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# Laparoscopic versus Open Appendectomy: Where Are We Now?

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**Rezumat**

***Apendicectomia prin abord laparoscopic versus abord deschis: pentru ce optăm?***

*Scop:* Deși avantajele procedurilor laparoscopice au fost intens studiate pe parcursul ultimelor două decenii, apendicectomia laparoscopică nu a putut fi desemnată ca procedură standard de tratament din cauza unor dezavantaje de tipul timpilor operatori și al costurilor crescute. Obiectivul studiului nostru este de a reevalua rezultatele pe termen lung ale abordului laparoscopic versus cel chirurgical deschis pentru această patologie pe baza datelor actuale.
*Metode:* Datele pacienților supuși apendicectomiei între ianuarie 2012 și iulie 2012 au fost analizate prospectiv. Datele demografice ale pacienților, durata procedurii, perioada de internare, nevoia de analgezice, scorul VAS și rata mortalității au fost înregistrate.
*Rezultate:* Din 241 de pacienți, 120 (49.8%) au suferit intervenție deschisă și 121 (50.2%) au fost operați laparoscopic. Perioada intervenției a fost similară între cele două grupuri (p=0.855). Scorurile VAS după prima oră (p=0.001), după 6 (p=0.001) și după 12 ore de la operație (p=0.028) au fost mai mari în grupul de apendicectomii prin abord deschis (p=0.001). Nu au existat diferențe statistice vizând ratele de morbiditate între grupul prin abord deschis și cel prin abord laparoscopic (p=0.617).
*Concluzii:* Cele două tehnici operatorii sunt similare în ceea ce privește perioada de internare, durata operației și complicațiile postoperatorii. Apendicectomia laparoscopică reduce nevoia de analgezice și scorurile VAS; aceasta ar trebui prin urmare luată în considerare ca standard de aur în tratamentul chirurgical al apendicitei acute.

**Cuvinte cheie:** apendicită, apendicectomie, procedură laparoscopică, abces abdominal, infecția plăgii chirurgicale

**Abstract**

*Purpose:* Although the advantages of laparoscopic procedures has been well studied over the last two decade, laparoscopic appendectomy could not to be a standard therapy due to some disadvantages such as longer operative time and higher cost. The objective of our study is to re-evaluate the outcomes of laparoscopic versus open appendectomy with current data.
*Methods:* Between January 2012 and July 2012, the data of the patients who had appendectomy were recorded prospectively. Patients' demographics, duration of procedure, length of hospital stay, need of analgesics, postoperative visual analogue scale scores and morbidity were assessed.
*Results:* Of 241 patients, 120 (49.8%) underwent open and 121(50.2%) laparoscopic appendectomy. The operating time was similar for both groups (p=0.855). The visual analog scale scores of 1$^{st}$ (p=0.001), 6$^{th}$ (p=0.001) and 12$^{th}$ (p=0.028) hours were higher in open the appendectomy group. The total need of analgesics significantly was higher in open group (p=0.001). There was no statistical difference in terms of total morbidity rate between open and laparoscopic appendectomy groups (p=0.617).

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*Conclusion:* Two operative techniques are similar in terms of length of hospital stay, operative time, and postoperative complications. Laparoscopic appendectomy reduces the need for analgesics and visual analog scale scores; therefore, it should be considered as the gold standard for surgical treatment of acute appendicitis.
*Key words:* appendicitis, appendectomy, laparoscopic surgical procedure, abdominal abscess, surgical wound infection

