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***Retrospective Study***

**Comparison of clinical and histopathological features of patients underwent incidental or standard appendectomy**

Akbulut S *et al.* Incidental appendectomy during living donor hepatectomy

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**Abstract**

***BACKGROUND***

Incidental appendectomy can be defined as the removal of a clinically normal appendix during another surgical procedure unrelated to appendicitis or other appendicular diseases.

***AIM***

To compare the demographic, biochemical and histopathological features of the patients underwent incidental and standard appendectomy

***METHODS***

The demographic, biochemical and histopathologic data of 72 patients (Incidental App group) who underwent incidental appendectomy during living donor hepatectomy at our Liver Transplant Center between June 2009 and December 2016 were compared with data of 288 patients (Acute App group) who underwent appendectomy for presumed acute appendicitis. Incidental App group were matched at random in a 1:4 ratio with Acute App group in the same time frame. Appendectomy specimens of both groups were re-evaluated by an experienced two pathologist.

***RESULTS***

Statistically significant differences were found between groups in terms of age (*P* = 0.044), white blood cell (*P* < 0.001), neutrophil (*P* < 0.001), lymphocyte (*P* < 0.001), red cell distribution width (*P* = 0.036), mean corpuscular hemoglobin (*P* = 0.001), bilirubin (*P* = 0.002), appendix width (*P* < 0.001) and presence of acute appendicitis histopathologically (*P* < 0.001). However, no statistically significant differences were found between groups in terms of gender, platelet, mean platelet volume, mean corpuscular volume, platelet distribution width, appendix length. While the most common histopathological findings in the Incidental App group were normal appendix vermiformis (72.2%), fibrous obliteration (9.7%) and acute appendicitis (6.9%), the most common histopathological findings in the Acute App group were non-perforated acute appendicitis (62.8%), perforated appendicitis (16.7%), lymphoid hyperplasia (8.3%) and appendix vermiformis (6.3%).

***CONCLUSION***

Careful inspection of the entire abdominal cavity is useful for patients undergo major abdominal surgery such as donor hepatectomy. We think that experience is parallel to the surgeon’s foresight and we should not hesitate to make incidental appendectomy when necessary

**Key words**: Living donor hepatectomy; Incidental appendectomy; Acute appendicitis

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**Core tip:** Incidental appendectomy is a terminology defined as resection of the appendix vermiformis in necessary situations such as a pathologic finding, during abdominal operations performed for other reasons. The question of to whom incidental appendectomy should be performed is not yet answered since 1902 when Kelly opened this issue for discussion. In this study, we compared demographic, biochemical and histopathological features of the patients underwent incidental appendectomy during living donor hepatectomy with patients who underwent appendectomy for presumed acute appendicitis.

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**INTRODUCTION**

Acute appendicitis is the leading cause of acute abdominal pain and appendectomy is the most frequent emergency abdominal procedure performed world-wide[1-4]. The most frequent etiologic factors underlying luminal obstruction appendicitis are lymphoid hyperplasia in child-hood and appendiceal fecalith in adults[3,4]. The lifetime acute appendicitis risk is 5%-20%. This risk is found to be 8.6% for men and 6.9% for women. Furthermore, epidemiologic studies have found that there is a 12% and 23% for men and women to undergoing appendectomy throughout their entire life[5]. The results of epidemiologic studies have formed the basis of evidence used by the proponents of incidental appendectomy. Incidental appendectomy is a terminology defined as resection of the appendix vermiformis in necessary situations such as a pathologic finding, during abdominal operations performed for other reasons[6,7]. The question of to whom incidental appendectomy should be performed is not answered for the past century. In the present study it is aimed to compare the various parameters of patients who underwent incidental appendectomy during donor hepatectomy with the patients who underwent appendectomy for acute appendicitis.

