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Laparoscopic Appendectomy for Perforated Appendicitis

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Abstract. Although laparoscopic appendectomy for uncomplicated appendicitis is feasible and safe, its application to perforated appendicitis is uncertain. A retrospective study of all patients with perforated appendicitis from 1992 to 1999 in a university hospital was performed. A series of 231 patients were diagnosed as having perforated appendicitis. Of these patients, 85 underwent laparoscopy (LA), among whom 40 (47%) required conversion to an open procedure. An open appendectomy (OA) was performed in 146 patients. The operating time was similar for the two groups. Return of fluid and solid diet intake were faster in LA than OA patients ($p < 0.01$). Postoperative infections including wound infections and abdominal abscesses occurred in 14% of patients in the laparoscopy group and in 26% of those with OA ($p < 0.05$). The surgeon's experience correlated with the conversion rate. Laparoscopic appendectomy is associated with a high conversion rate for perforated appendicitis. If successful, it offers patients faster recovery and less risk of infectious complications.

Laparoscopic appendectomy (LA) has been practiced for more than 10 years. There are at least 30 randomized trials and 5 meta-analyses reported in the literature. The results of meta-analyses have shown that LA causes less postoperative pain, resulting in faster recovery and shorter hospital stay [1–5]. In addition, they found that LA is associated with fewer wound infections than open appendectomy.

Perforated appendicitis occurs in 20% to 30% of patients with acute appendicitis [6]. This condition is associated with a significant risk of postoperative complications such as wound infection and intraabdominal abscess [7]. However, the benefits of LA in patients with perforated appendicitis remain uncertain. LA has less wound contamination during operation and direct visualization during peritoneal washing. Nevertheless, a few reports in the literature have suggested that there has been an increase in infectious complications following LA for perforated appendicitis [8, 9]. Another theoretical argument is the risk of bacterial translocation with carbon dioxide pneumoperitoneum [10–13].

In 1993 we reported one of the earliest randomized trials comparing LA and open appendectomy for acute appendicitis [14]. Our results showed that LA was associated with fewer wound infections and faster recovery than the open procedure. Since then, LA has been adopted by several surgeons in our unit for patients with acute appendicitis, even those with perforated appendicitis. The present study reviewed the results of laparoscopic appendectomy for perforated appendicitis and compared them with those for conventional open appendectomy during the same period.

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Materials and Methods

A retrospective review of patients with perforated appendicitis at National University Hospital, Singapore from January 1992 to June 1999 was performed. Perforated appendicitis was defined as free appendiceal perforation with purulent peritoneal fluid collection. Information on the postoperative course, including the 30-day mortality and morbidity rates, was obtained from hospital records.

All patients received preoperative intravenous antibiotics. Laparoscopic appendectomy was performed via three ports. A 12 mm subumbilical port was introduced using the open method to create a pneumoperitoneum. Two 5 mm ports were inserted at the left iliac fossa and suprapublic area, respectively. The mesoappendix was divided using cautery, clips, or a stapler. The appendix was then ligated and divided at its base with chromic catgut Endoloops (Ethicon, Cincinnati, OH, USA) or transected by stapler. The specimen was usually removed in a bag (EndoCatch; USSC, Norwalk, USA). In the case of an open appendectomy, a gridiron or midline incision was made depending on the surgeon's preference. The operation was performed in the standard manner followed by primary closure of the abdominal wound. Both groups of patients underwent thorough peritoneal lavage using copious amounts of warmed saline. Drains were used accordingly. Intravenous antibiotics were given until sepsis subsided. Analgesics with intramuscular pethidine and oral Naprosyn were given to patients on demand. Diet was introduced when bowel movements started. The patients were followed up at least once after discharge.

Patients with conversion to the open procedure were analyzed in the laparoscopy group on an "intention-to-treat" basis. The continuous variables were analyzed with Student's *t*-test. The chi-square or Fisher's exact test was used for categoric data. A value of $p < 0.05$ was considered significant.

Table 1. Operative results according to the procedure performed.

Parameter	Laparoscopic (n = 85)	Open (n = 146)
Operating time (minutes)	73 (25)	71 (25)
Fluid resumption (days)	1.8 (1.2)*	2.4 (1.4)*
Solid diet resumption (days)	3.9 (1.3)**	4.6 (1.8)**
Hospital stay (days)	5.2 (2.4)	5.9 (2.8)
Analgesic consumption (doses)		
Pethidine	2.9 (2.6)	3.2 (3.5)
Naproxen	4.0 (4.9)	2.9 (4.4)

Results are means (SD).
*p = 0.001; **p = 0.002.

Table 2. Postoperative infectious complications.

