



Laparoscopic versus Open Appendectomy: Prospective Randomized Trial

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Abstract. A prospective randomized trial comparing laparoscopic appendectomy with open appendectomy in patients with a diagnosis of acute appendicitis was conducted between October 1992 and April 1994. Of the 158 patients randomized, 7 patients were excluded because of protocol violations (conversion to laparotomy in 4, appendix not removed in 3). The 151 patients randomized to either a laparoscopic ($n = 79$) or an open appendectomy ($n = 72$) showed no difference in sex, age, American Society of Anesthesiology (ASA) rating, or previous abdominal surgery. The histologic classification of normal, catarrhal, inflamed, suppurative, and gangrenous appendicitis was not different between the two groups. Conversion from laparoscopic to open appendectomy was necessary in seven patients (9%) who had advanced forms of appendiceal inflammation. When compared to open appendectomy the laparoscopic group had a longer median operating time (63 minutes versus 40 minutes), fewer wound infections (2% versus 11%), less requirement for narcotic analgesia, and an earlier return to normal activity (median 7 days versus 14 days). There was no difference in morbidity, and both groups had a median time to discharge of 3 days. Laparoscopic appendectomy is as safe as open appendectomy; and despite the longer operating time, the advantages such as fewer wound infections and earlier return to normal activity make it a worthwhile alternative for patients with a clinical diagnosis of acute appendicitis.

Methods

Patients who presented with right-sided abdominal pain to the Princess Alexandra Hospital between November 1992 and April 1994 were considered for the study. The criteria for inclusion were a diagnosis of acute appendicitis (by consultant or surgical trainee), age of 12 years or more, patient suitable for a right iliac fossa muscle-splitting approach to the appendix, and no evidence of pregnancy. After obtaining informed consent, the patients were randomized to either a laparoscopic or open approach group using a sealed envelope system prepared from a random numbers table.

Consultant surgeons entering patients into the trial were required to be experienced in endoscopic surgery, notably laparoscopic cholecystectomy, and to have performed a minimum of five laparoscopic appendectomies. All surgical trainees were required to be supervised by the consultant when performing a laparoscopic appendectomy. They were also supervised performing an open appendectomy if they had performed fewer than 50 procedures.

At the time of induction of general anesthesia cefoxitin 1 g was administered intravenously. For the laparoscopic approach an open technique was used at the umbilicus allowing visualization of the peritoneal cavity prior to insertion of a blunt reusable Hasson cannula. Typically, two other ports were placed: a 5 mm port low in the right abdomen and a 10- to 12-mm port in the left lower abdomen similar to the positions described by Tate et al. [5]. A fourth port, either 5 mm or 10 to 12 mm was placed in the right upper quadrant if upward retraction of the cecum was required. The mesoappendix was controlled with clips and the appendix base tied with a single endloop. The appendix was removed through the left iliac fossa port or the umbilical port. If it was considered too bulky, it was removed within a plastic bag. The stump was not buried. The larger port sites were closed with a nonabsorbable suture to the fascia, and nylon interrupted sutures were placed in the skin.

Open appendectomy was performed using a standard muscle-splitting approach in the right iliac fossa. The appendix was removed with ligation of the stump, and the stump was not buried. The abdominal wall was closed in layers with absorbable sutures, and interrupted nylon sutures were placed in the skin incision.

Appendectomy using a muscle-splitting approach in the right iliac fossa has been the traditional operation for management of a patient who presents with a diagnosis of acute appendicitis. A number of studies with large numbers of patients undergoing laparoscopic appendectomy have been reported by various authors [1–3]. Comparative studies of laparoscopic and open appendectomy have supported the laparoscopic approach as an alternative to open appendectomy [4–6]. It was thought appropriate that laparoscopic appendectomy should be compared with the traditional right iliac fossa operation in a prospective randomized study of patients with a diagnosis of acute appendicitis. We were particularly interested in the results of such a trial performed in a teaching hospital with intimate involvement by surgical trainees as well as surgeons who were beginning their experience with laparoscopic appendectomy.

