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Frequency and Association of Perforated Appendix with Patient's Characteristics in Acute Appendicitis

Muhammad Zeb, Rafia Ahmad, Abdul Wadood, Ishtiaq Ahmed, Malak Maaz Hassan, Muhammad Moazzam Farooq

ABSTRACT

Objective: To determine the frequency of perforated acute appendicitis in patients with acute appendicitis and its association with patients clinic demographic characteristics.

Study design and setting: This cross sectional study was conducted in general surgery unit from 1st January 2022 to 31st December 2022.

Methodology: 171 patients were included. Patients who were provisionally diagnosed as acute appendicitis were included in the study. Sampling technique was nonprobability consecutive sampling. Statistical analysis was done through SPSS Version 23.

Results: The study included 171 patients, with 58.5% male and 41.5% female. The majority of patients were aged between 25-35 years and had a normal weight. Grossly inflamed appendix was the most common finding (69.6%), followed by perforated appendix (19.3%), normal appendix (8.2%), and gangrenous appendicitis (2.9%). There was no statistically significant difference between gender and intraoperative findings. Age categories and duration of symptoms were significantly associated with intraoperative findings.

Conclusion: In conclusion, 19.3% of patients with acute appendicitis presented with perforation. Age and duration of symptoms were found to be significantly associated with intraoperative findings, highlighting the importance of early diagnosis and timely surgical intervention.

Key Words: Appendicitis, Complications, Perforated, Ruptured

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INTRODUCTION

Acute appendicitis is recognized as the most common abdominal surgical emergency, with a lifetime risk of occurrence estimated to be between 7% and 8%. This condition is most frequently observed during the second decade of life, making it a significant health concern, particularly among adolescents and young adults.[1] The history of acute appendicitis dates back several centuries, with the earliest references in medical literature appearing in the 1500s. Originally termed parasyphilitic, acute appendicitis was a condition that puzzled early physicians. The first recorded appendectomy, the surgical removal of the appendix, was documented in 1736, marking a milestone in the surgical treatment of this condition.[1,2]

It wasn't until 1886 that Reginald Fitz, a prominent pathologist, emphasized the importance of appendectomy in managing acute appendicitis. [2] Fitz's work laid the foundation for the surgical approach to this condition, which remains the standard treatment today. Shortly after Fitz's contributions, Charles McBurney, a pioneering surgeon, described the clinical features of acute appendicitis, including the characteristic point of maximum tenderness in the right iliac fossa. This area, now known as McBurney's point, is a key diagnostic indicator in assessing patients suspected of having acute appendicitis.[2,3]

While the diagnosis of acute appendicitis is primarily clinical, advancements in imaging techniques have provided additional support for clinicians. Ultrasound and contrast-enhanced computed tomography (CT) scanning are now commonly used to confirm the diagnosis, particularly in cases where

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the clinical presentation is ambiguous.[3] These imaging modalities help to reduce the risk of misdiagnosis and ensure that patients receive timely and appropriate treatment. However, despite these advances, the diagnosis and treatment of acute appendicitis remain time-sensitive. Failure to promptly identify and treat the condition can lead to severe complications, such as gangrene and perforation. [3,4]

Perforation of the appendix is a particularly dangerous complication of acute appendicitis, leading to significant morbidity and mortality. The risk of perforation varies depending on several factors, including the patient's age, immune status, and the underlying cause of the appendicitis.[4] In general, perforation is associated with increased rates of hospitalization, longer recovery times, and greater financial costs for patients. Mortality rates in cases of perforated appendicitis can reach 5% or higher, especially among patients with multiple comorbidities or those at the extremes of age. [5] Both pediatric and geriatric patients are more susceptible to delayed presentations, which increases their risk of perforation. In adults, the risk of perforation begins to rise after 36 hours from the onset of symptoms, increasing by approximately 5% every 12 hours if the condition is left untreated. [6]

Despite technological advancements, the diagnosis of appendicitis continues to rely primarily on the patient's history and physical examination . [7]To assist in diagnosing acute appendicitis, various scoring systems have been developed .[8] These systems are designed to aid clinicians in evaluating patients with suspected appendicitis. Among them, the Alvarado score is the most widely recognized and has performed well in validation studies. However, it has certain limitations. For instance, the Alvarado score was initially created based on a review of patients who had already undergone surgery due to suspected appendicitis, yet it is intended to be applied to all patients with suspected appendicitis. Additionally, the score does not include C-reactive protein (CRP) as a variable, despite numerous studies highlighting the importance of CRP in assessing patients with appendicitis.[9] CRP is a key differential factor in the Appendicitis Inflammatory Response Score (AIRS). Utilizing AIRS can help reduce unnecessary radiological and surgical procedures. [10] The development of the AIR score enhances diagnostic accuracy by combining easily applicable clinical criteria with two simple laboratory tests—CRP and complete blood count (CBC)—to classify patients according to the likelihood of an appendicitis diagnosis .[11]

