



## Research Paper

Appendicitis: Clinical implications in negative appendectomy<sup>☆</sup>Ali Pooria<sup>a</sup>, Afsoun Pourya<sup>b</sup>, Alireza Gheini<sup>a,\*</sup><sup>a</sup> Department of Cardiology, Faculty of Medicine, Lorestan University of Medical Sciences, Khorramabad, Iran<sup>b</sup> Student of Research Committee, Tehran University of Medical Sciences, Tehran, Iran

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## ABSTRACT

**Objective:** Appendectomy is one of the most common surgical emergencies for appendicitis. Despite the improvement in diagnosis, increased incidence of negative appendectomy is widely reported. The aim of this study to investigate the incidence of negative appendectomy.

**Method:** In this observational study, records 538 patients who underwent appendectomy were evaluated. Demographic data and pathological findings of the appendix were noted, and statistical analysis was conducted on the data obtained.

**Result:** Among 200 female and 338 male patients, there were 28% and 18.3% negative appendectomies, respectively. Second half of the year was associated with greater frequency of negative appendectomy, 25.7%. According to the age groups, the highest incidence of the negative appendectomy was reported in patients aged 10–19 years and 50–59 years, respectively. Ovarian cyst had the greatest incidence among negative appendectomy cases.

**Conclusions:** Our findings indicate that the incidence of negative appendectomy is more common in female gender and reproductive disorders can be the common cause of this. Furthermore, young people are exposed to the increased incidence of negative appendectomy. Diagnostic methods to distinguish gynecological and abdominal dysfunction with acute appendicitis can reduce the incidence of negative appendectomy.

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## 1. Introduction

Appendicitis is one of the most common causes of abdominal surgeries and appendectomy is frequently performed surgical procedure [1–3]. Development in the diagnostic modalities and increased knowledge concerning the signs and symptoms of the disease, have made diagnosis of appendicitis easier and convenient [4,5]. However, these signs and symptoms are also closely related to the other abdominal conditions, which contributes the increased incidence of negative appendectomy [6–8].

Negative appendectomy candidates are reported to present increased hospitalization cost and duration, owing to the greater incidence of morbidities and mortalities in these patients [9,10]. Studies have reported that negative appendectomy contributes to 4–45% of total appendectomy cases where, females in reproductive

age are the most common target [6,11]. Furthermore, female gender, young age, decreased polymorph nuclear cells [12,13], normal white blood cells count and inaccessibility of the CT scan are the contributing factors to negative appendectomy [9,14,15]. Furthermore, delayed diagnosis and associated complications such as, peritonitis and sepsis also contribute to the need to abrupt diagnosis and thereby, increases the risk of negative appendectomy [16,17].

The aim of this study is to evaluate the incidence of negative appendectomy in two different halves of 2018, based the surgeons' record, age groups and gender.

## 2. Methods

In this observational study, all appendectomy cases referred to (XXX), were included. The appendix specimens were examined in the pathology department after surgery and its final diagnosis was archived in the database of (XXX). The sample size was based on all records in the Department of Medicine and Pathology. A questionnaire comprising of two-sections, was used to evaluate each case. Demographic data and pathological findings were recorded

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on these questionnaires. Furthermore, our data were categorized based on the surgeon and the frequency of false positive surgeries. Statistical analysis of the data was performed using SPSS software. Frequency distribution of each variable was calculated based on the data collected Chi-square test was used to compare the variables.

Since this study did not require any therapeutic intervention that would involve patients and was targeted to improve patients' health, the study did not require any informed consent. This study was approved by the Research Ethics Board of (XXX). With registration unique identifying number: researchregistry6413.

The work has been reported in line with the STROCSS criteria [18].

### 3. Results

Of the 614 cases, 38.3% (235) were female and 61.7% (379) were male. 41.7% of the patients (256 patients) were dealt by surgeon 1, 16.3% (100 patients) by surgeon 2, 19.9% (122 patients) by surgeon 3, 16.3% (100 patients) by surgeon 4, 5.9% (36 patients) were under surgeon 5. Of 614 cases, 12.4% (n = 76) of these patients did not have a pathologic for appendix specimens and were excluded from subsequent analysis (a negative appendectomy is defined based on confirmation of pathologic diagnosis).

The total of 538 cases was examined, of which 68.4% (420) had pathologically confirmed appendicitis and 19.2% (118) had a negative appendectomy. 44% (270 patients) underwent surgery during the first half of the year 2018 and 56% (344 patients) during the second half. 3.6% (n = 22) of the patients belonged in the age group below 10 years, 34.1% (n = 209) were aged 10–19 years, 35.3% (217) patients were 20–29 aged, 14% (n = 86) were 39–30 years, 7.2% (n = 44) were 40–49 years, 2.8% (n = 17) in the age group of 50–59 years, 1.8% (n = 11) aged 60–69 years, 1% (n = 6) were 70–79 years and 0.3% (n = 2) were in the age group of 80–89 years. Of the 238 appendectomies, 17.2% (41) had a negative appendectomy in the first half of the year, and 82.8% (197 patients) had an acute appendicitis pathology. During the second half of 2018, out of 300 appendectomies, 25.7% (n = 77) had a negative appendectomy and in 74.3% (n = 223) the pathology was confirmed as acute appendicitis. Overall, out of 538 appendectomies, 21.9% (118 patients) were negative and 78.1% (420) had pathologic evidence of acute appendicitis (Table 1). Among 200 female patients, 28% (56) had a negative appendectomy and 72% (144) had pathologically confirmed acute appendicitis.