Table 1. Patients enrolled in the trial.

Parameter	Appendectomy		
	Open (n = 72)	Laparoscopic (n = 84)	
Age (median years)	22 (13–66)	25 (14–89)	NS
Male/female	32/52	25/49	NS
ASA rating (median)	1 (1–3)	1 (1–3)	NS
Previous medical history	16	13	NS
Previous abdominal surgery	12	16	NS

NS: no significant difference.

The operative time from incision in the skin to the last suture insertion was recorded by the anesthetist.

For inclusion in the analysis of results the appendix had to be removed, ensuring compatibility between the two groups. After surgery the patients were prescribed intramuscular pethidine and oral panadeine. Once the patient was able to tolerate oral fluids, the oral analgesia was offered as first choice. A diet was resumed when oral fluids were tolerated. Discharge occurred with resumption of a diet and was at the discretion of the team in charge of the patient's management.

Planned review at the outpatients clinic was for 1 week from the time of surgery for removal of sutures and then subsequently at 4 weeks. Wound infections were defined as a purulent discharge from an incision site. Normal activity was defined as the time when patients were able to resume work or perform their usual daily activities without significant discomfort. Patients who had restricted activity at 1 month were seen 1 month from that time. If patients did not return to the outpatients clinic they were interviewed by telephone.

The data were collected on a pro forma and entered into a computer database. Comparison between the two groups was performed using the Mann-Whitney U test on the Statistical Package for the Social Sciences (SPSS).

Results

Patients

A total of 158 patients were enrolled in the trial. There were protocol violations in seven patients: The appendix was not removed in three (all laparoscopic), and conversion to a midline laparotomy occurred in four (laparoscopy two, open two). In the latter group the reasons for conversion were perforated cecal diverticulitis, cecal volvulus, eosinophilic enterocolitis, and acute cholecystitis. There were no significant differences between the two randomized groups at the time of enrollment (Table 1) or when the seven patients were excluded, leaving 151 patients for the final analysis. The results from the 79 patients who had a laparoscopic appendectomy and the 72 who had an open appendectomy are summarized in Table 2.

Conversion

Seven patients were converted from a laparoscopic appendectomy to an open right iliac fossa muscle-splitting approach. In five patients with gangrenous appendicitis and two patients with suppurative appendicitis the reason for conversion was difficult access to the appendix because of inflammatory adhesions.

Table 2. Results of appendectomy trial following exclusion of protocol violations (5 patients).

Parameter	Open (n = 72)	Laparoscopic (n = 79)	Converted (n = 7)	p
Pathology				
Normal	16	7		NS ^a
Catarrhal	6	8		NS
Inflamed	11	12		NS
Suppurative	29	34	2	NS
Gangrenous	17	11	5	NS
Operative time				
Median hours	40 (15–105)	63 (28–122)	85 (70–115)	< 0.05 ^b
Complications				
Wound infection	8	2	—	< 0.05 ^b
Chest infection	2	1	1	
Urinary	0	3	1	
Small bowel obstruction	1	2		
Analgesia (median dose)				
Minor drugs	3 (0–16)	4 (0–26)		NS
Narcotics	4 (1–23)	2 (0–28)		< 0.0002 ^b
Recovery (hours)				
Time until flatus	24 (10–240)	24 (10–192)		NS
Time until solid food	48 (24–456)	36 (12–552)		< 0.0009 ^b
Time until discharge (days)	3 (2–29)	3 (1–26)		NS
Normal activity				
Median days	14 (2–70)	7 (2–41)		0.0004 ^b

^aNS: no significant difference.

^bMann-Whitney U test.

Operating Time

The median operating time of 63 minutes for the laparoscopic group was significantly longer than the 40 minutes for the open group. Patients who required conversion from a laparoscopic to an open procedure had a median operative time double that of the open procedure group. The operating surgeon was a surgical trainee for 68 (94%) of the open appendectomies and 44 (56%) of the laparoscopic appendectomies.

Analgesia

The laparoscopic group required less narcotic analgesia and were able to tolerate a solid diet at a median of 36 hours compared to 48 hours for the open surgery group.

