



Frequency of perforated appendix in patients presenting with acute appendicitis in Surgical C Ward, Ayub Teaching Hospital

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Declaration

Authors' Contribution

BK – Conceptualization, study design, data collection, manuscript writing, and final approval.

IM & ZK – Data analysis and interpretation.

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ABSTRACT

Background: Acute appendicitis is a common surgical emergency, with perforation being a serious complication that increases morbidity and mortality. Identifying risk factors for perforation and allocation of adequate healthcare resources is crucial for timely intervention, particularly in diverse socioeconomic settings. While clinical diagnosis remains challenging, understanding demographic and comorbidity-related associations can improve patient outcomes. **Objective:** To determine the frequency of perforated appendix in patients presenting with acute appendicitis in Surgical C Ward at Ayub Teaching Hospital. **Study Design:** Cross-sectional study. **Duration and Place of Study:** The study was conducted from June 2024 to December 2024 at the Department of Surgery, Ayub Teaching Hospital, Abbottabad. **Methodology:** A total of 127 patients aged 12–50 years with acute appendicitis were enrolled. Diagnosis was based on clinical criteria (fever $>100^{\circ}\text{F}$, right lower quadrant pain >5 on scale, WBC count $\geq 10,000/\text{mm}^3$) and confirmed intra-operatively. Perforation was identified by purulent/feculent spillage, visible perforation, or abscess. Data on age, BMI, gender, residence, socioeconomic status, family history, diabetes, and hypertension were collected. **Results:** The mean age of patients was 30.70 ± 10.70 years, with 51.2% male representation. Perforated appendix was found in 19.7% of cases. Age >30 years (35.1% vs. 7.1%, $p<0.001$), BMI $>25 \text{ kg/m}^2$ (36.4% vs. 6.9%, $p<0.001$), urban residence (30.0% vs. 7.0%, $p=0.001$), and comorbidities like diabetes (62.5% vs. 16.8%, $p=0.008$) and hypertension (54.5% vs. 7.4%, $p<0.001$) were significantly associated with perforation. **Conclusion:** Perforated appendicitis is significantly associated with older age, obesity, urban residency, higher socioeconomic status, and metabolic comorbidities.

INTRODUCTION

Acute appendicitis is a prevalent surgical emergency syndrome characterized by inflammation of the appendix, classically presenting with right lower quadrant abdominal pain, nausea, vomiting, and fever.¹ The course of appendicitis is typically rapid with worsening of signs and symptoms in hours to days.² The pathogenesis of appendicitis most frequently is due to luminal obstruction by appendicoliths, lymphoid hyperplasia, or foreign bodies leading to increased intra-luminal pressure, ischemia, and bacterial overgrowth.³ When untreated, inflamed appendix is likely to perforate with significant consequences. Early diagnosis and therapy with appendectomy are warranted to prevent such potentially fatal sequelae.⁴

Unless treated in a timely manner, acute appendicitis can cause a variety of secondary complications including perforation, peritonitis, abscess formation, and sepsis.⁵ Peritonitis is a diffuse infection of the abdomen when perforation of the compromised appendix spills bacteria into the peritoneal space.⁶ This can cause severe illness in

the form of infection spreading rapidly throughout the abdomen. Abscess formation is a common complication in which purulent exudate is deposited in a localized space in the abdomen to be drained and treated with long-term antibiotics.⁷ Sepsis is a systemic inflammatory response to infection and is a serious and potentially fatal complication necessitating emergency critical care.⁸

Perforated appendix is a serious complication of acute appendicitis in which the wall of the appendix is ruptured and bacteria and intestinal contents are released into the abdominal cavity.⁹ This occurs typically between 24 and 48 hours of onset of illness when infection has exceeded the capacity of the appendix to contain it.¹⁰ Perforation is most commonly associated with more severe presentations of clinical signs such as diffuse abdominal tenderness, pyrexia, tachycardia, and hypotension.¹¹ The condition is a major contributor to increased morbidity and mortality in patients with appendicitis as it necessitates a more complex surgical procedure, a more prolonged convalescence course, and a higher rate of postoperative infection in the form of peritonitis and

sepsis.¹² Early diagnosis and urgent surgery with appropriate antibiotic therapy is essential in optimizing outcome in patients with perforated appendices.¹³

A study conducted by Potey K and colleagues revealed that the incidence of perforated appendix among patients with acute appendicitis was 13.8%.¹⁰

The investigation of perforated appendix in patients with acute appendicitis is important to know about the progression and complications of this prevalent surgical emergency. Preoperative diagnosis of perforation would be of benefit in individualizing appropriate treatment policies to minimize mortality and future complications like peritonitis and sepsis. The investigation may also help in assessing risk factors, time of perforation, and effectiveness of present diagnostic and therapeutic strategies and finally improve patient care along with making clinical decisions.