## Introduction

Acute appendicitis (AA) accounts for the commonest indication for emergency visits during daily surgical practice, and appendectomy is the most common emergent operative procedure performed worldwide (1). Although open appendectomy (OA) has been accepted as the standard treatment of choice for AA with low mortality and morbidity rates, laparoscopic appendectomy (LA) has gradually gained acceptance (2). Short hospital stay, faster recovery and earlier return to full activity, decreased postoperative pain, improved wound healing, and lower wound infection rates have been offered to be the benefits of LA (1, 3-6). However, a continuing controversy still remains in the literature regarding the most appropriate method of appendectomy. Any additional potential benefits resulting from the laparoscopic approach would be really difficult to prove, because it is believed that OA has most of the advantages of minimally invasive surgery such as small incision, faster recovery and short hospital stay (2,7). Additionally, some researchers also tend to disapprove LA because of significantly longer operative times, concern with increased incidence of intra-abdominal abscesses, and suspicious applicability in cases of complicated appendicitis (1,4,5,7). Therefore, no consensus exists as to whether laparoscopy should be performed in selected patients, such as young female, obese patients, and employed patients or routinely for all patients with suspected AA (4,7,8).

We hypothesized that LA is a safe and effective approach with superior outcomes compared with OA in the management of all AA in adults, either complicated or uncomplicated, and it may be possible to overcome the potential disadvantages of LA including longer operative time and increased incidence of intra-abdominal abscesses with the advent of laparoscopic experience in an advanced laparoscopy center. For that reason, we undertook a prospective randomized study to compare the short and long-term outcomes of patients who were operated on for AA either by open or laparoscopic approaches.

## Methods

Between January 2012 and July 2012, data of the patients who had appendectomy either as OA or LA, in Bezmialem Vakif University Faculty of Medicine Department of General Surgery were recorded prospectively. The study was approved by the research and ethics committee at the Bezmialem Vakif University Faculty of Medicine (Number: B.30.2.BAV.0.05. 05/251).

The patients who completed follow-up were included in the study. Pregnant patients and patients who have had history of lower abdominal surgery were excluded from the study.

The patients were randomized into LA and OA groups via a computer-generated number. Patients with conversion to open approach were also excluded from the study. Informed written consent was gained from all of them, and the patients who did not offer their consent were excluded from the study. The data including patients' demographics, duration of the procedure, feature of the surgeon as consultant or resident, histopathological diagnoses, need of analgesics, postoperative 1$^{st}$, 6$^{th}$, 12$^{th}$ and 24$^{th}$ hour visual analog scale (VAS) score, length of hospital stay, return to normal daily activities, morbidity and mortality were recorded.

Diagnosis of AA was decided by the attending surgeon based on history, physical examination, laboratory and imaging techniques including ultrasonography and/or computed tomography.

The consultant surgeons who were qualified to perform standardized LA and OA or the residents under their supervision performed all operations under general anesthesia. LA was performed by a three-trocar technique. A 10 mm port was placed at the umbilicus for the 30 degree angled laparoscope, a 5 mm port was placed in the left lower abdominal quadrate and a 10 mm port was placed in the suprapubic area. Energy devices transected the mesoappendix, and the appendix base was ligated and divided between 2 endo-loops (EndoLoop Vicryl Coated Ligature, Ethicon UK Ltd, Edinburgh, UK) with laparoscopic scissors. The specimen was extracted with an extraction bag through the suprapubic trocar. The appendicular stump was not buried. A drain was placed into the rectovesical area, if necessary.

OA was performed through a 3-4 cm McBurney incision in the standard fashion. The mesoappendix was ligated, and the appendix was divided at the base and removed. The stump was not buried in the cecum. A drain was placed into the rectovesical area, if necessary.

All specimens underwent histopathological examination. All patients received a standard prophylactic intravenous antibiotic regimen of first generation cephalosporine (cefazolin sodium -Sefazol, 1000 mg IV, Mustafa Nevzat, Istanbul, Turkey). In patients with complicated AA, antibiotic treatment with first generation cephalosporine and metronidazole (Flagyl, 500 mg IV, Eczacibasi, Istanbul, Turkey) was customized according to the clinical situation of each patient.