Complications

The wound infection rate of 2% for the laparoscopic group was significantly less than the 11% observed after an open appendectomy. Early postoperative adhesive small bowel obstruction requiring laparotomy occurred in three patients (two in the laparoscopic group, one in the open surgery group).

Table 3. Prospective randomized trials of laparoscopic versus open appendectomy.

Parameter	Tate et al. [8] Hong Kong	Kum et al. [9] ^a Singapore	Attwood et al. [10] Ireland	Fraze et al. [11] Texas	Hansen et al. [present study] Brisbane
Number (lap./open)	70/70	52/57	30/32	38/37	79/72
Operating time	Increased ^b	ND	ND	Increased	Increased ^b
Conversion rate	20%	NIL	6.6%	5%	9%
Postop. time	ND	ND	LA less ^b	ND	ND
Wound infection	ND	LA less ^b	ND	LA less ^b	LA less ^b
Return to normal activity	ND	LA less ^b	LA less ^b	LA less ^b	LA less ^b

ND: no difference; LA: laparoscopic appendectomy.

^aExcluded gangrenous appendicitis.

^bSignificant difference.

Time to Discharge

The median time to discharge was 3 days for each group. The 27 patients with gangrenous appendicitis had a median time to discharge of 4 days (range 2–29 days) with no difference between the laparoscopic and open surgery groups.

Activity

Four patients could not be contacted after the surgery, two in each group. For the 147 patients interviewed, return to normal activity occurred at a median 7 days in the laparoscopic group and 14 days in the open surgery group. The seven patients who were converted to an open procedure from the laparoscopic approach had the same time to normal activity as the group who had a primary open appendectomy. The results of the 79 patients who had a laparoscopic appendectomy and 72 who had an open appendectomy are summarized in Table 2.

Cost

The cost of performing the laparoscopic procedure was calculated by noting the disposable ports, instruments, and sutures used for each operation. The cost averaged \$144 for a laparoscopic appendectomy compared to \$38 for the open procedure. In our hospital, operating time has not been used as a measure of the cost of the procedure.

Discussion

Advantages of laparoscopic appendectomy such as less postoperative pain, shorter inpatient stay, and earlier return to normal activity have been described in a number of comparative studies [4–7]. There have been four prospective randomized studies [8–11] addressing the role of laparoscopic versus open appendectomy. A summary of the results of those studies along with this series is shown in Table 3.

The median time of 63 minutes to perform the operation laparoscopically was significantly longer than the 40 minutes for the open approach. This difference would have been greater if the time to set up the equipment for the open and laparoscopic appendectomies were included. Increased operating time has also been shown elsewhere [8, 11]. In our study the difference in surgical time may be related to the variety of consultants and surgical trainees performing the surgery with different levels of experience in the laparoscopic procedure. Laparoscopic operating

time should improve with increasing experience. The Singapore group did not show a difference in operating times, but patients with gangrenous appendicitis were excluded [9]. It was our experience that this group of patients was technically more difficult. Patients requiring conversion from laparoscopic to open appendectomy had gangrenous or suppurative appendicitis with inflammatory or omental adhesions, making dissection and visualization of the appendix difficult. Depending on the appearance at the time of laparoscopy and the experience of the operating surgeon, it seems sensible to consider early conversion if the appendix cannot be completely visualized or if there are inflammatory adhesions, which make the dissection difficult.

