Infectious complications following laparoscopic appendectomy

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Introduction: A meta-analysis of the literature suggests there is an increased rate of intra-abdominal abscess after laparoscopic appendectomy (LA) compared with open appendectomy (OA). **Methods:** To analyze the infectious complications of LA at one tertiary care centre, we completed a retrospective chart review for all patients undergoing LA for acute appendicitis from 1995 to 2002. **Results:** We used established exclusion criteria to identify 175 patients with a mean age of 37.6 (standard deviation [SD] 14.5) years (95 male, 80 female). The mean operating time was 61.9 (SD 22.5) minutes. Excluding conversions to OA (14/175, 8%), operating time was 59.9 (SD 20.5) minutes. On surgical assessment, 143 patients had acute nonperforated appendicitis (17 perforated, 15 gangrenous). However, on histopathology assessment, 13 cases of normal appendix were identified (13/175, 7.4%). The overall median length of stay was 2.0 days. Three patients had significant postoperative infectious complications, including 1 wound infection and 2 cases of intra-abdominal abscesses. All abscesses were managed successfully with percutaneous drainage. An analysis of perioperative factors that might have contributed to the infectious complications revealed that each case of postoperative intra-abdominal abscess occurred in patients with gangrenous appendicitis and when extensive irrigation was used during LA. **Conclusions:** An institutional review demonstrates outcomes comparable with the Cochrane systematic review of the published literature. Technical issues that may impact on intra-abdominal abscess formation after LA include aggressive manipulation of the infected appendix and increased use of irrigation fluid, possibly producing greater contamination of the peritoneal cavity.

Introduction : Une méta-analyse de la littérature médicale indique un taux accru de formation d'abcès intra-abdominaux après une appendicectomie par laparoscopie (AL) comparativement à une appendicectomie ouverte (AO). **Méthodes :** Pour analyser les complications infectieuses de l'AL à un centre de soins tertiaires, nous avons procédé à une étude rétrospective de dossiers de tous les patients qui ont subi une AL pour une appendicite aiguë de 1995 à 2002. **Résultats :** Nous avons utilisé des critères d'exclusion établis pour identifier 175 patients âgés en moyenne de 37,6 (écart type [ET] 14,5) ans (95 hommes, 80 femmes). L'opération a duré en moyenne 61,9 (ET 22,5) minutes. Sans compter les conversions en AO (14/175, 8 %), l'intervention a duré 59,9 (ET 20,5) minutes. Au moment de l'évaluation chirurgicale, 143 patients avaient une appendicite aiguë non perforée (17 perforées, 15 gangréneuses). L'évaluation histopathologique a toutefois révélé 13 cas où l'appendice était normal (13/175, 7,4 %). La durée médiane globale du séjour s'est établie à 2,0 jours. Trois patients ont eu des complications infectieuses postopératoires importantes, soit une infection de la plaie et deux abcès intra-abdominaux. On a traité avec succès tous les abcès par drainage percutané. Une analyse des facteurs périopératoires qui auraient pu contribuer aux complications infectieuses a révélé que chaque cas d'abcès intra-abdominal postopératoire s'est produit chez des patients qui avaient une appendicite gangréneuse et lorsqu'on a utilisé une irrigation importante au cours de l'AL. **Conclusions :** Un examen des cas en établissements révèle des résultats comparables à l'examen systématique Cochrane des écrits publiés. Les questions techniques qui peuvent avoir une incidence sur la formation d'abcès intra-abdominaux après une AL comprennent la manipulation agressive de l'appendice infecté et une plus grande utilisation de liquide d'irrigation, qui pourrait accroître la contamination de la cavité péritonéale.

Appendectomy remains one of the more common emergency procedures performed by gastrointestinal surgeons. Recent data show the incidence of appendicitis in Ontario to be 75 per 100 000 population.[1] Despite numerous clinical trials and 8 meta-analyses of the data, it is still not clear whether open appendectomy (OA) or laparoscopic appendectomy (LA) is the most efficacious and effective surgical approach to acute appendicitis.[2–9]

The Cochrane systematic review of randomized controlled trials comparing LA and OA is regularly updated and includes an analysis of 39 clinical trials.[9] This meta-analysis suggests that wound infections are about one-half as likely after LA and that intra-abdominal abscesses occur almost 3 times more often. The cause for this apparent increase in abscess formation after LA is unknown. There has been extensive research characterizing the immunological status of patients who undergo laparoscopic surgery; however, the results of these studies are conflicting, and the clinical implications of this research with respect to LA remains unclear.[10]

The limitations of a systematic review of the literature were clearly documented by the authors of the Cochrane review who analyzed LA and OA.[9] Our clinical experience suggested that there was no clinically important increase in the rate of postoperative intra-abdominal abscess after LA. To analyze the infectious complications in a large sample of patients, we reviewed all patients undergoing LA for acute appendicitis at one tertiary care centre, with specific attention to infectious complications and surgical technique.