Complication	Laparoscopic (n = 85)	Open (n = 146)
Wound infection	12	36
Intraabdominal abscess	0	2
Total	12 (14%)*	38 (26%)*
Reoperation[a]**	4 (5%)	14 (10%)

[a]Includes relaparotomy and secondary suture.
*p < 0.05, relative risk 0.46, confidence interval 0.23–0.95.
**p = 0.2.

Table 3. Factors related to conversion.

Factor	Laparoscopic (n = 45)	Converted (n = 40)	p
Age (years), mean	29	34	0.1
Male/female	28:17	23:17	0.8
Duration of presentation (hours)	55	64	0.3
Appendicular abscess			
Yes	5	9	
No	40	31	0.2
Surgeon's experience with laparoscopy			
≥ 20 Cases	23	2	
< 20 Cases	22	38	< 0.001

Results

There were 231 patients diagnosed with perforated appendicitis in this study: 146 underwent conventional open appendectomy and 85 (37%) had laparoscopy. The mean age of these two groups were 30 and 31 years, respectively. The male/female ratio was 100:46 in the open group and 52:33 in the laparoscopy group (p = 0.1). The mean durations of symptoms were 63 hours (range 24–168 hours) and 59 hours (range 7–336 hours), respectively (p = 0.5).

Altogether, 40 patients (47%) underwent conversion to the open procedure after laparoscopy. The reasons for conversion were difficulty of dissection (24 patients), unclear anatomy (5 patients), appendicular mass (4 patients), inadequate working space due to small bowel ileus (2 patients), necrosis at the base of appendix (1 patient), and surgeon's preference for open appendectomy (4 patients). There were no other intraoperative complications in the series.

The operative results according to the procedure are shown in Table 1. The operating time was similar for LA and open appendectomy. In the subgroup analysis, the mean operating time in patients with conversion to open appendectomy from laparoscopy (CA) was 81 minutes, which was significantly longer than patients with laparoscopic appendectomy or open appendectomy (OA) (p = 0.002 for CA vs. LA; p = 0.03 for CA vs. OA). Patients in the laparoscopy group were on liquid and full diets earlier than patients who underwent OA (p = 0.001 and p = 0.002, respectively).

There were no deaths in this series, although 50 patients (22%) developed postoperative infectious complications (Table 2). Among the laparoscopy group 12 patients (14%) developed superficial wound infections, and 3 had an umbilical infection. Of these 12 patients, 9 had undergone conversion to open appendectomy from laparoscopy. Four patients (5%) required secondary wound closure. No patient developed an intraabdominal abscess. In the open surgery group, 38 patients (26%) had infectious complications: 36 wound infections and 2 abdominal abscesses. Fourteen patients (10%) required reoperation: Twelve patients had a secondary suture, one patient needed open drainage of a pelvic abscess, and one developed small bowel ischemia due to volvulus of the small intestine and required relaparotomy. The difference in postoperative infections between the two groups was significant in favor of LA [relative risk (RR) 0.46, confidence interval (CI) 0.23–0.95; p < 0.05]. If the patients with conversion were considered separately, the difference in postoperative infections between laparoscopic appendectomy and the open procedure showed significance in favor of the former procedure (RR 0.2, CI 0.06–0.7; p = 0.006).

The characteristics of patients with LA or conversion are shown in Table 3. The surgeon's experience with laparoscopic appendectomy was the only factor related to conversion. Surgeons with less experience with laparoscopic appendectomy had a higher conversion rate.

Discussion

This study reviewed more than 230 patients with perforated appendicitis over a 7-year period. It covered the same period when laparoscopic surgery was in its evolutionary phase. In our institution, this procedure has gradually become a routine approach to appendicitis even for patients with perforated appendicitis. In this series, laparoscopy was performed in one-third of the patients with perforated appendicitis, among whom more than half had a successful laparoscopic appendectomy. The laparoscopic procedure was associated with a lower risk of postoperative infections and faster recovery.

One of the major advantages of LA is the reduced risk of wound infection [1–5]. However, the benefit of LA for perforated appendicitis is less certain, as none of the randomized trials has recruited a sufficient number of patients with perforated appendicitis. Moreover, in some randomized trials including ours, cases of perforated appendicitis were excluded [14–17]. Controversy exists regarding the effect of pneumoperitoneum on animal models of peritonitis [10–13]. One experimental study in rats demonstrated that peritoneal insufflation increases the translocation of bacteria from the peritoneal cavity into the bloodstream [10], but this has been proven otherwise by some authors [11–13]. Gurter et al. studied the effect of CO_2 pneumoperitoneum on bacteremia, endotoxemia, and physiologic correlates of sepsis in rabbits [11]. There was no obvious difference between animals with laparot-

omy and those with pneumoperitoneum. In another study of *Escherichia coli* peritonitis in a porcine model, there was also no difference in cardiopulmonary response between laparoscopic intervention and laparotomy [13]. On the other hand, in a clinical randomized study in which laparoscopic repair was compared with laparotomy for perforated peptic ulcer, the authors found that the serum levels of bacteria, endotoxin, and acute-phase proteins were similar for the two procedures [18].