Among 338 males, 18.3% (62) underwent a negative appendectomy and 81.7% (276) had pathologically confirmed appendicitis. During the first half of the year 2018, out of 71 females, 18.3% had negative appendectomy and 81.7% of them had acute appendicitis. During the second half, out of 129 females, 33.3% underwent a negative appendectomy and 66.7% had a pathologically confirmed appendicitis. During the same half of the year, of the 171 males, 19.9% had a negative appendectomy and 80.1% had a pathologically confirmed appendicitis. (Table 2). 11.1% of the patients in the age group below 10 years had a negative appendectomy and in 88.9% of them had acute appendicitis. However, during the first half of 2018,

33.3% of these patients had a negative appendectomy and 66.7% had pathologically confirmed acute appendicitis.

During the first half of the year, 17.5% of the age group of 10–19 year had a negative appendectomy and 82.5% had acute appendicitis. While during the second half, 31.4% of the same age group patients had a negative appendectomy and 68.6% had pathologically confirmed acute appendicitis (see Table 3).

Furthermore, during the first half of 2018, 15.2% in the age group 20–29 years had negative appendectomy and 84.8% confirmed acute appendicitis. During the second half of the year, 27.5% of the same age group had negative appendectomy and 72.5% acute appendicitis. Similarly, 21.1% of the age group 30–39 years had a negative appendectomy and 78.9% had acute appendicitis. During the second half of year, there were 15.4% and 84.6% of them, respectively.

Furthermore, 18.8% of the age group 40–49 years had a negative appendectomy and 81.3% had appendicitis, during the first half of 2018. During the first half of 2018, in the age group of 50–59 years, 25% patients underwent a negative appendectomy and 75% were presented with acute appendicitis. Out of 13 appendectomies performed by surgeon 1, during the first half of 2018, 15.4% were negative appendectomies and 84.6% had acute pathology. Of the 208 surgeries performed during the second half of the year, 26% were negative and 74% patients had appendicitis. Overall, he performed 221 appendectomies of which, 25.3% were negative and 74.3% were pathologically confirmed appendicitis.

For Surgeon 2, out of 61 surgeries performed during the first half, 14.8% were negative appendectomy and 85.2% were that of confirmed acute appendicitis. Of the 28 surgeries performed during the second half of the year, 17.9% were negative appendectomy and 82.1% were confirmed for acute appendicitis. Overall, there were 89 appendectomies surgeries, of which 15.7% were negative and 84.7% were positive for appendicitis.

During the first half of the year, surgeon 3 performed 84 surgeries where, 20.2% were found to be of negative appendectomy and 79.8% had pathologically confirmed acute appendicitis. Of the 26 surgeries performed during the second half of the year, 19.2% were negative and 80.8% were positive for appendicitis. In total, he performed 110 appendectomies, where, 20% were negative and 80% positive for appendicitis.

In Surgeon 4, of the 48 surgeries during the first half of the year, 18.8% were that of negative appendectomy and 81.3% patients had pathologically confirmed appendicitis. Of the 38 surgeries performed during the second half of the year, 34.2% were negative, whereas, 65.8% were confirmed for appendicitis. Overall, out of 86, 25.6% were negative appendectomy and 74.4% were otherwise.

For surgeon 5, of the 32 surgeries during the second half, 12.5% were negative appendectomy and 87.5% were pathologically confirmed acute appendicitis. He did not perform appendectomy during the first half of the year. An appendicitis tumor was reported in one case, and other important pathologies that were misdiagnosed as appendicitis included; cecal diverticulitis (n = 1), terminal ileitis and mesenteric lymphadenopathy (n = 2, each), ovarian cyst (n = 7), ovarian cyst twisting (n = 1), invagination

**Table 1**  
Frequency distribution of appendectomy patients in terms of time and pathologic response.

Pathology reports	Negative		Positive		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Time						
The first half of the year	41	17.2	197	82.8	238	100
The second half of the year	77	25.7	223	74.3	300	100
Total	118	21.9	420	78.1	538	100

**Table 2**  
Comparison of frequency distribution of appendectomy patients by age and pathological response.

Pathology reports		Negative		Positive		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
<b>Gender</b>							
Male	The first half of the year	13	18.3	58	81.7	71	100
	The second half of the year	43	33.3	86	66.7	129	100
	Total	56	28	144	72	200	100
Female	The first half of the year	28	16.8	139	83.2	167	100
	The second half of the year	34	19.9	137	80.1	171	100
	Total	62	18.3	276	81.7	338	100
Total	The first half of the year	41	17.2	197	82.8	238	100
	The second half of the year	77	25.7	223	74.3	300	100
	Total	118	21.9	420	78.1	538	100