Methods

We completed a retrospective chart review of all patients undergoing LA for a clinical presentation of acute appendicitis from 1995 to 2002. Exclusion criteria included incidental ap-

pendectomy, interval appendectomy and patients under 16 years of age. All procedures were performed at St. Joseph's Hospital in Edmonton, Alberta. Hospital and office charts were reviewed, and all data were abstracted and entered into standardized data collection forms. The presence of an erythematous, painful wound with purulent drainage was considered a wound infection; a febrile patient with typical sequelae (fever, elevated white cell count, ileus) and imaging that disclosed a fluid collection with characteristics of an abscess was considered to have an intra-abdominal abscess.

All data are expressed as mean, median and range. Statistical analysis was performed with Fischer's exact test, and we considered a 2-tailed p value of < 0.05 significant.

LA was completed by 7 surgeons within the time period of the study. There were important variations in technique, and operative reports were carefully scrutinized to identify parameters that might have influenced the rate of postoperative infectious complications. Ad hoc parameters selected were preoperative administration of antibiotics, operating time, use of irrigation at the operative site, method of extraction of the appendix and pathology of the appendix.

Results

After the chart review, 175 patients were considered eligible for study inclusion. Subjects' mean age was 37.6 (standard deviation [SD] 14.5, range 16–83) years, with 95 male (54%) and 80 female (46%) subjects. The mean operating time for all cases was 61.9 (SD 22.5, range 23–139) minutes. Excluding cases converted to open surgery (14, or 8%), the mean operative time was 59.9 (SD 20.5) minutes. We've listed the reasons for conversion to open surgery in Table 1.

On surgical assessment, 143 patients had acute nonperforated appendicitis (82%), 17 had gangrenous

appendicitis (10%) and 15 had perforated appendicitis (9%). Histopathology examination documented 13 cases of normal appendix (7.4%). The mean length of stay was 2.7 (SD 2.5, median 2.0) days; patients who had their procedure converted to open surgery were in hospital for a mean of 4.3 days. Four intraoperative complications were documented, including hemorrhage from the appendiceal artery malfunction of an endovascular stapler and suspected bowel injury (all required conversion to open surgery).

Postoperative complications were identified in 3 patients. One wound infection was managed by opening and packing the wound (0.57%) and 2 intra-abdominal abscesses were managed by percutaneous drainage (1.14%). Perioperative antibiotics were given to 172 of 175 patients (98.3%), and 84 patients underwent irrigation of the operative site (48%). Of all patients who underwent laparoscopic appendectomy (161), 4 had the appendix removed without the use of an extraction device (2.5%). Each patient with a postoperative intra-abdominal abscess had a gangrenous appendicitis removed with an extraction bag, and perioperative antibiotics were administered. Each patient also had extensive irrigation of the operative site at the end of the procedure.

Discussion

The Cochrane systematic review remains the most thorough and up-to-data analysis of clinical trials compar-

Table 1

Conversion to open surgery

Reason for conversion	No.
Bleeding from base of appendix	1
Technical	2
Adhesions	2
Perforated appendix with pus	6
Difficult anatomy	2
Suspicion of bowel injury	1
Total	**14**

ing LA and OA for acute appendicitis.[9] A summary of the essential data from the Cochrane review is presented in Table 2. Despite reviewing 39 clinical trials, Sauerland and colleagues comment on the mediocre quality of the data available from these trials. They describe the overall methodology as "moderate to poor" and cite problems related to randomization methods, variability in intention to treat analysis, unclear patient selection criteria, small trial size and heterogeneity for most outcomes. They also express concern that the surgical technique of LA and the training of surgeons in this technique have not been standardized. Their cautious conclusions reflect these concerns: "In those clinical settings where surgical expertise and equipment are available and affordable, di-

agnostic laparoscopy and LA (either in combination or separately) seem to have various advantages over OA."[9] Concerns over surgical technique relate to the surgical complications documented after LA, specifically, a threefold increase in postoperative intra-abdominal abscess (LA 1.8%, OA 0.61%, odds ratio 2.77). In this study, we identified a 1.1% rate of postoperative intra-abdominal abscess, which does not suggest a dramatic or clinically important increase in infectious complications following LA. Each of 2 patients with a postoperative intra-abdominal abscess in this study had a gangrenous appendicitis and extensive irrigation of the operative site at the conclusion of LA.

