



RESEARCH ARTICLE

Histopathological Spectrum of Appendectomy Specimens: A Retrospective Study at a Tertiary Care Hospital

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ABSTRACT

Background: Appendectomy is one of the most commonly performed emergency surgical procedures, and histopathological examination remains important for confirming acute appendicitis and detecting unexpected inflammatory, infectious, parasitic, and neoplastic lesions. This study aimed to evaluate the histopathological spectrum of appendectomy specimens received at a tertiary care hospital.

Methods: Demographic, clinical, and histopathological data were retrieved from pathology records. Specimens were routinely processed, stained with hematoxylin and eosin, and categorized according to the final histopathological diagnosis. Associations between demographic variables and histopathological findings were assessed using appropriate statistical tests, with $P < 0.05$ considered statistically significant.

Results: The mean age of the patients was 29.8 ± 15.2 years, with the highest proportion belonging to the 21–30-year age group (27.1%). Males constituted 55.7% of cases. Acute inflammatory lesions were identified in 106 specimens (75.7%), with acute suppurative appendicitis being the most frequent diagnosis (37.1%). Chronic/reactive lesions accounted for 12.9%, while 5.0% of specimens were histologically unremarkable.

Conclusion: Acute inflammatory lesions constituted the predominant histopathological finding in appendectomy specimens.

Keywords: Appendectomy; Acute appendicitis; Histopathology; Appendiceal neoplasms; Incidental findings; Neuroendocrinetumor; Low-grade appendiceal mucinous neoplasm.

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INTRODUCTION

Acute appendicitis is one of the most frequent causes of acute abdominal pain requiring emergency surgical evaluation and remains an important indication for abdominal surgery worldwide. Although the disease can occur at any age, its incidence is highest among adolescents and young adults. The estimated lifetime risk of developing acute appendicitis is approximately 7–8%, with a slightly greater risk reported in males than in females [1]. Despite substantial advances in diagnostic imaging, laboratory investigations, clinical scoring systems, and non-operative treatment strategies, appendectomy continues to be an important and widely performed procedure for patients with suspected or confirmed acute appendicitis [2].

The pathogenesis of acute appendicitis is complex and is not necessarily identical in every patient. Luminal obstruction caused by a fecalith, lymphoid hyperplasia, inflammatory processes, parasites, foreign material, or, less frequently, neoplastic lesions has traditionally been considered an important initiating event. Continued obstruction may increase intraluminal pressure, compromise venous and lymphatic drainage, promote bacterial

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proliferation, and ultimately produce ischemic injury and inflammation of the appendiceal wall. Depending

on the extent and duration of the inflammatory process, histopathological examination may demonstrate early acute inflammation, acute suppurative appendicitis, gangrenous changes, perforation, periappendicitis, or other associated pathological alterations [1,3].

Although the majority of appendectomy specimens demonstrate histological features compatible with acute appendicitis, the vermiform appendix may harbor a remarkably broad range of pathological conditions. Histopathological examination can reveal chronic inflammatory changes, fibrous obliteration, granulomatous appendicitis, parasitic infestation, endometriosis, diverticular disease, benign epithelial abnormalities, and primary or metastatic neoplasms. Some of these lesions may clinically and radiologically mimic conventional acute appendicitis and may not be evident during surgery. Consequently, microscopic examination of the resected appendix has diagnostic significance beyond simply confirming the clinical diagnosis of acute inflammation [4].

Several retrospective studies have documented unexpected pathological findings in appendectomy specimens. Limaïem et al., in an analysis of 1,627 appendectomy specimens, reported that while acute inflammation constituted the dominant histopathological diagnosis, several unexpected lesions were identified, including *Enterobius vermicularis* infestation, granulomatous inflammation, tuberculosis, endometriosis, appendiceal neoplasms, and adenocarcinoma [4]. Similarly, unusual histopathological conditions such as mucinous lesions, neuroendocrine tumors, granulomatous inflammation, parasitic infestation, and malignant tumors have been identified in large appendectomy series even when the preoperative diagnosis was uncomplicated acute appendicitis [5]. These observations emphasize that gross intraoperative appearance alone may be insufficient to exclude significant underlying pathology.

