

# Is There an Increased Risk of Intra-Abdominal Abscesses After Laparoscopic Appendectomy? Laparoscopic Versus Open Appendectomy: A Single-Institution Experience

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## Abstract

**Background:** Acute appendicitis is the most common cause of acute abdomen. Currently, larger numbers of appendectomies are being performed laparoscopically. The aim of this study was to compare laparoscopic appendectomies to open surgery in terms of intra- and post-operative complications, including the risk of intra-abdominal abscess formation, operative time, time of initiating oral diet, and the length of hospital stay in our institution.

**Methods:** The study group of 283 patients having undergone appendectomies between January 2013 and Jan 2016 was divided into two subgroups as 'open' and 'laparoscopic'. The data regarding the surgical outcomes of these groups were evaluated retrospectively and statistically analyzed.

**Results:** In terms of postoperative complications, intra-abdominal abscesses were found to be higher in the laparoscopic group ( $p=.045$ ). On the other hand, surgical site infection (SSI) rates were found to be higher in the open group (but did not reach statistical significance). Operative time was affected by the surgeon's expertise and was found to be shorter in the laparoscopic group ( $p<0.05$ ). The time of initiating oral diet was sooner in the laparoscopic group compared to the open group ( $p=0.043$ ), and the overall length of hospital stay was shorter in the laparoscopic group ( $p=0.0001$ ).

**Conclusions:** Laparoscopic appendectomy is associated with early return to a normal diet, fewer wound complications, and a shorter hospital stay, but also with a slightly higher rate of intra-abdominal abscesses. Notably, it is now the standard method of acute appendicitis management in some centers.

**Keywords:** Abscesses, laparoscopic appendectomy, open appendectomy

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## INTRODUCTION

The appendix, described as a vestigial organ, is the most frequent cause of acute abdomen.

Despite the mystery surrounding the discovery of this disease and its responsibility for mortalities in many unrecognized cases, acute appendicitis can now be surgically treated. Jacopo Berengario da Carpi, an Italian anatomist, was the first to describe the structure of the appendix in 1522 and the first appendectomy was performed by Claudius Amyand, who operated on a perforated appendix within the hernia sac of an 11-year-old boy in 1735 [1–2].

The aim of this study was to compare open

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to laparoscopic appendectomy in terms of early return to normal activity, intra- and post-operative complications, operative time, and length of hospital stay.

## **METHODS**

### *Data, inclusion, and exclusion criteria*

We collected the data of patients with acute appendicitis who underwent appendectomies between January 2013 and January 2016 in our institution and performed retrospective statistical analyses. Excluded from the final analysis were cases of: chronic abdominal pain; alternative pre-operative diagnoses (including gynecological diagnoses); laparotomy for other causes, involving bowel resection and incidental appendectomy; acute appendicitis in pregnant women; and, patients diagnosed pre-operatively with an appendicular mass whose laparoscopic appendectomies were converted to open surgery.

Following application of these exclusion criteria, 283 patients were finally enrolled. Parameters including age, sex, body mass index (BMI), comorbidities, the season of diagnosis, type of surgery performed, intra- and post-operative complications, time of initiating oral diet, operative time (minutes), and hospital stay were evaluated. For further analysis of the hospital stay, we excluded complicated cases found to have an intra-operative phlegmon or abscess, as well as cases with prolonged hospital stay due to other medical problems which could have affected the overall stay. We divided the patients into two subgroups, the open (117) and laparoscopic (166), in order to carry out the comparisons.

### *Statistical Analysis*

For comparisons between the groups in terms of the distribution of categorical variables, Pearson's chi-square or the Fisher-

Freeman-Halton tests were used, followed by the post-hoc Dunn test. The differences between the groups with regard to numerical variables were evaluated via the independent samples *t*-test or the Mann-Whitney *U* test. The value of  $p < 0.05$  was considered to be statistically significant. All calculations were performed with SPSS (IBM Statistics version 23).