All patients had one dose of parenteral analgesics (diclofenac sodium, 75 mg, IM, Abdi Ibrahim, Istanbul, Turkey) in the operating theatre before extubation. During postoperative follow up period, additional analgesics (diclofenac sodium, 75 mg, IM, Abdi Ibrahim, Istanbul, Turkey) were conducted upon patients' request. VAS scores were calculated at the postoperative 1$^{st}$, 6$^{th}$, 12$^{th}$ and 24$^{th}$ hours. VAS score evaluations were performed by telephone contact for the patients who were discharged before the first 24 hours. Patients were discharged when they tolerated a regular diet and were afebrile.

Patients were followed-up regularly in an outpatient clinic at weekly intervals for 3 weeks. Sutures were removed at the end of the first week, and patients were observed for development of any complications in the second- and third-week. Patients were informed to report for development of any complications after that.

Power calculations were performed for testing the hypotheses related to the comparisons between the treatment groups. The sample sizes of at least 120 for each group provided power of approximately 0.80 with a confidence level of 0.95 to compare two treatment groups.

Normally distributed continuous variables were expressed as mean ± standard deviation (SD). Categorical variables were expressed as frequencies and percentages of an appropriate denominator. All of the statistical analyses were performed using SPSS 16.0 software (SPSS Inc., Chicago, Illinois, USA). Student's t-test was used for analysis of normally distributed, descriptive continuous variables, which were expressed as mean ± SD. Chi-square test and Mann-Whitney test were used to compare qualitative variables. Differences were considered statistically significant if the p value was equal to or less than 0.05 with a 95% confidence interval.

## Results

Between January 2012 and July 2012, 246 patients were randomized to either OA (n = 120) or LA (n = 126). Five patients (4%) initially to have LA were converted to open approach and were excluded from the study due to protocol violations. Therefore, 121 patients remained in the LA group after the exclusion. No statistically significant differences were noted between the two groups in terms of demographic features, as shown in *Table 1*.

Operative data are shown in *Table 2*. The mean operative time was similar in the two groups. The histopathological diagnoses of phlegmonous, gangrenous and perforated appendicitis were distributed uniformly between the groups, except normal appendix which was significantly low in the LA group (chi-square test, p=0.011). The percentage of OA performed by residents was higher than LA without statistical significance (chi-square test, p=0.118). VAS scores of LA group were significantly less than that of OA group during the early post-operative period; however the difference did not reach statistical significance in 24 hour (*Table 3*). The LA group needed fewer parenteral analgesics in the overall postoperative period compared with the OA group. Length of hospital stay was shorter in the LA group than the OA group, but the difference was not statistically significant, as shown in *Table 3*.

The overall postoperative complication rate was similar for both groups (LA 7.4% vs. OA 8.3%, chi-square test, p=0.617) (*Table 3*). All of the wound infections could be managed conservatively by opening the wound and did not require any further surgical intervention. Percutaneous drainage was successfully performed in nine of ten patients for pelvic abscess. Only one patient needed surgical drainage because of the unsuccessful percutaneous intervention in LA group (*Table 4*).

There was no significant difference in the mean follow-up period of the two groups: 13.6 months for OA vs. 14.5 months for LA (chi-square test, p = 0.451). There was no mortality in the early postoperative or the follow-up period. There was no readmission for intestinal obstruction and incisional hernia for both groups.

***Table 1.*** *Patients' demographics*

| | OA (n=120) | LA (N=121) | p value |
|---|---|---|---|
| Age (years)[¥] (median, range) | 29.7±12.8 (30,19-65) | 26.4±9.7 (27,16-63) | 0.255[µ] |
| Sex (F/M) | 49/71 | 56/65 | 0.394[β] |
| BMI[¥] | 24.4±2.9 | 23.7±2.5 | 0.997[µ] |
| ASA score 1/2/3 | 105/12/3 | 107/17/2 | 0.455[β] |

[µ]: student's t test; [β]: chi-square test; [¥]: mean±SD; BMI: body mass index (kg/m$^2$);
ASA: American Society of Anesthesiology