METHODOLOGY

This cross-sectional study was conducted at the Department of Surgery, Ayub Teaching Hospital, from June 2024 to December 2024. A total sample size of 127 was calculated using the WHO sample size software, which took into account a 95% confidence level, a 6% margin of error, and an anticipated frequency of perforated appendix by 13.8% in patients with acute appendicitis.¹⁰ Patients were included in the study after permission from ethical committee (Ref: RC-EA-2023/233) and CPSP.

Inclusion criteria was individuals aged between 12 and 50 years, of both genders, who were diagnosed with acute appendicitis based on the presence of fever exceeding 100°F, localized pain and tenderness in the right lower quadrant with a pain scale greater than 5, and an elevated white blood cell count of 10,000/mm³ or higher. Only patients undergoing appendectomy were included in the study. Exclusion criteria involved individuals with a history of previous abdominal surgery, appendicular lump or mass, pregnancy, or colon cancer. Basic demographic information including age, gender, body mass index, family history of appendicitis, socioeconomic status, education level, profession, diabetes, hypertension, and residential status were recorded.

On admission, suspected cases of perforated appendicitis were investigated via ultrasonography and hematologic examinations. After these investigations were conducted, suspected perforation cases were urgently listed for emergency surgery. The diagnosis of perforated appendix was made on findings seen at surgery through evidence of purulent or feculent spilling in the peritoneal cavity, a distended or inflamed appendix with an obvious perforation seen, and inflammation or an abscess in surrounding tissue.

Data analysis was performed using IBM SPSS version 26, where categorical variables such as gender, family history of appendicitis, residence and socioeconomic status were presented as frequencies and percentages, while continuous variables such as age and BMI were recorded as mean and standard deviation. The relationship between perforated appendix and various factors was explored through stratification, and post-stratification chi-square tests were applied, considering a p-value of ≤ 0.05 as statistically significant.

RESULTS

Among the 127 patients studied, the mean age was 30.70 \pm 10.70 years and the mean BMI was 25.12 \pm 3.71 kg/m². The study population had a nearly balanced gender distribution with 65 (51.2%) males and 62 (48.8%) females. Regarding residential status, 57 (44.9%) patients came from rural areas while 70 (55.1%) were from urban settings. Socioeconomic distribution showed 46 (36.2%) patients belonged to poor status, 58 (45.7%) to middle status, and 23 (18.1%) to rich status. A family history of appendicitis was reported in 36 (28.3%) patients, while 91 (71.7%) had no such history. Comorbidities were present in a subset of patients, with diabetes affecting 8 (6.3%) and hypertension present in 33 (26.0%) of the study population (as shown in Table 1).

Table 1
Patient Demographics

Demographics	Mean \pm SD
Age (years)	30.70 \pm 10.70
BMI (Kg/m ²)	25.12 \pm 3.71
Gender	Male n (%)
	Female n (%)
Residential Status	Rural n (%)
	Urban n (%)
Socioeconomic Status	Poor n (%)
	Middle n (%)
	Rich n (%)
Family History of Appendicitis	Yes n (%)
	No n (%)
Diabetes	Yes n (%)
	No n (%)
Hypertension	Yes n (%)
	No n (%)

The primary outcome of the study revealed that perforated appendix occurred in 25 (19.70%) patients, while 102 (80.30%) presented with non-perforated acute appendicitis (as shown in Table 2).

Table 2
Frequency of Perforated Appendix

Perforated Appendix	Frequency	% age
Yes	25	19.70%
No	102	80.30%

Further analysis demonstrated several significant associations between demographic factors and appendix perforation (as shown in Table III). Age appeared to be a significant factor, with patients older than 30 years having a substantially higher perforation rate (35.1%) compared to those 30 years or younger (7.1%) ($p < 0.001$). Similarly, BMI showed a strong correlation with perforation rates, where patients with BMI > 25 kg/m² experienced significantly higher perforation rates (36.4%) than those with BMI ≤ 25 kg/m² (6.9%) ($p < 0.001$).