**Table 3**  
Comparison of frequency distribution of appendectomy patients by age and pathologic response.

Pathology reports		Negative		Positive		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
<b>Age group</b>							
10≥	The first half of the year	1	11.1	8	88.9	9	100
	The second half of the year	4	33.3	8	66.7	12	100
	Total	5	23.8	16	76.2	21	100
10–19	The first half of the year	14	17.5	66	82.5	80	100
	The second half of the year	32	31.4	70	68.6	102	100
	Total	46	25.3	136	74.7	182	100
20–29	The first half of the year	12	15.2	67	84.8	79	100
	The second half of the year	30	27.5	79	72.5	109	100
	Total	42	22.3	146	77.7	188	100
30–39	The first half of the year	8	21.1	30	78.9	38	100
	The second half of the year	6	15.4	33	84.6	39	100
	Total	14	18.2	63	81.8	77	100
40–49	The first half of the year	3	18.8	13	81.3	16	100
	The second half of the year	1	4.2	23	95.8	24	100
	Total	4	10	36	90	40	100
50–59	The first half of the year	2	25	6	75	8	100
	The second half of the year	1	16.7	5	83.3	6	100
	Total	3	21.4	11	78.6	14	100
60<	The first half of the year	1	12.5	7	78.5	8	100
	The second half of the year	3	37.5	5	62.5	8	100
	Total	4	25	12	75	16	100
Total	The first half of the year	41	17.2	197	82.8	238	100
	The second half of the year	77	25.7	223	74.3	300	100
	Total	118	21.9	420	78.1	538	100

(n = 2), ruptured graph follicle (n = 1), tubular ovarian abscess (n = 1), torn gastric ulcer and peritonitis (n = 1, each).

**4. Discussion**

Unnecessary removal of appendix imposes adverse effects of surgical complications and anesthesia-associated adverse effects among the patients [16]. Improper diagnosis, unavailability of the resources and poor clinical judgment can expose patients to needless surgical incision [19–21].

The aim of this study was to evaluate the frequency of negative appendectomies. The percentage of negative appendectomies during the first half of the year was 17.2% and the percentage of negative appendectomies during the second half was 25.7%, which was significantly different. In early 2018, the center was scarce of full-time surgeons and therefore, people were referred to the clinics, which was also due to the financial limitations. With the establishment of specialized polyclinics at the public hospitals and the use of full-time specialists, patients have become more welcomed and a significant increase in the number of patients the number of patients has been noted. A study in Nigeria by Mungadi

IA reported appendectomies over a 6-year period from 1997 to 2002, of which 38.9% of the emergency abdominal surgeries were that for appendicitis and 15.9% of those were negative appendectomy [22]. By comparing age groups and the percentage of negative appendectomies during the first and the second half of the year, a significant difference was seen during the frequency of the appendectomies between the two age groups of 10–19 years and 20–29 years. An increased incidence of abdominal pain in these age groups is likely to the reason behind this finding. Furthermore, owing to the increased prevalence of gastrointestinal diseases and the fear of complications such as rupture and peritonitis in these two age groups, it is believed that appendicitis is a disease of youth and 40% of cases occur between the ages of 10 and 29 years. In an Indian by Morjunk et al., among 114 young patients who underwent appendectomy due to acute appendicitis, 3 had a mean of 2.6% of normal appendix, 62 had a mean of 54.4% in the early stages of inflammation and 43% were presented with advanced appendicitis. Additionally, ponsky reported in their study that negative appendectomy averaged about 3.06% and appendix rupture averaged about 35.08% [23]. In a US study by the Centers for Disease Control, it was seen that during this period, there were an average

of 250,000 cases of appendicitis in the United States and the highest annual incidence of appendicitis was in 19 years old patients [24,25]. The results showed that there was no significant difference between the percentage of negative appendectomies performed by each surgeon in two halves of the year and among the surgeons. The frequency of negative appendectomy significantly differed in females in the two halves of the year. However, in the first half of 2018, there was no significant difference between the negative appendectomies among males and females, which was untrue for the second half. An increased number of gynecological cases among women contributes to the difficulty in the diagnosis and can significantly contribute to the increased incidence of negative appendectomy [9].

## 5. Conclusion

Our study reported that negative appendectomy cases more mostly associated with ovarian cysts.

## Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

## Funding

No funding was secured for this study.

## Author contributors

Dr. Ali Pooria: conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Dr. Alireza Gheini: Designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript.

Dr. Afsoun Pourya: Coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

## Conflict of interest statement

The authors deny any conflict of interest in any terms or by any means during the study.

## Guarantor

Ali Pooria.

## Research Registration Number

1. Name of the registry: N/a.
2. Unique Identifying number or registration ID: N/A.
3. Hyperlink to the registration (must be publicly accessible): N/A.

## Consent to participate

From the under 16 years old was given by a parent or legal guardian.

## Consent for publication

Not applicable.

## Availability of data and material

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

## Provenance and peer review

Not commissioned, externally peer-reviewed.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijso.2021.01.004>.

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