***Table 2.*** *Operative data*

| | | OA (n=120) | LA (n=121) | p value |
|---|---|---|---|---|
| Operative time (min)[¥] 0.855[µ] | | | 51.1±20.6 | 52.1±14.3 |
| Surgeon | | | | 0.118[β] |
| | Consultant | 38 (31.6%) | 47 (38.8%) | |
| | Resident | 82 (68.4%) | 74 (61.2%) | |
| Appendix | | | | |
| | Normal | 17 (14.0%) | 8 (6.6%) | 0.011[β] |
| | Phlegmonous | 87 (72.5%) | 92 (76%) | 0.081[β] |
| | Gangrenous | 11 (9.1%) | 13 (10.8%) | 0.155[β] |
| | Perforated | 6 (5.0%) | 8 (6.6%) | 0.074[β] |

[µ]: student's t test; [β]: chi-square test; [¥]: mean±SD

***Table 3.*** *Outcomes of OA versus LA*

| | | OA (n=120) | LA (n=121) | p value |
|---|---|---|---|---|
| VAS score[¥] | | | | |
| | 1st hour | 7.8±0.9 | 7.3±0.7 | 0.001[µ] |
| | 6th hour | 4.6±1.3 | 4.0±1.2 | 0.001[µ] |
| | 12th hour | 3.2±1.5 | 2.7±1.4 | 0.028[µ] |
| | 24th hour | 3.4±1.3 | 2.9±1.1 | 0.057[µ] |
| Number of analgesics | | | | 0.001[α] |
| | 1 | 17 (14.2%) | 34 (28.1%) | |
| | 2 | 43 (35.8%) | 45 (37.2%) | |
| | 3 | 28 (23.3%) | 26 (21.5%) | |
| | 4 | 32 (26.7%) | 16 (13.2%) | |
| Hospital stay (hours)[¥] | | 29.85±22.98 | 26.56±24.63 | 0.072[α] |
| Return to normal activities (days) | | 6 (3-16) | 5 (2-13) | 0.325[µ] |
| Mortality | | 0 | 0 | - |
| Overall morbidity | | 10 (8.3%) | 9 (7.4%) | 0.617[β] |

[µ]: student's t test; [β]: chi-square test; [α]: Mann-Whitney test; [¥]: mean±SD

## Discussion

Although laparoscopy has unique advantages in several areas of daily surgical practice as a minimally invasive technique, superiority of LA to open approach has been discussed for many years (1,9,10). Similar results with regard to surgical and cosmetic outcomes and low cost are the important issues favoring OA (3). However, less postoperative pain, increased diagnostic accuracy in certain groups including older and female patients, early recovery and improved cosmetic appearance are accepted as the main advantages of LA (2,4,9). But these findings have not been uniformly gained in the previously performed studies because of the heterogeneity of their protocols (3).

Longer operative time during LA is another issue in the comparison of these two approaches. Generally, it is accepted that laparoscopic procedures may take longer times especially during early learning periods, when performed by inexperienced surgeons (1-4,9). However, shorter operative time during LA was also reported, which might be explained by degree of experience and better visualization during laparoscopy (11). The surgical staff has performed basic and advanced laparoscopic procedures in our center. We may think that this practice may cause similar outcomes with regard to operative time both in OA and LA groups. Therefore, we believe that it is possible to perform LA with operative times no longer than its open counterpart, as in the present study, after gaining experience in laparoscopic techniques. Furthermore, operative times for LA, which are no longer than that of OA should be accepted as a criterion favoring feasibility and efficacy of this operation.

Length of hospital stay is a very important factor that directly influences the well-being of the patient (4). In previous studies, it was shown that length of hospital stay is shorter with LA which was also confirmed by several meta-analyses (3,6,7,9). A 48-hour discharge policy which was proposed by several authors for appendectomy either by open or laparos-copic approaches and different hospital discharge criteria may also cause this controversy (3,9). In several studies, the time periods for discharge were mentioned as days, most probably influenced by social standards, insurance systems and hospital discharge policies (3,4,9,12). In this study, the length of hospital stay was calculated as hours to highlight the difference. Nevertheless, the amount of decrease in the mean length of hospital stay for the LA group was almost 3 hours, most probably without clinical significance.

