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## Retrospective Study

# Comparison of clinical and histopathological features of patients who underwent incidental or emergency appendectomy

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**Informed consent statement:** Patients were not required to give informed consent to the study because the analysis used anonymous clinical data that were obtained after each patient agreed to living donor hepatectomy by written consent.

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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 who underwent incidental and standard appendectomy.

### METHODS

The demographic, biochemical, and histopathological 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. The Incidental App group was matched at random in a 1:4 ratio with the Acute App group in the same time frame. Appendectomy specimens of both groups were re-evaluated by two experienced pathologists.

### RESULTS

Statistically significant differences were found between groups in terms of age ( $P = 0.044$ ), white blood cell count ( $P < 0.001$ ), neutrophil ( $P < 0.001$ ), lymphocyte ( $P < 0.001$ ), red cell distribution width ( $P = 0.036$ ), mean corpuscular hemoglobin ( $P$

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= 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 undergoing major abdominal surgery such as donor hepatectomy. We think that experience is parallel to the surgeon's foresight, and we should not hesitate to perform incidental appendectomy when necessary

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

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**Core tip:** Incidental appendectomy is defined as resection of the appendix vermiformis in necessary situations such as a pathologic finding during abdominal operations performed for other reasons. A question remains as to whom incidental appendectomy should be performed. In this study, we compared demographic, biochemical, and histopathological features of the patients who 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 worldwide<sup>[1-4]</sup>. The most frequent etiologic factors underlying luminal obstruction appendicitis are lymphoid hyperplasia in childhood and appendiceal fecalith in adults<sup>[3,4]</sup>. 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% for men and 23% for women to undergo appendectomy throughout their entire life<sup>[5]</sup>. The results of epidemiologic studies have formed the basis of evidence used by the proponents of incidental appendectomy. Incidental appendectomy is defined as resection of the appendix vermiformis in necessary situations such as a pathologic finding during abdominal operations performed for other reasons<sup>[6,7]</sup>. The question of to whom incidental appendectomy should be performed has not been answered. In the present study various parameters of patients who underwent incidental appendectomy during donor hepatectomy were compared with patients who underwent appendectomy for acute appendicitis.

## MATERIALS AND METHODS

Between June 2009 and December 2016, the demographic, biochemical, and histopathological features of 72 living liver donors who underwent incidental appendectomy during living donor hepatectomy (LDH) at Inonu University Liver Transplantation Institute were obtained from ENLIL patient information management system and analyzed retrospectively. This group was defined as the Incidental



Appendectomy 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 obtained in the hospital information systems used before the ENLIL system was implemented in our hospital. The Incidental App group consisted of patients who underwent surgery for LDH and also received an appendectomy during routine abdominal exploration. The surgeons decided on an appendectomy because of one or more of the following reasons: (1) increased risk of appendicitis after major abdominal surgery; (2) both the risk of complications and the duration of surgery may increase when appendectomy was done in cases with a history of major abdominal surgery; (3) the lateral end of the J incision used for LDH was very close to the ileocecal region in some patients and therefore increased 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 included growth, wall edema, hyperemia, and erectile appendix vermiformis.

A control group was created for comparison and was defined as the Acute Appendicitis Group (Acute App group;  $n = 288$ ). The Acute App group consisted of patients who presented to the emergency unit with abdominal pain during the same time frame and underwent appendectomy with the preliminary diagnosis of acute appendicitis. The Incidental App group was matched at random in a 1:4 ratio with the Acute App group. For To the bias risk, selection of the control group was made by another surgeon unrelated 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 (year), gender (male, female), white blood cell, neutrophil, lymphocyte, platelets, mean corpuscular hemoglobin (MCH), red cell distribution width, mean platelet volume, mean corpuscular volume, platelet distribution width, bilirubin, appendix width (mm), appendix length (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  $\pm$  SD, median, min-max and interquartile range. The qualitative variables were reported as number and percentage (%). Kolmogorov-Smirnov tests were used to assess normality distribution of quantitative variables. Nonparametric Mann Whitney-*U* test was used to compare the quantitative variables. Pearson Chi-Square test was 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  $\pm$  SD:  $31.1 \pm 11.3$ , median: 28.5), and the age of the patients in the Acute App group ranged from 18 to 87 years (mean  $\pm$  SD:  $37.1 \pm 17.3$ , median: 32.0). 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 ( $P = 0.036$ ), 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 ( $P = 0.634$ ), platelets ( $P = 0.954$ ), ( $P = 0.441$ ), platelet distribution width ( $P = 0.286$ ), mean corpuscular volume ( $P = 0.078$ ), and appendix length ( $P = 0.096$ ).