From the Cochrane review, patients with a gangrenous or perforated appendix are at higher risk of

intra-abdominal infections and should be excluded from a laparoscopic approach.[11] However, on careful analysis of studies that document a high rate of postoperative abscess, several concerns become apparent (Table 3). Pedersen and others[11] randomized 583 patients to LA and OA for suspected appendicitis. Of 282 patients undergoing LA, 65 were converted to open surgery (23% conversion rate, intention to treat analysis). In the laparoscopy arm of this study, 50 patients had a normal appendix that was not removed (normal appendectomy rate with LA 18% v. 22% with OA). In addition, there was an important difference in the number of patients with a gangrenous or perforated appendix randomized to LA (LA 130 patients v. OA 100 patients). The authors documented 13 postoperative abscesses in patients after LA, compared with 3 abscesses in patients after OA (15/16 abscesses occurred in patients with gangrenous or perforated appendicitis). The most important bias in this study relates to the trainees who performed the procedures, described by Pedersen and colleagues as, "a large number of young surgeons relatively inexperienced with laparoscopy."[11]

Long and others[12,13] also recorded a high rate of postoperative intra-abdominal abscess in a trial that involved 198 patients and 13 surgeons at an academic centre. Of 93 patients undergoing LA, there were 15 conversions to open surgery (16%). The median operating time for LA was 107 minutes. Eighty-one percent of the patients in this study required a 4-port technique to complete LA, and all patients were given a nasogastric tube. The authors recorded a remarkably high wound infection rate in both arms of this study (LA 18.3%, OA 16.2%). Postoperative abscesses were identified in 4 patients after LA (4.3%) and 1 patient after OA (0.95%). Patients undergoing OA had subcutaneous antibiotics infused through a wound catheter if a

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Table 2

Data from Cochrane systematic review of trials comparing laparoscopic appendectomy and open appendectomy

	LA	OA
Wound infection, % (OR)	3.8 (0.47)	7.6
Intra-abdominal abscess, % (OR)	1.8 (2.77)	0.61
Operative time	LA 14 min > OA*	
Length of stay	LA 0.7 d < OA*	
Postoperative pain	LA 8 mm < OA*	
Return to:		
Normal activity	LA 6 d < OA*	
Work	LA 3 d < OA	
Sports	LA 7 d < OA	
Bowel function	LA < OA (borderline significance)	
Cosmesis	LA 10 mm > OA (2 studies)	
Costs	Balanced	

LA = laparoscopic appendectomy; OA = open appendectomy; OR = odds ratio
*Heterogeneity of outcomes.

Table 3

Comparison of outcomes following laparoscopic appendectomy (LA)

Outcomes	Pederson et al[11]	Long et al 2001[12]	Present study
Normal appendix, %	18.7	16	7.4
Patients undergoing LA, no.*	232	78	175
Conversion to open surgery, %*	28.0	19.2	8.0
OR time, median min.	60†	107†	60
Wound infection, %*	3.4	21.8	0.57
Intra-abdominal abscess, %*	5.6	5.1	1.14

*Excludes patients having a diagnostic laparoscopy for normal appendix.
†Data include patients having diagnostic laparoscopy for normal appendix.
OR = odds ratio

perforated appendix was identified.

Whenever an advanced laparoscopic procedure violates basic surgical tenets, the clinical outcomes have been uniformly poor.[14–17] There are no identifiable, biologically plausible reasons for an increase in infectious complications after LA. The literature on host peritoneal defenses and immunosuppression after laparoscopy is inconclusive and has not translated into meaningful clinical directives.[10] Therefore, the cause for an increased rate of intra-abdominal abscess formation after LA must be related either to the basic characteristics of LA or rooted in the specific surgical technique used in its completion.

A careful approach to LA and standardization of the technique may influence infectious complications. Basic surgical principles should be adhered to and not compromised, especially in the learning phase of LA. During LA, the infected appendix should be handled with atraumatic grasping forceps (preferably by the meso-appendix), and every attempt should be made to avoid disruption of the appendix and peritoneal contamination. The appendix should be removed from the peritoneal cavity as soon as it is transected and should not be released to contaminate surfaces or leak contaminated fluid from its lumen. Wound protection is also essential, and the appendix must be extracted intact within a 10-mm trocar or with the use of an extraction device (i.e., Endocatch, Ethicon Endosurgery, Cin-cinnati, Ohio). Bacterial contamination at the operative site and on the appendiceal stump can be controlled with pulsed suction throughout the procedure; extensive irrigation is unnecessary. Moreover, irrigation may worsen peritoneal contamination by dispersing fluid and bacteria that gravitate into the dependent areas (pelvis, subdiaphragmatic space). This contaminated fluid is unlikely to be retrieved by further suctioning. Peritoneal defenses may not be able to control the extent of contamination in these situations, with the end result being more frequent postoperative abscesses.

According to the Cochrane systematic review of the literature, the challenges facing LA include longer operating time and an increased rate of postoperative infectious complications. Despite these conclusions, careful scrutiny of individual studies included in the Cochrane review suggests that technical issues may impact on postoperative infectious complications. Aggressive manipulation of the infected appendix and unnecessary use of irrigation may produce greater bacterial contamination of the peritoneal cavity. Further, standardization of the technical approach to LA and appropriate surgical instruction for residents in training will improve surgical outcomes. The quality of the literature makes it challenging to determine whether there is truly an increased risk of intra-abdominal abscess after LA. Further studies must be considered to understand this important issue.

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