## **RESULTS**

Descriptive statistics of the variables according to final diagnosis are shown in Table 1. A diagnosis of acute appendicitis was found to be more frequent in males, with more correct diagnoses observed in male patients ( $n_{M\&T}/N_M = 134/155$ ; 86.5%) compared to females ( $n_{F\&T}/N_F = 90/121$ ; 74.4%). This finding was statistically significant ( $p = 0.013$ ). The mean  $\pm$ SD age of patients with acute appendicitis was ( $26.21 \pm 15.21$ ) and the mean  $\pm$ SD BMI was ( $23.86 \pm 4.84$ ). There was no significant difference in terms of age and BMI between negative appendectomies and positive appendicitis ( $p = 0.226$  and  $p = 0.117$ , respectively). Patients who had acute appendicitis were diagnosed more frequently in the summer and autumn periods compared to winter and spring, although these results were not statistically significant ( $p = 0.185$ ).

Three laparoscopic cases were found to have been converted to open surgery; two were appendicular masses and one was due to a gynecological cause, and so they were not included in the final analysis. The conversion rate was calculated 1.72%.

Intra-operative complications were found to vary according to the procedure performed ( $p = 0.001$ ). Extensive adhesions between the inflamed appendix and the cecum or surrounding tissues were encountered more in the open group,

where it affected 12 patients (10.7%), compared to the laparoscopic group, where it affected five patients (3%). Seven cases (7%) resulted in large bowel injuries (including minor injuries such as cecal serosal tears) in the open group, far more than the laparoscopic group (there were no reported cases of large bowel injuries in the laparoscopic group). In the laparoscopic group, one case of small bowel injury was found (0.6%), and one case of bleeding from the fimbria end (0.6%). Other 'combined' complications were encountered in two patients, one in the open and one in the laparoscopic group. More intra-operative complications were observed in the open group, with most complications being minor cecal serosal tears which were significant ( $p=0.001$ ). The rate of post-operative complications was found to be 7.2% and 7.7% in laparoscopic and open appendectomies, respectively. Wound infections were more common in the open group, as seven patients (6%) were affected compared to five (3%) in the laparoscopic group. Intra-abdominal abscesses occurred in four patients in the laparoscopic group (2.4%). One case of wound dehiscence was reported in the laparoscopic group (0.6%). Intestinal obstruction was observed in two cases, one in the open surgery group (0.9%) and one in the laparoscopic surgery group (0.6%). Overall, the post-operative complications rate did not differ significantly between the laparoscopic and open appendectomy groups ( $p=0.415$ ), although the rate of wound complications was higher in the open group; however, intra-abdominal abscesses were reported exclusively in patients who underwent laparoscopic procedures in our study, which was significant ( $p=0.045$ ).

The time of initiating diet, calculated as when the patients started a clear fluid or full fluid diet, was shorter in the laparoscopic group after excluding the cases of complicated

appendicitis (phlegmonous appendicitis or abscess-related), which was significant ( $p=0.043$ ). The operative time (minutes) was affected by the surgeon's expertise and was significantly shorter in the laparoscopic group ( $n=115$ ,  $64.6\pm24.8$ ) compared to the open group ( $n=21$ ,  $83.6\pm44.1$ ) when the operators were specialists ( $p=0.006$ ). The operative time was also significantly shorter in the laparoscopic group ( $n=17$ ,  $65.6\pm21.4$ ) compared to the open group ( $n=84$ ,  $79.2\pm30.1$ ) when the operator was a resident ( $p=0.034$ ). In addition, the mean operative time was higher for surgical trainees ( $n=138$ ,  $79.3\pm30.5$ ) compared to specialists ( $n=136$ ,  $67.5\pm29.2$ ) ( $p=0.001$ ). The mean length of hospital stay was significantly shorter in the laparoscopic group ( $n=153$ ,  $1.9\pm0.988$ ) compared to the open group ( $n=100$ ,  $2.44\pm0.925$ ) for those cases without complications ( $p=0.0001$ ). However, the difference between laparoscopic ( $n=12$ ,  $6.83\pm2.17$ ) and open ( $n=17$ ,  $7.53\pm3.48$ ) surgery with regard to hospital stay was not found to be statistically significant in the group with complications ( $p=0.546$ ).