The clinical importance of incidental appendiceal lesions varies considerably. Some abnormalities may require no additional treatment after appendectomy, whereas others may substantially alter postoperative management. Identification of an appendiceal neuroendocrine tumor, mucinous neoplasm, adenocarcinoma, lymphoma, Crohn's disease, tuberculosis, or other specific inflammatory or neoplastic conditions may necessitate additional investigations, surveillance, medical therapy, or further surgical intervention. Al-Balas et al. demonstrated that histopathological assessment can detect infectious, congenital, inflammatory, and malignant conditions that may clinically resemble acute appendicitis or coexist with acute appendiceal inflammation [6]. Therefore, the

final histopathological diagnosis may have important implications for subsequent treatment and prognosis.

The value of routine histopathological examination of appendectomy specimens has nevertheless been debated, particularly in healthcare settings where pathology services and financial resources are limited. The principal argument for selective examination is that unexpected clinically significant abnormalities occur relatively infrequently. However, selective examination based solely on macroscopic operative findings carries a risk of overlooking occult pathology. A systematic review and meta-analysis by Bastiaenen et al. demonstrated that a substantial proportion of aberrant histopathological findings with available management information resulted in a change in postoperative care. The authors therefore supported routine histopathological examination until reliable criteria capable of safely identifying specimens that do not require microscopic assessment become available [7].

This approach is also supported by international clinical guidance. The 2020 World Society of Emergency Surgery Jerusalem guidelines acknowledge that the overall incidence of unexpected findings in appendectomy specimens is low but emphasize that intraoperative assessment alone is inadequate for detecting all unexpected diseases. Accordingly, routine histopathological examination following appendectomy is recommended [3]. Histopathology consequently remains an essential component of quality surgical care by confirming the diagnosis, identifying unsuspected etiologies, assessing the severity of inflammation, and detecting lesions with potential therapeutic or prognostic consequences.

The distribution of appendiceal pathology may vary according to age, sex, geographic location, socioeconomic conditions, prevalence of infectious and parasitic diseases, referral patterns, and characteristics of the population served by a healthcare facility. Institution-based studies are therefore valuable for determining the local spectrum and relative frequency of appendiceal lesions. Data from tertiary care hospitals are particularly important because these institutions receive a heterogeneous patient population and frequently manage both uncomplicated and complicated appendicitis as well as diagnostically challenging cases.

Against this background, the present retrospective study was undertaken to evaluate the histopathological spectrum of appendectomy specimens received at a tertiary care hospital. The study aims to determine the frequency of acute inflammatory lesions and other histopathological patterns, identify uncommon and incidental pathological findings, and assess their distribution across relevant

demographic groups. Such information may contribute to a better understanding of appendiceal pathology in the local population and further establish the importance of systematic histopathological evaluation of all surgically resected appendix specimens.

MATERIALS AND METHODS

Study design and setting

A retrospective, record-based observational study was conducted in the Department of Pathology at FMHS SGT UNIVERSITY, SGT hospital, Gurugram, Haryana, India, a tertiary care referral hospital. The study included appendectomy specimens received for histopathological examination during the period from December 2023-August 2026. The study was designed to characterize the histopathological spectrum of appendectomy specimens and to determine the frequency of inflammatory, infectious, parasitic, neoplastic, and other incidental pathological lesions.

Study population and sample size

A total of 140 appendectomy specimens submitted to the histopathology laboratory during the defined study period were included in the analysis. As this was a retrospective study, all eligible consecutive appendectomy specimens with complete clinical and histopathological records available during the study period were considered. Thus, a total enumeration approach was followed rather than prospective sample size estimation.

Inclusion criteria

The study included:

- All appendectomy specimens received in the Department of Pathology during the study period.
- Specimens obtained from patients undergoing appendectomy for clinically or radiologically suspected acute appendicitis.
- Incidental appendectomy specimens removed during other abdominal surgical procedures, where applicable.
- Cases with adequate histopathological material and complete pathology records.
- Patients of all age groups and both sexes.

Exclusion criteria

The following cases were excluded:

- Specimens with inadequate or severely autolysed tissue precluding reliable histopathological assessment.
- Cases with incomplete histopathology records or unavailable slides/blocks when review was required.
- Repeat specimens from the same patient.

- Appendiceal tissue obtained only as part of an extensive bowel resection in which the primary pathology originated outside the appendix, unless a distinct appendiceal lesion was identified.

Data collection

Data were retrieved from histopathology requisition forms, pathology registers, laboratory information records, and archived histopathology reports. For each case, available demographic and clinicopathological information was recorded using a predefined data collection form. The variables included age, sex, clinical diagnosis, type of surgical procedure, gross appearance of the appendix, and final histopathological diagnosis.