**MATERIALS AND METHODS**

Between June 2009 and December 2016, the demographic, biochemical and histopathological features of the 72 living liver donors who underwent incidental appendectomy during living donor hepatectomy (LDH) in Inonu University Liver Transplantation Institute were obtained from ENLIL patient information management system and analyzed retrospectively. This group was defined as the Iincidental Appedectomy Group (Incidental App Group; *n* = 72). The living liver donors who underwent incidental appendectomy before June 2009 were not included in this study because most of the biochemical parameters could not be reached in the hospital information systems was used before ENLIL system in our hospital. Incidental App group consists of patients who underwent surgery for LDH and decided to perform appendectomy during routine abdominal exploration. Decision of appendectomy in this group was based on the clinical prediction of surgeons experienced in gastrointestinal surgery. The surgeons decided on appendectomy because of one or more reasons mentioned as follows: (1) increased risk of appendicitis after major abdominal surgery; (2) both the risk of complications and the duration of surgery may increase when appendectomy should be done in cases with history of major abdominal surgery; (3) the lateral end of the J incision used for LDH is very close to the ileocecal region in some patients and therefore increases the risk of manipulation of the appendix vermiformis during the abdominal wall retraction; (4) palpable fecalith within appendix vermiformis; and (5) intraoperative findings suggestive of acute appendicitis include growth of sizes, wall edema, hyperemia and erectile appendix vermiformis. A control group was created to compare with the Incidental App Group and this group was defined as Acute Appendicitis Group (Acute App Group; *n* = 288). Acute appendicitis group consist of patients who presented to the emergency unit with abdominal pain at the same time frame and underwent appendectomy with the preliminary diagnosis of acute appendicitis. Incidental App group were matched at random in a 1:4 ratio with Acute App group. For minimise the bias risk, selection of control group is made by another surgeon who is not related with the study. After obtaining an approval from the Inonu University Rectorate Ethics Committee (Approval No: 2018/16-18), patients‘ medical records were retrospectively reviewed. Both groups were compared in terms of age (yr), gender (male, female), white blood cell (WBC), Neutrophil, Lymphocyte, Plateletes, mean corpuscular hemoglobin (MCH), red cell distribution width (RDW), mean platelet volume (MPV), mean corpuscular volume (MCV), platelet distribution width (PDW), bilirubin, appendix widht (mm), appendix lenght (mm) and histopathological findings (acute appendicitis, appendix vermicularis, perforated appendicitis, fibrous obliteration, mucinous cystadenoma *etc*).

***Statistical analysis***

The statistical analyses were performed using IBM SPSS Statistics v25.0 (Statistical Package for the Social Sciences, Inc, Chicago, IL, United States). The quantitative variables were expressed as mean ± SD, Median, Min-Max and Interquartile Range (IQR). The qualitative variables were reported as number and percentage (%). Kolmogorov-Smirnov tests were used to assess normality distribution of quantitative variables. Nanparametric Mann Whitney-*U* test was used to compare the quantitative variables. Pearson Chi-Square and Monte Carlo simulated Chi-square tests were used to compare qualitative variables. A *P* value of less than 0.05 was considered statistically significant.

**RESULTS**

A total of 360 patients aged between 18 and 87 years were retrospectively reviewed. The age of the patients in the Incidental App group ranged from 19 to 63 years (mean ± SD: 31.1 ± 11.3, median: 28.5), and the age of the patients in the Acute App group ranged from 18 to 87 years (mean ± SD: 37.1± 17.3, median: 32). Statistically significant differences were found between groups in terms of age (*P* = 0.044), WBC (*P* < 0.001), neutrophil (*P* < 0.001), lymphocyte (*P* < 0.001), RDW (*P* = 0.036), MCH (*P* = 0.001), bilirubin (*P* = 0.002), appendix width (*P* < 0.001) and presence of acute appendicitis histopathologically (*P* < 0.001). However, no statistically significant differences were found between groups in terms of gender (*P* = 0.634), plateletes (*P* = 0.954), MPV (*P* = 0.441), PDW (*P* = 0.286), MCV (*P* = 0.078) and appendix length (*P* = 0.096)

Histopathological findings in the Acute App group were ranked according to frequency as follows: Non-perforated acute appendicitis (*n* = 181; 62.8%), perforated appendicitis (*n* = 48; 16.7%), lymphoid hyperplasia (*n* = 18; 6.3%), appendix vermiformis (*n* = 18; 6.3%), fibrous obliteration (*n* = 8; 2.8%) and mucinous cystadenoma (*n* = 5; 1.7%). Histopathological findings in the Incidental App group were ranked according to frequency as follows: appendix vermiformis (*n* = 52; 72.2%), fibrous obliteration (*n* = 7; 9.7%), acute appendicitis (*n* = 5; 6.9%), Enterobius vermicularis (*n* = 3; 4.2%) and lymphoid hyperplasia (*n* = 3; 4.2%). Demographic, biochemical and histopathological features of both groups were summarized in Table 1.