Several studies have reported varying rates of perforation in patients with acute appendicitis. For example, Omari AH reported a perforation rate of 25.8%, [1] while Imad et al. documented a rate of 20%.[12]

Despite the wealth of research on acute appendicitis, there is a notable gap in the literature regarding the rate of perforation in patients with acute appendicitis in certain regions, including ours. Understanding the frequency of perforation and its association with patient clinicodemographic characteristics in our region is crucial for improving patient outcomes. To address this gap, we have planned a study to determine the frequency of perforation in patients with acute appendicitis and to explore its association with various clinicodemographic factors. By identifying the factors that contribute to the risk of perforation, we aim to enhance early diagnosis and treatment strategies, ultimately reducing the morbidity and mortality associated with this common surgical emergency.

METHODOLOGY:

After obtaining approval from the ethical review board of the institution (ERC No: 904/ HMC/QAD-00), a comprehensive cross-sectional study was meticulously designed and conducted. The study focused on 171 patients who presented with a diagnosis of acute appendicitis, ranging in age from 15 to 50 years. Perforated appendicitis was defined as the presence of a visible perforation in the appendix wall identified during surgery, accompanied by one or more of the following findings:

- Visible hole/breach in the appendicular wall
- Presence of free pus in the peritoneal cavity
- Presence of fecalith in the peritoneal cavity
- Gross contamination of the peritoneal cavity with purulent material

These patients were admitted to the General Surgery department of Hayatabad Medical Complex, located in Peshawar, Pakistan. The study period spanned a full calendar year, commencing on 1st January 2022 and concluding on 31st December 2022, allowing for a thorough examination of seasonal variations and potential trends in appendicitis cases.

The sampling technique employed in this study was nonprobability consecutive sampling, a method chosen for its practicality and ability to capture all eligible patients within the specified timeframe. This approach ensured that every patient meeting the inclusion criteria during the study period was considered for participation, thereby minimizing selection bias and enhancing the representativeness of the sample.

Sample size calculation was performed using the World Health Organization (WHO) sample size calculator, a widely recognized tool in epidemiological research. The calculation was based on several key parameters: the expected frequency of perforated appendicitis was set at 20%, as informed by previous literature and regional data. A confidence interval of 95% was selected to ensure a high level of statistical reliability, and a margin of error of 6% was deemed acceptable for the study's objectives. These parameters were carefully chosen to balance statistical power with feasibility considerations.

To maintain the integrity and specificity of the study, several exclusion criteria were established. Patients presenting with enteric perforation, a condition that can mimic appendicitis symptoms, were excluded to prevent confounding results. Similarly, cases of mesenteric ischemia and intestinal obstruction were omitted due to their potential to complicate the diagnosis and management of acute appendicitis. Pregnant patients were also excluded from the study cohort, considering the unique physiological changes and diagnostic challenges associated with pregnancy. Additionally, patients with known malignancies were not included, as cancer could potentially alter the presentation and progression of appendicitis. Through the rigorous application of these exclusion criteria, a total of twenty patients were deemed ineligible and subsequently excluded from the study population.

Ethical considerations were paramount in the conduct of this research. Written informed consent was diligently obtained from all participating patients or their legal guardians in cases where patients were unable to provide consent themselves. This process ensured that all participants were fully aware of the study's objectives, procedures, potential risks, and benefits, thereby upholding the principles of autonomy and informed decision-making in medical research.

Prior to surgical intervention, all patients underwent a standardized preoperative assessment and investigation protocol, adhering strictly to the institutional guidelines of Hayatabad Medical Complex. This comprehensive evaluation typically included a detailed medical history, physical examination, laboratory tests (such as complete blood count, C-reactive protein levels, and liver function tests), and imaging studies (which may have included abdominal ultrasound or computed tomography scans, depending on clinical indications). The uniformity of this preoperative protocol across all study participants ensured consistency in patient evaluation and decision-making.