Urban residents demonstrated a markedly higher perforation rate (30.0%) compared to rural residents (7.0%) ($p = 0.001$). An unexpected finding was observed regarding socioeconomic status, where perforation rates showed a progressive increase from poor (6.5%) to middle (10.3%) to rich (69.6%) socioeconomic groups ($p < 0.001$). Contrary to what might be expected, patients without a family history of appendicitis had higher perforation rates

(24.2%) compared to those with a positive family history (8.3%) ($p=0.049$). Both comorbidities exhibited strong associations with perforation: diabetic patients had significantly higher perforation rates (62.5%) compared to non-diabetic patients (16.8%) ($p=0.008$), and hypertensive patients also showed markedly elevated perforation rates (54.5%) compared to normotensive patients (7.4%) ($p<0.001$). Gender was the only demographic factor that did not demonstrate a significant association with appendix perforation (males 24.6% vs females 14.5%, $p=0.152$) (as shown in Table 3).

Table 3

Association of Perforated Appendix with Demographic Factors

Demographic Factors		Perforated Appendix		p-value
		Yes n(%)	No n(%)	
Age (years)	≤30	5 (7.1%)	65 (92.9%)	<0.001*
	>30	20 (35.1%)	37 (64.9%)	
Gender	Male	16 (24.6%)	49 (75.4%)	0.152
	Female	9 (14.5%)	53 (85.5%)	
BMI (Kg/m ²)	≤25	5 (6.9%)	67 (93.1%)	<0.001*
	>25	20 (36.4%)	35 (63.6%)	
Residential Status	Rural	4 (7.0%)	53 (93.0%)	0.001*
	Urban	21 (30.0%)	49 (70.0%)	
Socioeconomic Status	Poor	3 (6.5%)	43 (93.5%)	<0.001*
	Middle	6 (10.3%)	52 (89.7%)	
	Rich	16 (69.6%)	7 (30.4%)	
Family History of Appendicitis	Yes	3 (8.3%)	33 (91.7%)	0.049*
	No	22 (24.2%)	69 (75.8%)	
Diabetes	Yes	5 (62.5%)	3 (37.5%)	0.008*
	No	20 (16.8%)	99 (83.2%)	
Hypertension	Yes	18 (54.5%)	15 (45.5%)	<0.001
	No	7 (7.4%)	87 (92.6%)	

*Fischer Exact Test

DISCUSSION

Our results demonstrated a 19.70% prevalence of perforated appendix among patients presenting with acute appendicitis, which falls within the reported range of 15-30% in contemporary literature. The significantly higher perforation rates observed in patients over 30 years of age (35.1% vs 7.1%, $p<0.001$) may be attributed to age-related alterations in immune response, diminished visceral pain perception, and delayed healthcare-seeking behavior in older adults. The strong association between elevated BMI (>25 kg/m²) and appendiceal perforation (36.4% vs 6.9%, $p<0.001$) likely reflects diagnostic challenges posed by obesity, including difficulties in physical examination and imaging interpretation, potentially leading to delayed diagnosis and intervention. The striking finding of higher perforation rates among urban residents (30.0% vs 7.0%, $p=0.001$) challenges conventional assumptions about better healthcare access in urban areas. While urban settings are generally associated with greater availability of medical services, factors such as self-medication, delayed referrals from private practitioners or underestimation of symptoms especially when patients are occupied with work or daily responsibilities may actually contribute to delays in seeking timely surgical evaluation and consequently, a higher risk of perforation.

Additionally, the progressive increase in perforation rates across socioeconomic strata (poor: 6.5%, middle: 10.3%,

rich: 69.6%, $p<0.001$) is particularly noteworthy and may be explained by differential healthcare utilization patterns, with affluent patients possibly postponing treatment due to prioritizing work commitments or seeking multiple consultations before opting for surgery, which can further contribute to disease progression.

The counterintuitive finding of lower perforation rates among patients with a family history of appendicitis (8.3% vs 24.2%, $p=0.049$) suggests that familial experience with the condition may enhance symptom recognition and promote earlier medical consultation. Comorbidities demonstrated strong associations with perforation, with diabetic patients showing markedly higher rates (62.5% vs 16.8%, $p=0.008$), likely due to immunocompromised status, neuropathy affecting pain perception, and vascular insufficiency impairing tissue healing. Similarly, hypertensive patients exhibited significantly elevated perforation rates (54.5% vs 7.4%, $p<0.001$), possibly attributable to microvascular changes affecting appendiceal blood flow and the confounding influence of age, as hypertension is more prevalent in older adults who independently demonstrated higher perforation rates.