Where available, associated clinical findings such as abdominal pain, fever, vomiting, leukocytosis, radiological diagnosis, appendicular perforation, mass formation, or other operative findings were also documented. Patient identifiers were removed before analysis to maintain confidentiality.

Gross examination and tissue processing

All appendectomy specimens had been received in the histopathology laboratory in 10% neutral-buffered formalin. Gross examination was performed according to standard surgical pathology protocols. The length and external diameter of the appendix were recorded, and the serosal surface was evaluated for congestion, exudate, adhesions, perforation, nodularity, or other visible abnormalities. The lumen was examined for fecaliths, purulent material, parasites, mucin, or masses.

Representative tissue sections were obtained from the appendiceal tip, body, and base, along with any grossly abnormal areas. Additional sections were taken in cases demonstrating focal thickening, mucinous material, nodules, perforation, or suspected neoplastic lesions.

The tissues were routinely processed using paraffin embedding. Sections of approximately 3–5 µm thickness were prepared and stained with hematoxylin and eosin. Additional histochemical or special stains were considered in selected cases when required to establish a specific diagnosis.

Histopathological evaluation

All available histopathology reports were reviewed, and representative slides were reassessed where necessary to confirm or further categorize the diagnosis. Histopathological findings were classified broadly into inflammatory, non-inflammatory, infectious/parasitic, and neoplastic categories.

Acute appendicitis was diagnosed when neutrophilic infiltration involved the muscularispropria. Cases were further categorized, wherever histological features permitted, into acute appendicitis, acute suppurative appendicitis, gangrenous appendicitis, perforated appendicitis, or periappendicitis. Chronic inflammatory changes were recorded separately when lymphoplasmacytic inflammation, fibrosis, or related chronic alterations predominated without histological evidence of active acute appendicitis.

Other findings, including fibrous obliteration of the lumen, lymphoid hyperplasia, granulomatous inflammation, appendiceal diverticular disease, parasitic infestation, endometriosis, mucocoele-associated lesions, neuroendocrine tumors, mucinous neoplasms, adenocarcinoma, and other uncommon lesions, were recorded individually whenever identified.

Cases in which no significant inflammatory or other pathological abnormality was identified were categorized as histologically unremarkable appendix.

Categorization of histopathological findings

For analysis, the histopathological findings were grouped into the following major categories:

- Acute inflammatory lesions
- Chronic inflammatory lesions
- Gangrenous or perforated appendicitis
- Reactive or non-specific changes
- Parasitic or infectious lesions
- Granulomatous lesions
- Non-neoplastic incidental lesions
- Benign or low-grade neoplastic lesions
- Malignant neoplasms
- Histologically unremarkable appendix

Rare or unexpected diagnoses were additionally analyzed separately because of their potential influence on postoperative management.

Outcome measures

The primary outcome of the study was the distribution and relative frequency of different histopathological diagnoses among the 140 appendectomy specimens.

The secondary outcomes included:

- Frequency of acute appendicitis and its histological subtypes.
- Proportion of histologically unremarkable appendices.
- Frequency and nature of incidental or unexpected histopathological findings.
- Distribution of histopathological diagnoses according to age and sex.

- Frequency of neoplastic, parasitic, granulomatous, and other uncommon appendiceal lesions.

Statistical Analysis

Data were entered into Microsoft Excel and subsequently analyzed using IBM SPSS Statistics, version 26.0 or equivalent statistical software. Continuous variables such as age were assessed for distribution and summarized as mean with standard deviation for normally distributed data or median with interquartile range for non-normally distributed data. Categorical variables, including sex and histopathological diagnosis, were presented as frequencies and percentages.

A two-sided P value <0.05 was considered statistically significant. Because the study was primarily descriptive and exploratory, emphasis was placed on reporting the frequency and distribution of histopathological findings along with appropriate measures of variability rather than relying solely on statistical significance.

RESULTS

A total of 140 appendectomy specimens were included in the study. The age of the patients ranged from 6 to 78 years, with a mean age of 29.8 ± 15.2 years. The median age was 27 years (interquartile range: 18–39 years). The largest proportion of patients belonged to the 21–30-year age group (27.1%), followed by the 11–20-year age group (21.4%). There were 78 males (55.7%) and 62 females (44.3%), giving a male-to-female ratio of approximately 1.26:1.