Early recovery to full activity is another advantage of LA, which was supported by a large scale meta-analysis conducted by the Cochrane Colorectal Cancer Group (9,13). It is believed that minimal trauma to the abdominal wall during trocar placement causes less pain and a faster recovery (14). Early mobilization following LA was another appealing advantage, resulting from minimal manipulation of the cecum and the ileum (3). Although one day earlier recovery was seen in the LA group, there was no statistically significant difference between groups.

Postoperative pain can be assessed quantitatively by the daily requirements for analgesics and qualitatively by means of VAS scores on the first postoperative day (3). Nevertheless, the various kinds of analgesics, routes of administration and perception of pain by the patients under the influence of their cultural beliefs make it more difficult to estimate degree and relief of the pain. For that reason, we aimed to use both assessment methods to clarify this issue more efficiently. Various pain scores and number of analgesics after LA have been shown to be low in comparison to open approach in many previous studies (3,9). In the present study, degree of

***Table 4.*** *Postoperative complications*

| | OA (n=120) | LA (n=121) |
|---|---|---|
| Wound infection | 6 | 2 |
| Pelvic abscess | 4 | 6[¥] |
| Atelectasis | - | 1 |

[¥]: One patient required further surgery due to inability of percutaneous drainage

the postoperative pain measured by VAS scores and total requirement for analgesics were lower in LA group, and both differences were statistically significant. In this respect, all these findings also favor LA for the treatment of AA.

Postoperative complications usually are considered as an assessment of a procedure's safety. The common complications of appendectomy are wound infection, intra-abdominal abscess and postoperative ileus (9). Generally it was shown that the overall incidence of postoperative complications was lower in LA patients (3,4,7,9). This difference usually comes from a lower incidence of wound infections after laparoscopy as in this study.

Intra-abdominal abscess formation following appendectomy as a serious and potentially life-threatening complication is a controversial issue (9). In the literature, there were several reports showing higher incidence of intra-abdominal abscess formation following LA, especially for complicated AA cases (1-3,15,16). There were also studies favoring LA with regard to lower incidence of such complication. Although controlled lavage for removal of the inflammatory fluid collections can be performed easily via laparoscopy, there may be some confounding factors causing more abscess formations such as aggressive manipulation of the infected appendix, increased use of irrigation fluid, possibly producing greater contamination of the peritoneal cavity and carbon dioxide pneumoperitoneum contributing to the mechanical diffusion of bacteria inside the peritoneal cavity (3,9,13). It is believed that increased mastery of the learning curve and the use of standardized and experienced surgical techniques can cause a significant reduction in the incidence of intra-abdominal abscess after LA (3). The reduction of wound infection is a significant advantage of LA because of the controlled removal of the inflamed appendix via trocar or protective bag and smaller port-site wounds (3,4,9).

## Conclusion

LA reduces the number of postoperative analgesics and VAS scores together with similar length of hospital stay, operative time, and postoperative complications. Therefore, it should be considered as the gold standard for surgical treatment of AA.

### *Conflict of interest statement*

Gokhan Cipe states that he has no financial interest or conflict of interest to report. Oguz Idiz states that he has no financial interest or conflict of interest to report. Mustafa Hasbahceci states that he has no financial interest or conflict of interest to report. Suleyman Bozkurt states that he has no financial interest or conflict of interest to report. Huseyin Kadioglu states that he has no financial interest or conflict of interest to report. Halil Coskun states that he has no financial interest or conflict of interest to report. Oguzhan Karatape states that he has no financial interest or conflict of interest to report. Mahmut Muslumanoglu states that he has no financial interest or conflict of interest to report.

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