The critical decision to proceed with surgery for acute appendicitis was made exclusively by a specialist consultant general surgeon. This approach leveraged the expertise and clinical judgment of experienced professionals, ensuring that surgical interventions were warranted and appropriate for each case. The involvement of senior surgeons in this decision-making process added a layer of quality assurance to the study methodology.

Intraoperative findings were meticulously documented, with particular attention paid to the gross pathology of the appendix. In cases where perforation was suspected or confirmed, the surgical team conducted a thorough inspection of the appendicular wall during the appendectomy procedure. This detailed examination focused on identifying any breach in the continuity of the appendix wall, which is a hallmark of perforation. Furthermore, the peritoneal cavity was carefully explored for the presence of any collections, such as pus or inflammatory exudates, which could indicate advanced disease or complications.

Data regarding perforated appendicitis were recorded with precision, adhering strictly to the operational definition established for the study. This definition likely included specific criteria for classifying an appendix as perforated, such as visible holes in the appendix wall, presence of fecaliths in the peritoneal cavity, or extensive peritoneal contamination. The primary focus of data collection was on determining the frequency of perforated acute appendicitis within the study population.

To ensure consistency and minimize variability in surgical technique and assessment, all surgeries were performed by the same surgical team. This team was led by a highly qualified consultant surgeon with a minimum of 5 years of post-fellowship experience in general surgery. The researcher, who was also involved in the study design and data collection, assisted in these surgeries, providing an additional layer of observation and data verification. This approach not only standardized the surgical procedures but also allowed for real-time documentation of intraoperative findings.

Data was analysed using statistical analysis program IBM SPSS version 23. Frequencies and percentages were recorded for categorical variables including gender and presence of perforated acute appendicitis. Mean standard deviation was computed for numerical variables including age, BMI and duration of pain. Effect modifiers like age, gender, BMI and pain duration was controlled by rough stratification. Post-stratification chi square test/Fischer exact test was be applied. P value =0.05 was considered statistically significant.

RESULTS:

The study encompassed a total of 171 patients, providing a substantial sample size for robust statistical analysis. The mean age of the study participants was calculated to be 26.4 years, with a standard deviation of 10.0263 years. This relatively young average age, coupled with a considerable standard deviation, suggests a wide age range within the study population, potentially capturing diverse presentations of acute appendicitis across different life stages.

Gender distribution within the study cohort revealed a slight male predominance. Males constituted the majority, comprising 100 patients, which represented 58.5% of the total sample. Females, on the other hand, accounted for 71 patients, making up 41.5% of the study population. This gender disparity, while notable, is consistent with some epidemiological studies suggesting a higher incidence of acute appendicitis in males.

Age categorization of the participants yielded interesting insights. The largest age category by far was the 25-35 year group, which included 134 participants, representing a substantial 78.4% of the total sample. This predominance of young adults in the study population could have significant implications for understanding the peak incidence age for

acute appendicitis in this particular geographic and demographic context.

Body Mass Index (BMI) classification of the participants revealed that the majority fell within the normal weight range. Specifically, 118 patients, constituting 69% of the total sample, were classified as having a normal BMI. This was followed by the overweight category, which included 29 patients or 17% of the sample. Interestingly, 14 patients (8.2%) were categorized as underweight. The remaining 5.8% of patients, though not explicitly stated, can be inferred to fall into the obese category. These BMI distributions provide valuable information about the potential relationship between body weight and the incidence or presentation of acute appendicitis. These demographic and BMI data are presented in Table 1.

Intraoperative findings offered crucial insights into the pathological states of the appendix at the time of surgery. The most prevalent finding was a grossly inflamed appendix, observed in 119 cases, which accounted for a significant 69.6% of all surgeries. This high percentage of inflamed appendices underscores the importance of timely diagnosis and intervention in preventing more severe complications.

The second most common intraoperative finding was a perforated appendix, encountered in 33 cases, representing 19.3% of the total. This substantial proportion of perforated cases highlights the potential for rapid progression of appendicitis and the critical nature of early diagnosis and treatment. Perforated appendicitis is associated with increased morbidity and can lead to more complex postoperative courses, emphasizing the need for strategies to reduce the incidence of this complication.

Surprisingly, 14 cases (8.2%) revealed a normal appendix upon intraoperative examination. This finding is particularly noteworthy as it points to the challenges in preoperative diagnosis of acute appendicitis and the potential for false-positive clinical assessments. These cases of negative appendectomies warrant further investigation into improving diagnostic accuracy to minimize unnecessary surgeries.