Table 1: Demographic characteristics of patients undergoing appendectomy (n = 140)

Characteristic	Number (n)	Percentage (%)
<i>Age group (years)</i>		
≤10	12	8.6
11–20	30	21.4
21–30	38	27.1
31–40	25	17.9
41–50	16	11.4
51–60	11	7.9
>60	8	5.7
<i>Sex</i>		
Male	78	55.7
Female	62	44.3
Total	140	100.0

Mean age: 29.8 ± 15.2 years, Median age: 27 years (IQR: 18–39 years), Age range: 6–78 years

Table 2: Detailed histopathological spectrum of appendectomy specimens (n = 140)

<i>Histopathological diagnosis</i>	<i>n</i>	<i>%</i>
Acute appendicitis	31	22.1
Acute suppurative appendicitis	52	37.1
Gangrenous appendicitis	14	10.0
Acute appendicitis with perforation	9	6.4
Chronic appendicitis	8	5.7
Lymphoid hyperplasia	6	4.3
Fibrous obliteration	4	2.9
Enterobiusvermicularis infestation	2	1.4
Granulomatous appendicitis	2	1.4
Endometriosis	1	0.7
Neuroendocrine tumor	2	1.4
Low-grade appendiceal mucinous neoplasm	1	0.7
Adenocarcinoma	1	0.7
Histologically unremarkable appendix	7	5.0
Total	140	100.0

Acute inflammatory lesions constituted the predominant histopathological finding. Acute suppurative appendicitis was the single most frequent diagnosis, observed in 52 specimens (37.1%), followed by acute appendicitis without further subclassification in 31 specimens (22.1%). Gangrenous and perforated appendicitis were observed in 14 (10.0%) and 9 (6.4%) specimens, respectively.

Chronic appendicitis was identified in 8 cases (5.7%), while lymphoid hyperplasia and fibrous obliteration were identified in 6 (4.3%) and 4 (2.9%) specimens, respectively. Seven specimens (5.0%) showed no significant histopathological abnormality.

Uncommon findings included Enterobius vermicularis infestation, granulomatous appendicitis, endometriosis, neuroendocrine tumor, low-grade appendiceal mucinous neoplasm, and adenocarcinoma.

When the histopathological findings were grouped into broader diagnostic categories, 106 specimens (75.7%) demonstrated acute inflammatory pathology. Chronic or reactive non-neoplastic alterations accounted for 18 specimens (12.9%). Infectious or granulomatous lesions accounted for 4 specimens (2.9%).

Neoplastic lesions were identified in 4 specimens (2.9%), comprising two neuroendocrine tumors, one low-grade appendiceal mucinous neoplasm, and one

Table 3: Distribution of appendectomy specimens according to major histopathological categories

<i>Major histopathological category</i>	<i>n</i>	<i>%</i>
Acute inflammatory lesions	106	75.7
Chronic/reactive non-neoplastic lesions	18	12.9
Infectious/granulomatous lesions	4	2.9
Endometriosis	1	0.7
Neoplastic lesions	4	2.9
Histologically unremarkable appendix	7	5.0
Total	140	100.0

adenocarcinoma. Endometriosis was detected in one specimen (0.7%).

Acute inflammatory pathology was more frequent among patients aged ≤ 40 years. Among 105 patients aged ≤ 40 years, 86 (81.9%) demonstrated acute inflammatory changes, compared with 20 of 35 patients (57.1%) aged >40 years. Conversely, non-acute and other histopathological findings were proportionally more frequent among patients older than 40 years (42.9% vs. 18.1%). The association between age category and type of histopathological finding was statistically significant ($p = 0.006$).

Among males, acute inflammatory pathology was observed in 62 of 78 cases (79.5%), compared with 44 of 62 female patients (71.0%). Although acute inflammatory lesions were proportionally more common among males, the difference according to sex was not statistically significant ($p = 0.332$).

Clinically suspected acute appendicitis represented the predominant indication for appendectomy. Among 126 patients operated on with a clinical diagnosis of acute appendicitis, histopathological evidence of acute inflammation was demonstrated in 101 cases (80.2%). The remaining 25 cases showed chronic, reactive, incidental, infectious, neoplastic, or histologically unremarkable findings.