## DISCUSSION

The term 'acute appendicitis' was used by the pathologist-physician Reginald Fitz in 1886 [1–2]. Through the 18<sup>th</sup> to the late 19<sup>th</sup> century, the pathogenesis of this disease was obscure, despite many reported cases of a perforated appendix, and the associated intra-abdominal abscesses which resulted in many fatalities at that time [1–2]. Laparoscopic appendectomy was first performed in 1981 by Kurt Semm, a German gynecologist [3], who pioneered the introduction of laparoscopy to the surgical field; he inspired other surgeons such as Erich Mühe to perform a cholecystectomy laparoscopically in 1985 [3]. Performing

appendectomies laparoscopically was adopted relatively late, given the criticism and fears over safety and feasibility often voiced to surgeons at the beginning of the laparoscopic era.

Acute appendicitis is still the most common cause of acute abdomen [4]. Multiple etiologies were described as causing this common disease and the progression to complications, including the presence of intraluminal obstructions like fecalith formation or infestation with parasites, to inflammation by invasions of certain types of bacteria or viruses (shown in studies of the microbiological profiles of appendectomy specimens and swab cultures from perforated cases) [4–5].

Acute appendicitis exhibits seasonal variation, peaking in the summer period, with most cases in the third quarter of the year [4, 6]. There is also some ethnic variability, as more cases are found in White and Hispanic races compared to African and Asian [7]. It mainly affects younger age groups with a male predilection, although it can affect subjects of a wide range of ages, from those in the neonatal period to the elderly [7–8]. Immunology, inflammatory markers, and cytokines also play an important role in the initiation and progression of this disease [9–10].

Appendectomies are now increasingly performed laparoscopically, as it is considered to be a feasible and safe procedure. It is also associated with less pain [11–13], shorter hospital stays [12–14], and earlier return to normal activities (which could make it cost-effective given its comparable post-operative complications).

A study using data derived from the Taiwan health insurance research database that included 65,339 patients showed 30 days less readmission to hospitals in laparoscopic patients compared to open surgery, with shorter

hospital stays, albeit higher hospital costs per discharge [14].

The reported higher association of intra-abdominal abscesses with laparoscopic appendectomies is still a matter of debate, as some meta-analyses and studies have shown this association, while other studies contradict this association [12, 15–19]. In spite of these conflicting reports, this issue should be considered by the surgeon when operating on a complicated case [5, 20–21]. Possible explanations of the aforementioned association could be the dissemination of localized abscess during insufflation of the abdomen, frequent irrigation instead of suctioning (which could lead to the spread of bacteria), or inadequate experience in the operating surgeon when handling a complicated case [12]. With an increasing number of appendectomies being performed laparoscopically and an improvement in the learning curve of operators, fewer intra-abdominal abscesses are now being encountered, as supported by a Canada-wide analysis of discharge using an abstract database of 105,882 patients with acute appendicitis from 2004–2008 [15].

Antonio Biondi reported much higher post-operative complications, with these being mostly wound-related in open appendectomies (24.5%) compared to laparoscopic (6.7%). In our study, the overall rates of complications encountered in open and laparoscopic appendectomies were comparable at around 7%, but fewer surgical site infections were reported in laparoscopic appendectomies compared to open appendectomies, which is consistent with the findings reported by other studies [12].

In our study, the operative time of surgery differed significantly between the open appendectomy and laparoscopic appendectomy

groups. The average time of surgery was found to be shorter in the laparoscopic group and it was affected by the operator's expertise, with less time needed when a consultant performed the procedure compared to a surgical trainee. Operative time was found to be shorter in some studies; this is affected by the surgeon's experience and the BMI of the patients. A recent meta-analysis by Ciarrocchi and Amicucci which studied the outcomes of laparoscopic appendectomies in obese patients (BMI>30) favored laparoscopic appendectomy in terms of post-operative complications, hospital stay, and overall hospital charge. Their study reveal that laparoscopy is advantageous in obese patients and in female patients when another pathology is sought [20].

The time of initiating oral diet, defined as when the patient started a clear fluid diet or full fluid diet, which could reflect post-operative ileus, was shorter in the laparoscopic group with a significant  $p$  value after excluding the complicated cases (perforated cases and those who were found to have phlegmon or an abscess intraoperatively in both groups) ( $p=0.043$ ). The shorter returns to diet and normal activity, shorter hospital stays, and lower rates of wound complications were clear in our study, consistent with the findings of other studies [12–14, 16, 18–19, 21–22].

