were longer for laparoscopic appendectomies, with a mean of 87 minutes *versus* 65 minutes for open appendectomies. The duration of the use of both parenteral and oral pain medication was shorter in

the laparoscopic group, which reflects the diminished pain seen with laparoscopic surgery. One of the main advantages seen in the laparoscopic group, however, was the recovery after discharge from the hospital. All patients were instructed to resume full activities 2 weeks postoperatively. Patients who had laparoscopic appendectomies resumed full activities 14 days postoperatively, whereas patients who underwent open appendectomies did not do so until 25 days postoperatively.

This study confirmed the safety and efficacy of laparoscopic appendectomy. It can be performed in a high percentage of patients, even in the presence of perforation. In addition, however, it demonstrated the superiority of laparoscopic *versus* open appendectomy in terms of diminished postoperative pain and length of recovery. We conclude that laparoscopic appendectomy is the procedure of choice for patients with suspected acute appendicitis.

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Discussion

DR. R. SCOTT JONES (Charlottesville, Virginia): First, I want to compliment Dr. Roberts and Dr. Frazee for approaching this question with a randomized clinical trial. This is, obviously, the optimal method for answering the questions about difference in therapies, and this was a well-designed, well-conducted, and well-presented clinical study. I will begin by commenting that the results of this work and overall effectiveness of the therapies, morbidity, and so forth, certainly reflected the same kinds of outcomes reported by Drs. Schirmer and Hanks and others in a previous nonrandomized study from our department, as well as other work. I have a couple or three questions I wanted to ask. But first, I would mention at the outcome of this, there was a statistically significantly reduced consumption of analgesics in the laparoscopic group and that there was a faster return to work in the laparoscopic group, were conclusions that I believe were clearly supported by the data and certainly would influence our judgment about choosing the two operations. Now I'd like to ask a couple of questions, or I should say invite the presenters to elaborate on some of their data if they can. And the first point would be to ask if they could comment on how often the correct diagnosis was made when the patients didn't have appendicitis. In other words, a patient had a normal appendix and you've got a McBurney incision *versus* laparoscopy, could you tell us how effectively those situations permitted the correct diagnosis when it wasn't acute appendicitis? The second question was that they had 8% morbidity in the laparoscopic group and a 5% in the open group. Perhaps, you could share with us qualitatively what the nature of the complications were in both of those groups. Lastly, I would like to know whether you thought that the laparoscopic technique permitted a decrease in morbidity when the patients had a normal appendix. In other words, was the morbidity of the operation less if there was a normal appendix?

DR. HUNTER HOLMES MCGUIRE (Richmond, Virginia): Thirty-five years ago, I had my own appendix removed in a 15-minute operation, and I was on the tennis court a week later. It