Table 4: Association of age and sex with acute inflammatory and other histopathological findings

<i>Variable</i>	<i>Acute inflammatory lesions, n (%)</i>	<i>Other findings, n (%)</i>	<i>Total</i>	<i>P value</i>
Age				
≤40 years	86 (81.9)	19 (18.1)	105	0.006*
>40 years	20 (57.1)	15 (42.9)	35	
Sex				
Male	62 (79.5)	16 (20.5)	78	0.332†
Female	44 (71.0)	18 (29.0)	62	
Total	106 (75.7)	34 (24.3)	140	

Table 5: Relationship between clinical indication and histopathological evidence of acute inflammation

Clinical indication	Acute inflammatory histology, n (%)	Other histopathology, n (%)	Total
Suspected acute appendicitis	101 (80.2)	25 (19.8)	126
Recurrent/chronic appendicitis	2 (33.3)	4 (66.7)	6
Appendicular mass	3 (75.0)	1 (25.0)	4
Incidental appendectomy	0 (0.0)	4 (100.0)	4
Total	106 (75.7)	34 (24.3)	140

Table 6: Uncommon histopathological findings identified in appendectomy specimens

Uncommon finding	n	% of total specimens
Enterobiusvermicularis infestation	2	1.4
Granulomatous appendicitis	2	1.4
Endometriosis	1	0.7
Neuroendocrine tumor	2	1.4
Low-grade appendiceal mucinous neoplasm	1	0.7
Adenocarcinoma	1	0.7
Total	9	6.4

Among patients presenting with an appendicular mass, acute inflammatory pathology was demonstrated in three of four specimens. Four specimens obtained as incidental appendectomies showed no acute inflammatory changes.

Uncommon specific lesions were identified in 9 of 140 specimens (6.4%). These included two cases each of *Enterobiusvermicularis* infestation, granulomatous appendicitis, and neuroendocrine tumor. One case each of appendiceal endometriosis, low-grade appendiceal mucinous neoplasm, and adenocarcinoma was identified.

Neoplastic lesions therefore accounted for 2.9% (4/140) of all appendectomy specimens. Among these, neuroendocrine tumor was the most frequently identified neoplasm.

Overall, acute inflammatory pathology accounted for approximately three-fourths of all appendectomy specimens. Acute suppurative appendicitis represented the predominant individual diagnosis. However, 6.4% of specimens demonstrated uncommon specific pathological conditions, including parasitic, granulomatous, endometriotic, and

neoplastic lesions. Neoplasms constituted 2.9% of the total specimens. Non-acute pathological findings were significantly more common among patients older than 40 years, whereas no statistically significant association was observed between sex and broad histopathological category.

Figure 1 Age-wise distribution showed that appendectomy was most commonly performed in patients aged 21–30 years, accounting for 38 cases (27.1%), followed by the 11–20-year age group with 30 cases (21.4%). The frequency gradually declined with increasing age, with the lowest proportion observed among patients aged >60 years (5.7%). Overall, appendectomy was more frequent among adolescents and young adults.

Figure 2 demonstrates that acute inflammatory lesions were markedly more frequent in patients aged ≤40 years, being observed in 86 cases (81.9%), compared with 20 cases (57.1%) in patients aged >40 years. In contrast, other histopathological findings were proportionally more common in the >40-year age group, accounting for 15 cases (42.9%), compared with 19 cases (18.1%) among patients aged ≤40 years. This difference was found to be statistically significant ($P = 0.006$).

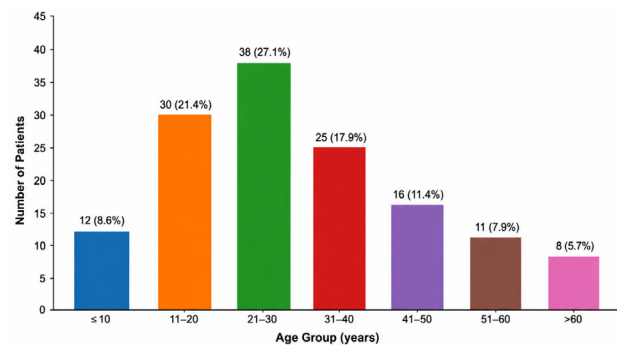


Figure 1: Age-wise distribution of patients undergoing appendectomy

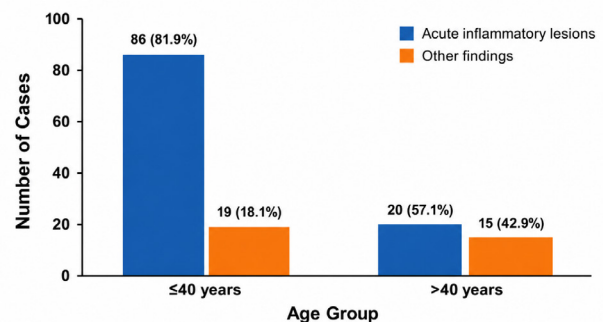


Figure 2: Comparison of acute inflammatory and other histopathological findings among patients aged ≤40 years and >40 years