The least common but potentially most severe presentation was gangrenous appendicitis, observed in 5 cases (2.9%). Although relatively rare, gangrenous appendicitis represents a critical stage of the disease with potentially serious complications, further emphasizing the importance of prompt diagnosis and treatment. The distribution of these intraoperative findings is illustrated in Figure 1.

Stratification of intraoperative findings by various factors provided additional depth to the analysis. Gender stratification, while showing a slight male predominance, did not yield statistically significant differences in appendicitis types between males and females ($p = 0.174$). This suggests that gender may not be a strong predictor of the type or severity of appendicitis in this population.

Age stratification revealed a striking concentration of cases in the 26-35 year age bracket, with 134 patients (78.4%) falling into this category. The 36-45 year category included 27 patients (15.8%), while 9 patients (5.3%) were aged 46-50 years. Notably, only 1 patient (0.6%) was in the 15-25 year category. The distribution of appendicitis types across these age categories demonstrated high statistical significance ($p = 0.00$), indicating a strong relationship between age and the presentation or progression of appendicitis.

BMI classification analysis showed that the majority of patients (118, 69.0%) were of normal weight, followed by 29 overweight patients (17.0%), 14 underweight patients (8.2%), and 9 obese patients (5.3%). The variation in appendicitis types across these BMI categories reached statistical significance ($p = 0.020$), suggesting that body mass index may play a role in the development or presentation of different types of appendicitis.

Analysis of symptom duration revealed that a majority of patients (117, 68.4%) experienced symptoms for more than 24 hours before seeking medical attention, while 54 patients (31.6%) reported symptoms lasting less than 24 hours. The difference in appendicitis types based on symptom duration was highly statistically significant ($p = 0.00$). This finding underscores the critical importance of timely medical intervention and suggests that longer symptom duration may be associated with more advanced stages of appendicitis. The stratification of intraoperative findings by age, gender, BMI, and symptom duration is detailed in Table 2.

DISCUSSION:

Acute appendicitis stands as one of the prevalent surgical emergencies confronted by surgical residents during their residency tenure. Diagnosis of acute appendicitis heavily relies on clinical assessment, making it a notably challenging task. In cases where diagnostic ambiguity persists, CT scan of the abdomen and pelvis with contrast emerges as a commonly employed diagnostic tool, given its impressive sensitivity (94%) and specificity (95%) compared to alternative investigative modalities.[12,13] However, in peripheral healthcare settings where CT scan availability may be limited,

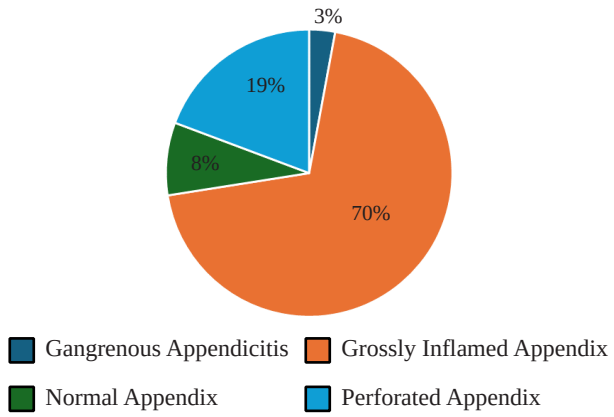
Table 1: Descriptive statistics of preoperative and intraoperative variables

Variables	Categories	Frequency	Percentage
Gender	**Female**	71	41.5
	Male	100	58.5
Age Categories	**15-25yrs**	1	0.5
	25-35yrs	134	63.5
	35-45yrs	27	12.8
	45-50yrs	9	4.3
BMI Categories	**Underweight**	14	8.2
	Normal Weight	118	69
	Overweight	29	17
	Obese	10	5.8

Table 2: Comparison of Intraoperative findings with Gender, Age, BMI and Durations of Symptoms