**DISCUSSION**

The discussions related incidental appendectomy medical literature is not new. In 1902 Kelly[8] have made a study asking the surgeons if they performed incidental appendectomy during laparotomies regarding other pathologies and hava asked two important questions. Ninety percent of the surgeons replied to the first question of Kelly that they had in deed performed incidental appendectomy during laparotomies if appendix vermiform was adherent to the surrounding tissues. Thirty-seven percent of the surgeons replied to the second question of Kelly that they performed incidental appendectomy during laparotomy even if it appeared structurally normal[8]. Since the beginning of the discussions made by Kelly, incidental appendectomy has been documented to be performed during gynecologic and abdominopelvic elective surgery (cholecystectomy, colorectal surgery, urologic diversion procedures, urinary bladder resection) and trauma surgeries[1]. The American College of Obstetrics and Gynecologic surgery recommend that appendectomy should be performed during all procedures planned in young female patients under 35 years of age[1,9]. Furthermore, in case with diagnostic laparotomy or laparoscopy for indeterminate abdominal pain that mimic acute appendicitis, it is suggested that incidental appendectomy should be performed to avoid future unnecessary radiologic and laboratory evaluation[1]. We prefer to perform a diagnostic laparoscopy during non-specific intermittent abdominal pain and perform appendectomy if we do not find specific disease process in the abdomen.

As there are proponents of incidental appendectomy, there are also opponents of incidental appendectomy as well. The proponents state that adhesion following any abdominal procedure causes higher complication risk and longer operations in the proceeding abdominal surgeries and recommend that incidental appendectomy should be performed in these patients when the life-time appendicitis risk is considered[2]. In addition, proponents also state that procedure of appendectomy is short, with almost no additional anesthesia risk and low complication rate; for these reasons they recommend that incidental appendectomy should be performed[1,7]. Another reason that proponents recommend incidental appendectomy is due to discovery of incidental tumors during appendectomy[1]. Appendiceal neoplasm is detected in 3.8%-4% of the cases operated for abdominal cancer[1]. The opponents of incidental appendectomy suggest that removing an organ in relation with the colon carries a significant risk of fecal contamination of the peritoneal cavity and caries a risk of surgical site infection and morbidity[1,2,7]. We found incidental carcinoid tumor in one patient who underwent LDH (0.6%) which is consistent with the rates given in other studies[3,4]. Our literature review showed that although there are proponents of incidental appendectomy stating that it is a cost-effective and low morbidity procedures, there are also opponents stating that it is not a cost-effective procedure with higher postoperative morbidity[2,10]. Nevertheless, there is a general consensus stating that incidental appendectomy should not be performed in patients receiving chemotherapy and/or radiotherapy, patients with Crohn’s disease, patients with unstable condition and in patients whom artificial vascular grafts was used for vascular reconstruction.

Another controversial point in literature is that incidental appendectomy and prophylactic appendectomy are terminologically same. We did not come across any information regarding this point in our literature review. Seemingly, this point will be controversial in future as well. Incidental appendectomy can be defined as resection of appendix vermiformis due to various reasons during abdominopelvic operations[6,7]. On the other hand, prophylactic appendectomy is defined as an elective resection of appendix vermiformis in a healthy individual who has no complaints or any other abdominopelvic surgical indication. Prophylactic appendectomy can be performed in individuals (soldiers, Antarctic or north pole workers, astronauts etc.) who is anticipated to have limited access to medical care for long durations.

In the present study, there was an age difference among the Incidental App and Acute App groups. The donor candidates are chosen from younger individuals and Incidental App group being younger is an expected finding. MCH was significantly higher in Incidental App group. This can be explained by the fact that incidental appendectomy patients were younger and healthy individual and therefore had higher MCH. Inflammatory markers such as WBC, neutrophil, RDW and bilirubin was higher in Acute App group which is also an expected finding. Interestingly, MPV, PDW and MCV which are markers of inflammatory process did not significantly change among the Incidental App and Acute App groups. Low lymphocyte counts in Acute App group clearly showed that during the disease process of acute appendicitis lymphocytes are reduced. In acute appendicitis the diameter of the appendix vermiformis is wider however in Incidental App group the length of the appendix vermiformis is longer than Acute App group. One of the main results of the study and the most important finding that we have difficulty in explaining is that acute appendicitis rate in Incidental App group was high being 6.9%.

There are some limitations of the present study. Firstly, the study design is retrospective. All the disadvantages of retrospective studies are valid for our study as well. In the present study, in order to reduce the bias we chose the control group in a ratio of 1:4 case matching method. Second limitation is that we could not present any result regarding the wound site infections in our study. The patient charts were retrospectively analyzed and unfortunately there were no data regarding the wound site infections observed in the patients.