DISCUSSION

Histopathological examination of appendectomy specimens remains important not only for confirming acute appendicitis but also for identifying unsuspected inflammatory, infectious, parasitic, and neoplastic conditions. The present study evaluated 140 appendectomy specimens and demonstrated a broad histopathological spectrum, with acute inflammatory lesions accounting for the majority of cases. At the same time, a clinically relevant proportion of specimens showed non-acute and uncommon findings that would have been difficult to establish on clinical or operative assessment alone.

The demographic pattern observed in the present study was consistent with the established epidemiology of acute appendicitis. The mean age was 29.8 ± 15.2 years, and the largest proportion of patients belonged to the 21–30-year age group. A mild male predominance was observed, with 55.7% males and 44.3% females. Singhal et al., in an Indian retrospective series of 348 appendectomy specimens, similarly reported the highest frequency of cases in the 21–30-year age group and a predominance of male patients [8]. Emre et al. also observed a mean age of approximately 30 years in their series of 1,255 patients, with males constituting 56.7% of the study population [9]. These observations reinforce the fact that appendicitis predominantly affects adolescents and young adults, although it may occur across a wide age range.

Acute inflammatory pathology was identified in 106 of 140 specimens, representing 75.7% of all cases. Acute suppurative appendicitis was the most frequent individual diagnosis, accounting for 37.1%, followed by acute appendicitis at 22.1%, gangrenous appendicitis at 10.0%, and perforated appendicitis at 6.4%. The overall proportion of acute inflammatory lesions in the present study is comparable to, although somewhat lower than, rates reported in several large histopathological series. Charfi et al., in an extensive analysis of 24,697 appendectomy specimens, reported acute appendicitis in 79.5% of specimens [10]. Singhal et al. found histopathological evidence of acute appendicitis in 282 of 348 specimens, corresponding to approximately 81% [8]. In contrast, Emre et al. reported histological evidence of appendicitis in 94% of their 1,255 specimens [9]. Such differences between studies may reflect variations in patient selection, diagnostic imaging practices, thresholds for operative intervention, referral patterns, and the histological criteria used to classify inflammatory changes.

The predominance of suppurative inflammation in the present series is of particular pathological relevance.

Suppurative appendicitis represents progression of the acute inflammatory process with prominent transmural neutrophilic infiltration and purulent exudation. If untreated, continued inflammation can progress to ischemic necrosis, gangrene, and perforation. In the present study, gangrenous and perforated appendicitis together accounted for 16.4% of specimens, indicating that a meaningful subset of patients presented with advanced disease. Large histopathological series have also demonstrated a spectrum ranging from uncomplicated inflammation to gangrene and perforation [9,10]. These findings highlight the value of histology in documenting disease severity even when the primary clinical diagnosis of appendicitis is already established.

A noteworthy finding of the present study was the relationship between age and histopathological category. Acute inflammatory lesions were found in 81.9% of patients aged ≤ 40 years compared with 57.1% among those aged >40 years. Conversely, other histopathological diagnoses occurred in 42.9% of patients older than 40 years compared with 18.1% of younger patients, and this association was statistically significant ($P=0.006$). This finding suggests that although conventional acute appendicitis predominates in younger individuals, increasing age should raise awareness of alternative or underlying appendiceal pathology. Large studies have similarly demonstrated important age-related differences in appendiceal disease, including greater proportions of complicated or unexpected pathology in older populations [10].

In contrast, sex was not significantly associated with the broad histopathological category in the present study ($P=0.332$). Acute inflammatory lesions were present in 79.5% of males compared with 71.0% of females. Although the difference was not statistically significant, the pattern is consistent with earlier observations that histologically confirmed appendicitis may be somewhat more frequent in males. In the Indian study by Singhal et al., acute appendicitis also demonstrated an overall higher occurrence among males [8]. Differences between males and females in clinically suspected appendicitis may partly reflect the wider differential diagnosis of right lower quadrant pain in women, particularly those of reproductive age.