Laparoscopic appendectomy is associated with less post-operative pain compared to open appendectomy [11, 13, 16, 21]. One prospective study which evaluated post-operative pain

based on a visual analogue scale showed less post-operative pain and analgesic consumption compared to open surgery [11]. Given that there was no standardized protocol for assessing the degree of pain and that most patients received post-operative analgesia on a regular basis, we were unable to uncover conclusive results regarding post-operative pain.

## CONCLUSIONS

Currently, laparoscopic appendectomies are increasingly performed with comparable overall complications to open appendectomies, including fewer surgical site infections, earlier return to normal activities, less post-operative pain, better cosmesis, and shorter hospital stays; these factors make it a safe and feasible procedure. However, laparoscopic appendectomies are associated with a slightly increased rate of intra-abdominal abscess formation.

## COMPLIANCE WITH ETHICAL STANDARDS

The study (IRB number 10/2017/972) was approved by the appropriate institutional research ethics committee (IRB) and has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standard.

## CONFLICT OF INTEREST DISCLOSURES

All authors declare that they have no conflict of interest.

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## هل استئصال الزائدة الدودية بالمنظار الجراحي يزيد من فرص حدوث مضاعفات كتكوين الخراج البطني ؟ استئصال الزائدة الدودية بالمنظار مقارنة بالطريقة التقليدية (الفتح الجراحي)

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### الملخص

**خلفية الدراسة:** يعد التهاب الزائدة الدودية السبب الأكثر شيوعا للبطن الحاد.حالياً، يتم إجراء عمليات استئصال الزائدة الدودية بالمنظار الجراحي بشكل اكبر .

**الأهداف:** هدف الدراسة هو مقارنة عمليات استئصال الزائدة الدودية بالمنظار بالجراحة المفتوحة من حيث حدوث المضاعفات أثناء الجراحة وبعدها بما في ذلك تكوين خراجات داخل البطن بعد العملية والمدة الزمنية لإجراء العملية والوقت المستغرق لعودة المريض للنظام الغذائي المعتاد وفترة مكوثه في المستشفى.

**منهجية الدراسة:** تم تقسيم مجموعة الدراسة المكونة من 283 مريضاً ممن خضعوا لعملية استئصال الزائدة الدودية بين يناير 2013 ويناير 2016 إلى مجموعتين فرعيتين هما "من خضعوا للعملية بالطريقة التقليدية الفتح الجراحي" و "من أجروا العملية بالمنظار". تم تقييم النتائج الجراحية لهذه المجموعات بأثر رجعي وتحليلها إحصائياً..

**النتائج:** فيما يتعلق بمضاعفات ما بعد الجراحة، وجد أن الخراجات داخل البطن أعلى في مجموعة التنظير البطني. ( $p = 0.045$ ) وفيما يتعلق بالتهابات الجروح كانت النسب أعلى في مجموعة المرضى الذين أجريت لهم العملية بالطريقة التقليدية مقارنة بالذين أجريت لهم العملية بالمنظار (لكنها لم تصل إلى دلالة إحصائية). تأثر وقت الجراحة بخبرة الجراح ووجد أنه أقصر في مجموعة التنظير البطني. ( $P < 0.05$ ) كان وقت عودة المريض للنظام الغذائي أقصر في مجموعة التنظير البطني مقارنة بالمجموعة المفتوحة ( $P = 0.043$ ) ، وكانت المدة الإجمالية للإقامة في المستشفى أقصر في مجموعة التنظير البطني ( $P = 0.0001$ )

**الاستنتاجات:** يرتبط استئصال الزائدة الدودية بالمنظار الجراحي بالعودة المبكرة إلى النظام الغذائي، ومضاعفات أقل للجروح وإقامة أقصر في المستشفى، على الرغم من ارتباطه أيضاً بمعدل أعلى قليلاً لتكوين خراجات داخل البطن. والجدير بالذكر أن استئصال الزائدة الدودية بالمنظار أضحت العملية المعتمدة لعلاج التهاب الزائدة الدودية الحاد في بعض المستشفيات المركزية حول العالم.

**الكلمات الدالة:** خراجات، استئصال الزائدة الدودية بالمنظار، استئصال الزائدة الدودية المفتوح.