In conclusion, we do not intend to give the message of performing incidental appendectomy in every major abdominal operation. We do not recommend appendectomy in cases with absolute contraindications stated in the discussion section. We recommend performing appendectomy during diagnostic laparoscopy or laparotomy performed for FMF or endometriosis; even if the appendix vermiform is appears normal. In our opinion, during major abdominal surgery such as LDH the peritoneal cavity should be gently explored thoroughly and we think that appendectomy should be performed if there are any suspicious findings in patients without clinical contraindication.

**ARTICLE HIGHLIGHTS**

***Research background***

Incidental appendectomy can be defined as the removal of a clinically normal appendix during another surgical procedure unrelated to appendicitis or other appendicular diseases. Although this issue was discussed by Kelly in 1902, the issue of incidental appendectomy is still unclear.

***Research objectives***

The aim of this study was to compare the clinical and histopathological parameters of patients who underwent incidental appendectomy during donor hepatectomy with the patients who underwent appendectomy for acute appendicitis.

***Research methods***

The clinical and histopathological data of 72 patients who underwent incidental appendectomy during living donor hepatectomy (LDH) at our Liver Transplant Center were compared with data of 288 patients who underwent appendectomy for presumed acute appendicitis. Incidental App group were matched at random in a 1:4 ratio with Acute App group in the same time frame. Appendectomy specimens of both groups were re-evaluated by an experienced two pathologist.

***Research results***

Statistically significant differences were found between groups in terms of age (*P* = 0.044), white blood cell (*P* < 0.001), neutrophil (*P* < 0.001), lymphocyte (*P* < 0.001), red cell distribution width (*P* = 0.031), mean corpuscular hemoglobin (*P* = 0.001), bilirubin (*P* = 0.002), appendix width (*P* < 0.001) and presence of acute appendicitis (*P* < 0.001). However, no statistically significant differences were found between groups in terms of gender, platelet, mean platelet volume, mean corpuscular volume, platelet distribution width, appendix length. While the most common histopathological findings in the Incidental App group were appendix vermiformis (72.2%), fibrous obliteration (9.7%) and acute appendicitis (6.9%), the most common histopathological findings in the Acute App group were non-perforated acute appendicitis (62.8%), perforated appendicitis (16.7%), lymphoid hyperplasia (6.3%) and appendix vermiformis (6.3%).

***Research conclusions***

We do not intend to give the message of performing incidental appendectomy in every major abdominal operation. We think that experience is parallel to the surgeon’s foresight and we should not hesitate to make incidental appendectomy when necessary.

***Research perspectives***

During major abdominal surgery such as LDH the peritoneal cavity should be gently explored thoroughly and we think that appendectomy should be performed if there are any suspicious findings in patients without clinical contraindication.