Seven specimens in the present study were histologically unremarkable, resulting in a negative appendectomy rate of 5.0%. This rate is relatively low compared with several previously published series. Singhal et al. reported a negative appendectomy rate of approximately 10.9% [8], while Charfi et al. reported a rate of 15% in their large series [10]. More recently, Elfaedy et al., in an analysis of 4,012 consecutive appendectomy

specimens, found a negative appendectomy rate of 5.6%, which closely approximates the finding of the present study [11]. The comparatively low negative appendectomy rate may reflect improved preoperative diagnostic accuracy resulting from systematic clinical assessment and increased use of ultrasonography and computed tomography. Nevertheless, a histologically normal appendix remains an important finding because it may prompt reconsideration of alternative causes of the patient's symptoms.

The most important observation from the pathological perspective was the presence of uncommon specific lesions in 9 of 140 specimens, corresponding to 6.4%. These included *Enterobius vermicularis* infestation, granulomatous appendicitis, endometriosis, neuroendocrine tumors, low-grade appendiceal mucinous neoplasm, and adenocarcinoma. Interestingly, Elfaedy et al. also identified unusual histopathological findings in exactly 6.4% of their 4,012 appendectomy specimens [11]. Their spectrum included chronic appendicitis, parasitic infestations, Crohn's disease, neuroma, carcinoid tumor, mucinous lesions, and mucinous adenocarcinoma. This close similarity supports the observation that although individual uncommon entities occur at low frequency, their combined prevalence may be clinically meaningful.

Two cases of *Enterobius vermicularis* infestation were detected in the current study, representing 1.4% of the total specimens. Parasites may reside within the appendiceal lumen without producing typical transmural inflammation, although luminal obstruction or local mucosal irritation may produce symptoms that mimic acute appendicitis. Emre et al. identified parasitic infection among unusual appendiceal findings in their series and emphasized that such diagnoses would frequently remain unsuspected without histological examination [9]. Detection of parasitic infection is clinically relevant because the patient, and occasionally close household contacts depending on the organism and clinical context, may require appropriate antihelminthic treatment.

Granulomatous appendicitis was also detected in two cases (1.4%). Although uncommon, granulomatous inflammation of the appendix deserves particular attention because it may be associated with infectious diseases, inflammatory bowel disease, foreign-body reactions, or other systemic disorders. Emre et al. documented granulomatous inflammation among the unusual findings in appendectomy specimens [9]. Recognition of this histological pattern should therefore prompt appropriate clinicopathological correlation rather than being regarded as a variant of uncomplicated appendicitis.

Appendiceal endometriosis was identified in one female patient, corresponding to 0.7% of the entire study

population. Although rare, appendiceal endometriosis is an important mimic of acute appendicitis and may be difficult to recognize clinically or radiologically. Schrempf et al. recently evaluated 2,484 women undergoing appendectomy for suspected appendicitis and detected appendiceal endometriosis in 17 patients, corresponding to 0.7%, remarkably similar to the proportion identified in the present study [12]. They also demonstrated the diagnostic difficulty associated with the condition, as clinical features may overlap substantially with conventional appendicitis. Histological identification is therefore important for appropriate gynecological evaluation when indicated.

Neoplastic lesions constituted another important group in the current study. Four neoplasms were identified, accounting for 2.9% of all appendectomy specimens. These consisted of two neuroendocrine tumors, one low-grade appendiceal mucinous neoplasm (LAMN), and one adenocarcinoma. Although the absolute number was small, the identification of four neoplasms among 140 specimens emphasizes the importance of microscopic evaluation.

The 2.9% overall neoplasm rate in this study is somewhat higher than that described in larger populations. Charfi et al. reported neoplastic lesions in approximately 0.7% of 24,697 appendectomy specimens [10]. Ozdemir et al., in a study of 2,336 appendectomies, identified neuroendocrine tumors in 0.7%, LAMN in 0.5%, and primary appendiceal carcinoma in 0.2% of cases [13]. The higher proportion in the present study should be interpreted cautiously because of the relatively small sample size of 140 specimens; a small increase in the absolute number of tumors can substantially alter the percentage. In addition, the tertiary care setting may contribute to referral of a more heterogeneous or complex patient population.