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%). 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%). Demographic, biochemical, and histopathological features of both groups were summarized in [Table 1](#).

## DISCUSSION

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

Parameters	Incidental App (n = 72)	Acute App (n = 288)	P value
<b>Age</b>			0.044 <sup>a</sup>
mean ± SD	31.1 ± 11.3	37.1 ± 17.3	
Median	28.5	32.0	
Min-max	19.0-63.0	18.0-87.0	
IQR	12.0	24.0	
<b>Gender</b>			0.634 <sup>b</sup>
Male	37 (51.4%)	157 (54.5%)	
Female	35 (48.6%)	131 (45.5%)	
<b>WBC</b>			< 0.001 <sup>a</sup>
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	2.4	6.6	
<b>Neutrophil</b>			< 0.001 <sup>a</sup>
mean ± SD	4.6 ± 2.0	11.0 ± 6.2	
Median	4.2	11.1	
Min-max	0.1-13.5	1.9-21.5	
IQR	1.8	7.2	
<b>Lymphocyte</b>			< 0.001 <sup>a</sup>
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	1.0	1.3	
<b>Platelets</b>			0.954 <sup>a</sup>
mean ± SD	248.0 ± 63.4	248.8 ± 84.2	
Median	241.0	236.0	
Min-max	103.0-461.0	43.0-641.0	
IQR	73.0	90.0	
<b>RDW</b>			0.036 <sup>a</sup>
mean ± SD	13.4 ± 1.0	14.4 ± 7.2	
Median	13.2	13.5	
Min-max	11.8-18.0	11.4-28.8	
IQR	1.1	1.4	
<b>MCH</b>			< 0.001 <sup>a</sup>
mean ± SD	29.8 ± 2.1	28.8 ± 3.1	
Median	29.9	29.3	
Min-max	20.0-33.0	19.3-46.9	
IQR	2.4	2.4	
<b>MPV</b>			0.441 <sup>a</sup>
mean ± SD	8.4 ± 1.0	8.9 ± 1.8	
Median	8.2	8.5	
Min-max	6.3-11.6	5.4-12.4	
IQR	1.1	1.7	
<b>MCV</b>			0.078 <sup>a</sup>
mean ± SD	86.8 ± 5.2	85.4 ± 6.9	
Median	87.5	86.0	
Min-max	60.4-95.5	30.5-96.5	
IQR	6.2	6.7	
<b>PDW</b>			0.286 <sup>a</sup>
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	1.0	
<b>Bilirubin</b>			0.002 <sup>a</sup>
mean ± SD	0.7 ± 0.3	0.9 ± 0.6	
Median	0.6	0.7	
Min-max	0.1-2.1	0.1-6.0	
IQR	0.4	0.6	
<b>Appendix width (mm)</b>			< 0.001 <sup>a</sup>
mean ± SD	6.4 ± 1.8	10.9 ± 6.6	
Median	6.0	10.0	
Min-max	4.0-13.0	1.5-40.0	
IQR	2.0	7.0	
<b>Appendix length (mm)</b>			0.096 <sup>a</sup>
mean ± SD	70.3 ± 18.8	66.5 ± 19.9	
Median	70.0	65.0	
Min-max	30.0-110.0	10.0-155.0	
IQR	21.0	25.0	
<b>Acute appendicitis</b>			< 0.001 <sup>b</sup>
Yes	5 (6.9%)	238 (82.6%)	
No	67 (93.1%)	50 (17.4%)	
<b>Histopathological findings</b>			
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 neoplasm	1 (1.4%)	0 (0.0%)	

<sup>a</sup>Mann Whitney U.<sup>b</sup>Pearson 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.