The study by Humera Sadaf Bugti et al.¹⁴ reported a perforation rate of 9%, which is lower than our findings of 19.70%. This discrepancy may be attributed to differences in study populations and healthcare access, as our study included a broader demographic with urban-rural distribution and socioeconomic stratification. Notably, our results showed urban residents had significantly higher perforation rates (30.0% vs 7.0%, $p=0.001$), suggesting delayed presentation in urban areas despite better healthcare infrastructure, possibly due to initial self-medication or misdiagnosis.

Abdul Hafeez Arain et al.¹⁵ found a higher perforation rate (35%) compared to our study (19.70%). Their study focused exclusively on complicated appendicitis cases, which likely skewed results toward more severe presentations. In contrast, our study included all acute appendicitis cases, providing a more generalizable perforation rate. Similar to our findings, Arain et al. reported male predominance (65%), though our gender distribution was nearly equal (51.2% males vs. 48.8% females), with no significant association between gender and perforation ($p=0.152$).

Muhammad Riaz et al.¹⁶ reported a perforation rate of 13.8%, closer to our results. Both studies identified age as a significant risk factor, with our data showing higher perforation rates in patients >30 years (35.1% vs 7.1%, $p<0.001$). Riaz et al. also highlighted severe peritoneal contamination as a predictor of poor outcomes, aligning with our findings that comorbidities like diabetes (62.5% vs 16.8%, $p=0.008$) and hypertension (54.5% vs 7.4%, $p<0.001$) significantly increased perforation risk. These similarities underscore the role of systemic factors in disease progression.

Fazal Manan et al.¹⁷ reported an 8% perforation rate, lower than our 19.70%. This difference may stem from their younger cohort (mean age 24 years vs. our 30.70 years), as older age was strongly associated with perforation in our study. Both studies, however, noted that clinical diagnosis remains challenging, with Manan et al. relying on Alvarado scores, while our study incorporated broader

demographic and comorbidity data to identify high-risk groups.

Nighat Ghas et al.¹⁸ found an 11% perforation rate, midway between Manan et al.¹⁷ and our results. Their study, like ours, reported no significant gender difference in perforation rates, reinforcing that sex may not be a decisive factor despite historical male predominance in some studies.^{14,15}

Our results highlighted socioeconomic disparities, with rich patients having markedly higher perforation rates (69.6%) than poor (6.5%) or middle-class (10.3%) patients ($p < 0.001$). This contrasts with most literature, which rarely examines socioeconomic status. We also found that hypertension and diabetes were strongly linked to perforation, suggesting metabolic factors may exacerbate appendiceal inflammation. The lack of family history association (24.2% vs. 8.3%, $p = 0.049$) implies environmental or lifestyle factors may outweigh genetic predisposition.

Study design plays a significant role in outcomes. Retrospective studies^{14,17} may underreport perforation rates due to selection bias, whereas our prospective design captured more comprehensive data. Population heterogeneity is another factor—our inclusion of rural/urban and socioeconomic strata revealed disparities absent in hospital-based studies.^{15,16} Few studies analyzed comorbidities, which our study identified as critical risk factors.

While perforation rates vary across studies (8–35%), our findings (19.70%) align closely with Riaz et al.¹⁶ and Ghas et al.¹⁸ The strong associations with age, BMI, urban residence, and comorbidities in our study provide new

insights into preventable risk factors. Future research should explore why urban and affluent patients present later, despite better healthcare access.

The observed associations, especially regarding urban residency and metabolic comorbidities, emphasize the need for tailored public health strategies and timely clinical interventions to reduce complication rates.

However, this study has several limitations. Being a single-center study, its findings may not be generalizable to other populations or healthcare settings. Additionally, the sample size, though statistically adequate, may not capture all variations across diverse ethnic or geographic groups. Further multi-center, longitudinal studies with larger cohorts are recommended to validate and expand upon these results.

CONCLUSION

Our study has concluded that perforation in acute appendicitis is significantly influenced by patient age, comorbidities, socioeconomic status, and urban residency. These factors collectively contribute to delayed presentation and increased risk of complications. The findings highlight the importance of early diagnosis and targeted awareness, particularly among high-risk groups, to improve clinical outcomes and reduce the burden of perforated appendicitis.

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