Neuroendocrine tumor was the most frequent appendiceal neoplasm identified in the present study, accounting for two cases (1.4%). These tumors are characteristically discovered incidentally following appendectomy because they frequently produce no specific preoperative manifestations. Emre et al. identified 11 neuroendocrine tumors among 1,255 appendectomy specimens [9], while Ozdemir et al. reported 16 neuroendocrine tumors among 2,336 specimens [13]. The clinical implications depend on tumor size, location, histological grade, resection margins, mesoappendiceal invasion, lymphovascular invasion, and other risk characteristics. Therefore, the pathology report plays a central role in determining whether appendectomy alone is sufficient or whether further investigation and surgical management are necessary.

One low-grade appendiceal mucinous neoplasm was identified in the present series. LAMNs have distinctive biological behavior and are clinically significant because rupture or dissemination of mucin-producing epithelial cells into the peritoneal cavity can result in pseudomyxomateritonei. Identification of such a lesion requires careful pathological evaluation of the appendix, including assessment of the margin, appendiceal wall, serosal surface, mucin deposition, and evidence of extra-appendiceal spread. Ozdemir et al. found LAMN in approximately 0.5% of appendectomy specimens, further demonstrating that these lesions are uncommon but repeatedly encountered during routine pathological examination [13].

One case of adenocarcinoma was also detected. Appendiceal adenocarcinoma is uncommon and can present clinically as acute appendicitis, making preoperative recognition difficult. Parkash et al., in a recent cohort of 947 appendectomy patients, identified malignant tumors in 0.8% of specimens and emphasized the importance of considering an underlying malignancy, particularly among older patients and those presenting with a periappendiceal mass or atypical clinical course [14]. This is especially relevant to the present finding that non-acute histopathological abnormalities were significantly more frequent among patients over 40 years of age.

The diversity of unusual lesions observed in this study is consistent with other retrospective series. Yabanoglu et al. analyzed 1,466 adult appendectomy specimens and identified unusual histopathological findings in 3.88%, including parasitic disease and malignant lesions [15]. Importantly, they concluded that macroscopic examination during surgery could fail to identify unusual disease and supported routine histopathological examination of appendectomy specimens. This principle is supported by the present findings, since several of the conditions identified, particularly neuroendocrine tumors, endometriosis, granulomatous inflammation, and early mucinous lesions, may not be reliably predicted from clinical presentation alone.

The findings also have implications for the ongoing debate regarding selective versus routine histopathological examination of appendectomy specimens. Although the majority of specimens in this study demonstrated conventional acute inflammatory pathology, 6.4% contained uncommon specific lesions and 2.9% harbored neoplasia. The consequences of overlooking such diagnoses may be considerable. Histological identification of a parasite can result in medical therapy; granulomatous inflammation may trigger investigation for an underlying inflammatory or infectious condition; endometriosis may necessitate

gynecological assessment; and a neuroendocrine tumor, mucinous neoplasm, or adenocarcinoma can lead to additional staging, surveillance, or surgical treatment. Elfaedy et al. similarly demonstrated that unusual histopathological diagnoses may directly alter subsequent clinical management [11].

The present study has several strengths. All eligible appendectomy specimens were systematically assessed histologically, permitting evaluation of both common inflammatory patterns and rare incidental abnormalities. Categorization according to age, sex, and broad histopathological groups also enabled assessment of clinicopathological relationships. The demonstration of a statistically significant increase in non-acute pathological findings among patients older than 40 years provides an additional clinically relevant observation.

However, certain limitations should be acknowledged. First, the retrospective design depended on the completeness and accuracy of existing clinical and pathology records. Second, the study was performed at a single tertiary care center with a relatively modest sample size of 140 specimens; consequently, the frequency of rare conditions, particularly neoplasms, may be influenced considerably by small absolute changes in case numbers. Third, detailed radiological, operative, laboratory, and postoperative follow-up data may not have been consistently available for every patient. Finally, because uncommon lesions occurred in small numbers, meaningful multivariable analysis of predictors for individual rare diagnoses was not feasible. Larger multicenter studies with standardized histopathological criteria and long-term follow-up would provide more precise estimates of their prevalence and clinical consequences.

CONCLUSION

The present study demonstrates that acute inflammatory lesions constitute the predominant histopathological pattern in appendectomy specimens, particularly among younger patients. Acute suppurative appendicitis was the most common individual diagnosis. Nevertheless, appendectomy specimens exhibited a wide pathological spectrum that included chronic and reactive alterations, parasitic infestation, granulomatous inflammation, endometriosis, neuroendocrine tumors, low-grade appendiceal mucinous neoplasm, and adenocarcinoma.

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