Variables	Categories	Gangrenous n (%)	Gross Inflamed n (%)	Perforated n (%)	Normal n (%)	Total	P value
Gender	Female	0 (0%)	46 (64.8%)	16 (22.5%)	9 (12.7%)	71	0.174
	Male	5 (5%)	73 (73%)	17 (17%)	5 (5%)	100	
Age Category	15-25 yrs	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1	0.00
	26-35 yrs	1 (0.7%)	101 (75.4%)	22 (16.4%)	10 (7.5%)	134	
	36-45 yrs	3 (11.1%)	14 (51.9%)	9 (33.3%)	1 (3.7%)	27	
	46-50 yrs	0 (0%)	4 (44.4%)	3 (33.3%)	2 (22.2%)	9	
BMI	Underweight	1 (7.1%)	6 (42.9%)	6 (42.9%)	1 (7.1%)	14	0.020
	Normal Weight	1 (0.8%)	87 (73.7%)	17 (14.4%)	13 (11%)	118	
	Overweight	1 (3.4%)	21 (72.4%)	7 (24.1%)	0 (0%)	29	
	Obese	1 (11.1%)	5 (55.6%)	4 (44.4%)	0 (0%)	9	
Duration of Symptoms	Less than 24 hours	1 (1.9%)	40 (74.1%)	2 (3.7%)	11 (20.4%)	54	0.00
	More than 24 hrs	3 (2.6%)	79 (67.5%)	32 (27.4%)	3 (2.6%)	117	

Figure 1: Intraopertative Findings



reliance on clinical examination remains prominent. Consequently, there exists a heightened risk of missing the diagnosis and delay in diagnosis lead to significant morbidity and mortality due to perforation.[14,15]

The distribution of intraoperative findings in the present study is consistent with the current literature on appendicitis. Grossly inflamed appendix was the most common finding, which is in line with previous studies reporting an incidence of inflamed appendix ranging from 65% to 85% .[16,17] Perforated appendix was the second most common finding, which is consistent with the literature indicating that approximately 20-30% of appendicitis cases result in perforation.[1,18] In our study the incidence of perforated appendicitis was 19.3% while study by Nighat G et al in Pakistan reported 11.3% in her study.[19] Finally, the incidence of normal appendix was 8.2%, which is consistent with the reported incidence of negative appendectomy ranging from 5% to 25%.[1,20]

Several studies have examined the association between gender and appendicitis, with mixed results. Some studies have found no significant difference in the incidence of appendicitis between males and females, while others have reported higher incidence rates in males.[21,22] One study conducted in a large hospital in Turkey found no significant difference in the frequency of appendicitis or other intraoperative findings between males and females .[23] Our study results are consistent with this finding, as we found no statistically significant difference in intraoperative findings between male and female patients undergoing appendectomy.

The finding that the highest proportion of patients with grossly inflamed appendix was in the age group of 25-35 years is consistent with previous studies. A study conducted by Bolandparvaz et al. reported that the majority of their study population with acute appendicitis belonged to the age group of 20-40 years.[24] Another study by Al-Qahtani et al. also found that the highest incidence of acute appendicitis was in the age group of 20-30 years.[25]

Moreover, the absence of gangrenous appendicitis in the 15-25 age group in the current study is in line with previous reports. A study by Karaman et al. (2018) also reported no cases of gangrenous appendicitis in the age group of 10-19 years.[26]

One study conducted by Tsai et al. found that patients with acute appendicitis who had symptoms for more than 24 hours had a higher risk of perforation and abscess formation.[27] Similarly, a study by Zhao et al. also found that the duration of symptoms was significantly associated with the severity of appendicitis and the risk of complications.[28]

The association between BMI and intraoperative findings in patients undergoing appendectomy has been investigated in several studies. A systematic review and meta-analysis of 11 studies with a total of 7,163 patients found that higher BMI was associated with increased risk of complicated appendicitis, such as perforation and abscess formation (24).[29] Another study of 1,253 patients showed that overweight and obese patients were more likely to have a complicated appendicitis compared to normal weight patients.[30]

However, there are also studies that have reported no significant association between BMI and appendicitis severity. For example, a study of 399 patients found that BMI was not a significant predictor of appendiceal perforation.[31]

The study highlights the increasing age and late intervention to be the significant factors leading to perforation.

Despite these findings, there are certain limitations of this study worth mentioning. Firstly, it was a cross sectional study. Secondly, it was a single centre study. Thirdly, the sample size can be increased to enhance the power of findings. Lastly, we didn't gather the follow up data.

CONCLUSIONS:

The perforation of the appendix remains a significant complication of acute appendicitis, with implications for both clinical outcomes and patient morbidity. Timely detection of risk factors, such as patient age and the duration of symptoms, plays a critical role in expediting appropriate intervention and potentially preventing perforation.

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Abdul Wadood: Data Collection, Proof Reading, Critical Analysis, Final Drafting
Ishtiaq Ahmed: Data Collection, Proof Reading, Critical Analysis, Drafting.
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