We have shown a reduction in the wound infection rate from 11% in the open surgery group to 2% for the laparoscopic group. Laparoscopically, the appendix was always removed via a port or within a plastic bag, which decreased the potential for the wound contamination that may occur with an open procedure. The median postoperative inpatient time of 3 days for both the laparoscopic and open surgery groups was increased by 1 day in both groups if the appendix was gangrenous. Three other randomized studies have also concluded that the postoperative inpatient time was the same for both groups [8, 9, 11]. Previous comparative studies had shown less time in hospital following a laparoscopic appendectomy, and we may have expected the same given the decreased requirement for narcotic analgesia postoperatively. One report examining the time to discharge after open appendectomy (patients were informed they would be discharged the next day) has shown that 80% of patients could be discharged the day after surgery and that this policy was safe and had good patient acceptability [12]. In our study 23% of the laparoscopic appendectomy patients and 7% of the open appendectomy patients were discharged the day after surgery. Overall recovery and therefore time to discharge is likely to be related to the patient's response to the inflammatory illness and to the expectations of the patients and the doctors in charge of their care. Reflecting the experience of Ramesh and Gallard [12], it seems appropriate that other studies of laparoscopic appendectomy should pursue an aggressive discharge policy rather than the policy we had of leaving the time to discharge for each patient to the discretion of the surgical team in charge with no specific instructions.

Similarly, a patient's return to normal activity may have a number of influencing factors apart from the physical disability. We have found that the median time to normal activity was 7 days after a laparoscopic appendectomy and 14 days after open appen-

dectomy. A study from Hong Kong found no difference between the groups, but only 88 of the 140 patients admitted into the study were available for follow-up [8], which may have influenced the results in terms of assessing return to normal activity.

It has been suggested that there may be fewer adhesion-related complications, such as intestinal obstruction, after a laparoscopic appendectomy [13]. We had two patients with early postoperative adhesive obstruction requiring laparotomy in the laparoscopic group and one in the open surgery group. Before making conclusions relating to the reduction of adhesions as a reason to perform a laparoscopic appendectomy, a much larger comparative study with long-term follow-up is needed.

In our institution, the costs relate primarily to the disposable instruments and not to the time the operating room is in use. If operating time is considered a major factor in terms of the cost of surgery, laparoscopic appendectomy becomes even less cost-effective. In that situation the use of more expensive technology, such as stapling devices, may improve the cost efficiency by reducing the operating time.

In summary, we have provided evidence that laparoscopic appendectomy is as safe as an open appendectomy performed via the traditional right iliac fossa muscle-splitting approach. The laparoscopic approach has advantages that allow it to be considered a good alternative technique for patients who present with the clinical features of acute appendicitis. The results do not strongly favor one approach over the other. We agree with a report from Hong Kong stating that the decision between a laparoscopic or an open approach for acute appendicitis is determined by the preferences of the patient and the surgeon [8].

Résumé

Entre Octobre 1992 et Avril 1994, on a comparé par un essai prospectif et randomisé l'appendicectomie par laparoscopie et l'appendicectomie par laparotomie chez 158 patients ayant le diagnostic d'appendicite aiguë. Sept patients déjà randomisés ont dû ensuite être exclus de l'analyse en raison de violation de protocole (conversion dans 4, appendice laissé en place dans 3). Des 151 patients restants, il n'y avait aucune différence statistiquement significative en ce qui concerne le sexe, l'âge, le score ASA ou l'antécédent de chirurgie entre le groupe laparoscopie ($n = 79$) et le groupe laparotomie ($n = 72$). De même, il n'y avait aucune différence statistiquement significative en ce qui concerne l'histologie de l'appendice, classée comme normale, catarrhale, inflammée, suppurative, ou gangrenée. Sept patients ont nécessité une conversion (9%) de laparoscopie en laparotomie en raison d'inflammation importante. Comparée à l'appendicectomie par laparotomie, l'appendicectomie par laparoscopie a pris plus de temps (médiane 63 vs 40 minutes), a donné moins d'infection pariétale (2% vs 11%), a nécessité moins d'analgésie par médicament narcotique, et les patients ont pu regagner une activité normale plus vite (médiane 7 vs 14 jours). Il n'y avait aucune différence statistiquement significative en ce qui concerne la morbidité. La médiane de durée d'hospitalisation était de 3 jours dans les deux groupes. En conclusion l'appendicectomie par laparoscopie est aussi sûre que par laparotomie, et en dépit du temps opératoire plus élevé, nous pensons que les avantages tels le taux diminué d'infections pariétales et un retour au travail plus précoce, en font une alternative valable pour les patients ayant le diagnostic d'appendicite aiguë.