Results of clinical studies on laparoscopic appendectomy for perforated appendicitis have been controversial. Frazee and Bohannon reported an incidence of 26% of intraabdominal abscesses and 10% wound infections in patients with perforated appendicitis after laparoscopic appendectomy [9]. In a series reported by Bonanni et al., 5 of 11 patients who underwent a laparoscopic appendectomy for perforated appendicitis required readmission, mostly due to pelvic abscesses [19]. Other studies, however, showed that there is no difference between laparoscopic and open appendectomy regarding infectious complications for perforated appendicitis [20–22]. We found that laparoscopic appendectomy reduced the risk of infections postoperatively in patients with perforated appendicitis. No patients in the laparoscopic group of our series developed an intraabdominal abscess. Infection in the umbilical wound may be a problem, but it can be avoided by thoroughly washing and closing the umbilical wound with absorbable suture material.

Our laparoscopic results were comparable to most of the series reported in the literature. The operating time was obviously longer for the patients who converted to the open procedure than for those with laparoscopy alone or conventional appendectomy. The length of hospital stay showed in our study and others that there was no difference between LA and OA for patients with perforated appendicitis [9, 21]. A study by Johnson and Peetz, however, suggested that the hospital stay was reduced after laparoscopic appendectomy compared with the open procedure [20]. Laparoscopic appendectomy for perforated appendicitis is technically more demanding and has been associated with a higher conversion rate than uncomplicated appendicitis [20, 21, 23, 24]. However, our results indicated that a high conversion rate correlates with the surgeon's experience. In this series, most of the appendectomies were performed by surgeons-in-training after office hours. The current recommendation for accreditation of surgeons to perform laparoscopic appendectomy is a minimum of 20 cases [25].

Conclusions

Our study has demonstrated that laparoscopic appendectomy is a safe approach for perforated appendicitis. It reduces the risk of postoperative infections. The rate of conversion is high, but it will improve with the surgeon's experience.

Résumé. Alors que l'appendicectomie par laparoscopie pour appendicite non compliquée est faisable et sûre, son rôle dans l'appendicite perforée reste incertain. On a analysé rétrospectivement les résultats chez tous les patients traités pour appendicite perforée entre 1992 et 1999 dans un service de chirurgie d'un hôptial universitaire: 231 patients ont ainsi été inclus dans cette étude. Quatre-vingt-cinq patients ont eu une laparoscopie (LA): 40 patients (47%) ont nécessité une conversion à la voie tradtionnelle. Une appendicectomie par voie traditionnelle (OA) a été réalisée chez 146 patients. La durée de l'intervention était similaire entre les deux groupes. La reprise d'alimentation orale et solide a été plus rapide dans le groupe LA par rapport au groupe OA ($p < 0.01$). On a noté des complications infectieuses, y compris des infections pariétales et des abcès intra-abdominaux chez 14% dans le groupe L, comparé à 26% pour le groupe O ($p < 0.05$). L'expérience du chirurgien a été corrélée directement avec le taux de conversion. L'appendicectomie laparoscopique est associée à un taux élevé de conversion en raison de l'appendicite perforée. En cas de succès, la récupération est plus rapide et il y a moins de risque de complications infectieuses.

Resumen. Mientras que la apendicectomía laparoscópica es posible y segura en las apendicitis no complicadas, el papel de la laparoscópia en el tratamiento de la apendicitis perforada está muy controvertido. En un hospital universitario se efectuó un estudio retrospectivo de todos aquellos casos de apendicitis perforada, intervenidos entre 1992 y 1999. 231 pacientes fueron diagnosticados de perforación apendicular. 85 fueron tratados por laparoscopia (LA) pero 40 (47%) requirieron reconversión a cirugía abierta. Con apendicectomía abierta (OA) se trataron 146 enfermos. La duración de la operación fue similar en ambos grupos. La iniciación de la ingesta de líquidos y sólidos fue más precoz en el grupo LA que en el OA ($p < 0.01$). Infección postoperatoria que comprende tanto la de la herida como abscesos abdominales, se constató en el 14% de los pacientes del grupo LA y en el 26% de los del grupo OA ($p < 0.05$). La experiencia del cirujano se correlacionó directamente con la tasa de reconversión. Ésta es mucho más frecuente en el tratamiento laparoscópico de las apendicitis perforadas. Si la apendicectomía laparoscópica puede realizarse satisfactoriamente el paciente se recuperará con más rapidez y el riesgo de complicaciones infecciosas será menor.

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