Discussions related to incidental appendectomy in medical literature is not a recent phenomenon. In 1902, Kelly<sup>[8]</sup> asked surgeons if they performed incidental appendectomy during laparotomies regarding other pathologies. Ninety percent of the surgeons replied that they had performed incidental appendectomy during laparotomies if appendix vermiform was adherent to the surrounding tissues. Thirty-seven percent of the surgeons replied that they performed incidental appendectomy during laparotomy even if it appeared structurally normal<sup>[8]</sup>. Since then incidental appendectomy has been documented to be performed during gynecologic and abdominopelvic elective surgeries (cholecystectomy, colorectal surgery, urologic diversion procedures, urinary bladder resection) and trauma surgeries<sup>[1]</sup>. The American College of Obstetrics and Gynecologists recommends that appendectomy should be performed during all procedures planned in young female patients less than 35 years of age<sup>[1,9]</sup>. Furthermore, in the case of 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<sup>[1]</sup>. We prefer to perform a diagnostic laparoscopy during non-specific intermittent abdominal pain and perform appendectomy if we do not find a 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<sup>[2]</sup>. In addition, proponents also state that the appendectomy procedure is short, with almost no additional anesthesia risk and low complication rate<sup>[1,7]</sup>. Another reason that proponents recommend incidental appendectomy is due to discovery of incidental tumors during appendectomy<sup>[1]</sup>. Appendiceal neoplasm is detected in 3.8%-4.0% of the cases for abdominal cancer<sup>[1]</sup>. The opponents of incidental appendectomy suggest that removing an organ in relation to the colon carries a significant risk of fecal contamination of the peritoneal cavity and carries a risk of surgical site infection and morbidity<sup>[1,2,7]</sup>. We found incidental carcinoid tumor in one patient who underwent LDH (0.6%), which is consistent with the rates given in other studies<sup>[3,4]</sup>. 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<sup>[2,10]</sup>. 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 conditions, and in patients whom artificial vascular grafts was used for vascular reconstruction.

Another controversial point in the literature is that incidental appendectomy and prophylactic appendectomy are terminologically the 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 the appendix vermiformis due to various reasons during abdominopelvic operations<sup>[6,7]</sup>. On the other hand, prophylactic appendectomy is defined as an elective resection of the appendix vermiformis in a healthy individual who has no complaints or any other abdominopelvic surgical indication. Prophylactic appendectomy can be performed in individuals who anticipate having limited access to medical care for long durations (*e.g.*, soldiers, astronauts).

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 the Incidental App group being younger was an expected finding. MCH was significantly higher in the Incidental App group. This can be explained by the fact that incidental appendectomy patients were young and healthy individuals and therefore had higher MCH. Inflammatory markers such as white blood cell, neutrophil, red cell distribution width, and bilirubin were higher in the Acute App group, which was also an expected finding. Interestingly, mean platelet volume, platelet distribution width, and mean corpuscular volume, which are markers of inflammatory processes did not significantly change among the Incidental App and Acute App groups. Low lymphocyte counts in the 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 was wider. However, in the Incidental App group the length of the appendix vermiformis was longer than the 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 rates in the Incidental App group was high at 6.9%.

There are some limitations of the present study. Firstly, the study design was 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. The second limitation was that we could not present any results 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 familial Mediterranean fever or endometriosis; even if the appendix vermiform appears normal. In our opinion, during major abdominal surgery such as LDH the peritoneal cavity should be gently explored thoroughly and 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.

### 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 at our Liver Transplant Center were compared with data from 288 patients who underwent appendectomy for presumed acute appendicitis. The Incidental Appendectomy group was matched at random in a 1:4 ratio with the Acute Appendectomy group from the same time frame. Appendectomy specimens of both groups were re-evaluated by two experienced pathologists.

### 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, or appendix length. While the most common histopathological findings in the Incidental Appendectomy 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 recommend performing incidental appendectomy in every major abdominal operation. We think that experience is parallel to the surgeon's foresight and should not hesitate to perform an incidental appendectomy when necessary.

### Research perspectives

During major abdominal surgery such as living donor hepatectomy, the peritoneal cavity should be gently explored thoroughly and that appendectomy should be performed if there are any suspicious findings without clinical contraindication.

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