Resumen

Se realizó un ensayo clínico prospectivo y randomizado para comparar la apendicectomía laparoscópica con la apendicectomía abierta en pacientes con diagnóstico de apendicitis aguda en el período octubre de 1992 a abril de 1994. De 158 pacientes randomizados, 7 fueron excluidos por violaciones del protocolo (conversión a laparotomía 4, apéndice no resecado 3). Los 151 pacientes randomizados a laparoscópica (79) o a abierta (72) mostraron que no había diferencias significativas entre los dos grupos en cuanto a sexo, edad, categorización del riesgo anestésico (A.S.A.) o cirugía abdominal previa. Tampoco hubo diferencias en cuanto a clasificación histológica de normal, catarral, inflamado, supurativo o gangrenoso. La conversión de apendicectomía laparoscópica a abierta fue necesaria en 7 pacientes (9%) que presentaban estados avanzados de inflamación apendicular. Al compararlo con la apendicectomía abierta, el grupo laparoscópico demostró un tiempo operatorio más prolongado (promedio 63 vs. 40 minutos), menor tasa de infección de la herida (2% vs. 11%), menor requerimiento de analgesia narcótica y más pronto retorno a la actividad normal (promedio 7 vs. 14 días). No se encontró diferencia en la morbilidad y ambos grupos tuvieron un promedio de egreso de 3 días luego del procedimiento. La apendicectomía laparoscópica es tan segura como la apendicectomía abierta y a pesar de que significa un tiempo operatorio más prolongado, las ventajas representadas por menos infecciones de herida y más temprano retorno a la actividad normal, la constituye en una alternativa valiosa en pacientes con el diagnóstico clínico de apendicitis aguda.

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Invited Commentary

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Following the success of laparoscopic cholecystectomy, surgeons began to use this new approach to perform other operations in the abdominal cavity. We have thus witnessed a period during which it has been shown that nearly all abdominal surgery can be done via the laparoscopic approach. To recommend using it, however, we need prospective randomized studies that, by comparing a significant number of cases with laparotomy or laparoscopy, demonstrate the advantages of this new procedure. Furthermore, the results must be reproduced by most authors. The study by Hansen et al. seems appropriate as well as methodologically correct.

Their results coincide with ours [1] in one important aspect: the decreased number of postoperative abdominal wall infections in the laparoscopy group. However, there were no significant differences in surgical time for the two procedures in our series, probably because all the laparoscopic appendectomies were performed by surgeons with major experience in laparoscopic surgery. On the other hand, in our series the hospital stay was significantly shorter with the laparoscopic approach, although we agree with Hansen et al. that this parameter is difficult to evaluate because there were no specific instructions about discharge. An important aspect in our series, not mentioned in this study, is that the laparoscopic approach in patients with a normal appendix enables better identification of the pathology responsible for the acute abdomen and significantly reduces the percentage of fruitless laparotomies. It is important to note that all gynecologic disorders confused with acute appendicitis can be managed with laparoscopic surgery [2].

In short, we agree with Hansen et al.'s final conclusion that laparoscopic appendectomy is as safe as open appendectomy, with their results not strongly favoring one approach over the other. They believe that the decision should be determined by the preferences of the patient and surgeon. However, we believe the question remains open and the task unfinished. Prospective studies should be carried out, with separation of the patients into groups according to age, sex, obesity, presence of perforation, and so on. There may be no differences between approaches to a nonperforated acute appendicitis in the nonobese adolescent boy, but there may be differences in obese patients, young and fertile women, cases complicated with diffuse acute peritonitis, and so on. There is still another important question: adhesion formation induced by the two procedures. Open appendectomy for acute appendicitis is a relatively frequent cause of late intestinal obstruction due to adhesions, which may require reoperation, in some cases with intestinal resection. Fertile women may also present with sterility due to tube obstruction. Showing that laparoscopic appendectomy reduces the incidence of such complications because it induces fewer adhesions [3] would be an important argument in favor of this technique, although, it is not going to be easy. Further clinical and experimental studies are necessary.

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