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**Table 1 Comparison of demographic: Clinical and histopathological features of both groups**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Incidental App (*n* = 72)** | **Acute App (*n* = 288)** | ***P* value** |
| **Age** |   |   | 0.044**a** |
|  mean ± SD | 31.1 ± 11.3 | 37.1 ± 17.3 |
|  Median | 28.5 | 32 |
|  Min-Max | 19-63 | 18-87 |
|  IQR | 12 | 24 |
| **Gender** |   |   | 0.634b |
|  Male | 37 (51.4) | 157 (54.5) |
|  Female | 35 (48.6) | 131 (45.5) |
| **WBC** |   |   |  < 0.001**a** |
| mean ± SD | 7.8 ± 2.1 | 13.2 ± 4.5 |
|  Median | 7.2 | 13 |
|  Min-Max | 4.5-15.4 | 1.1-23.8 |
|  IQR | 2.35 | 6.6 |
| **Neutrophil** |   |   |  < 0.001**a** |
|  mean ± SD | 4.6 ± 2 | 11 ± 6.2 |
|  Median | 4.2 | 11.1 |
|  Min-Max | 0.1-13.5 | 1.9-21.5 |
|  IQR | 1.8 | 7.2 |
| **Lymphocyte** |   |   |  < 0.001**a** |
|  mean ± SD | 2.3 ± 0.6 | 1.8 ± 1.0 |
|  Median | 2.3 | 1.7 |
|  Min-Max | 0.9-4.2 | 0.3-9.6 |
|  IQR | 1 | 1.3 |
| **Plateletes** |   |   | 0.954**a** |
|  mean ± SD | 248 ± 63.4 | 248.8 ± 84.2 |
|  Median | 241 | 236 |
|  Min-Max | 103-461 | 43-641 |
|  IQR | 73 | 90 |
| **RDW** |   |   | 0.036**a** |
| mean ± SD | 13.4 ± 1 | 14.4 ± 7.2 |
|  Median | 13.2 | 13.5 |
|  Min-Max | 11.8-18 | 11.4-28.8 |
|  IQR | 1.1 | 1.4 |
| **MCH** |   |   |  < 0.001**a** |
| mean ± SD | 29.8 ± 2.1 | 28.8 ± 3.1 |
|  Median | 29.9 | 29.3 |
|  Min-Max | 20-33 | 19.3-46.9 |
|  IQR | 2.4 | 2.4 |
| **MPV** |   |   | 0.441**a** |
| mean ± SD | 8.4 ± 1 | 8.9 ± 1.8 |
|  Median | 8.2 | 8.5 |
|  Min-Max | 6.3-11.6 | 5.4-12.4 |
|  IQR | 1.1 | 1.7 |
| **MCV** |   |   | 0.078**a** |
| mean ± SD | 86.8 ± 5.2 | 85.4 ± 6.9 |
|  Median | 87.5 | 86 |
|  Min-Max | 60.4-95.5 | 30.5-96.5 |
|  IQR | 6.2 | 6.7 |
| **PDW** |   |   | 0.286**a** |
| mean ± SD | 16.1 ± 2.1 | 15.8 ± 2.1 |
|  Median | 16.3 | 16.5 |
|  Min-Max | 11.3-18.3 | 8.9-19.2 |
|  IQR | 0.6 | 1 |
| **Bilirubin** |   |   | 0.002b |
| mean ± SD | 0.65 ± 0.3 | 0.87 ± 0.6 |
|  Median | 0.6 | 0.7 |
|  Min-Max | 0.1-2.1 | 0.1-6.0 |
|  IQR | 0.4 | 0.6 |
| **Appendix width (mm)** |   |   | < 0.001**a** |
| mean ± SD | 6.4 ± 1.8 | 10.9 ± 6.6 |
|  Median | 6 | 10 |
|  Min-Max | 4.0-13 | 1.5-40 |
|  IQR | 2 | 7 |
| **Appendix lenght (mm)** |   |   | 0.096**a** |
|  mean ± SD | 70.3 ± 18.8 | 66.5 ± 19.9 |
|  Median | 70 | 65 |
|  Min-Max | 30-110 | 10-155 |
|  IQR | 21 | 25 |
| **Acute appendicitis** |   |   | < 0.001a |
|  Yes | 5 (6.9) | 238 (82.6) |
|  No | 67 (93.1) | 50 (17.4) |
| **Histopathological findings** |   |   |  |
|  Acute App | 5 (6.9) | 181 (62.8) |
|  Perforated App | 0 (0.0) | 48 (16.7) |
|  Appendix Vermiformis | 52 (72.2) | 18 (6.3) |
|  Lymphoid Hyperplasia | 3 (4.2) | 18 (6.3) |
|  Granulomatous App | 0 (0.0) | 3 (1.0) |
|  E. Vermicularis | 3 (4.2) | 1 (0.3) |
|  F. Obliteration | 7 (9.7) | 8 (2.8) |
|  Mucinous Cystadenoma | 1 (1.4) | 5 (1.7) |
|  Acute App + E. Vermicularis | 0 (0.0) | 1 (0.3) |
|  Acute App + Diverticulitis | 0 (0.0) | 1 (0.3) |
|  Acute App + F. Obliteration | 0 (0.0) | 3 (1.0) |
|  Acute App + Eosinophilic Infiltration | 0 (0.0) | 1 (0.3) |
|  Low Grade Mucinous Neoplas | 1 (1.4) | 0 (0.0) |

aMann Whitney *U*; bPearson Chi-square. IQR: Interquartile range; Min: Minimum; Max: Maximum; SD: Standard deviation; Acute App: Acute appendicitis; E. vermicularis: Enterobius vermicularis; F. obliteration: Fibrous obliteration; WBC: White blood cell; MCH: Mean corpuscular hemoglobin; RDW: Red cell distribution width; MPV: Mean platelet volume; MCV: Mean corpuscular volume; PDW: Platelet distribution width.