

Factors Associated with Perforated Appendix in Elderly Patients in Tertiary Care Hospitals

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ABSTRACT

Background: Perforated appendicitis is an important complication of acute appendicitis in older adults and may be associated with delayed presentation and atypical clinical features.

Objective: To determine the frequency of perforated appendicitis and compare demographic and clinical factors associated with perforation among patients with acute appendicitis.

Methodology: A descriptive cross sectional study was done on 100 patients of age 40 to 80 years with acute appendicitis at Combined Military Hospital Muzaffarabad from 30 August 2022 to 2 March 2023. Non-probability consecutive sampling was used for patients' enrolment. Demographic and clinical parameters (sex, duration of pain, fever, anorexia, BMI, occupation) were noted. Associations were evaluated by the chi-square test and $p \leq 0.05$ was considered statistically significant.

Results: Among 100 patients, 29 (29.0%) had perforated appendicitis and 71 (71.0%) had non-perforated appendicitis. Males accounted for 59 (59.0%) patients and females for 41 (41.0%). Perforation was significantly associated with male sex (44.1% vs. 7.3%, $p < 0.001$), pain duration > 24 hours (40.3% vs. 6.1%, $p < 0.001$), fever (34.1% vs. 5.6%, $p = 0.015$), longer mean pain duration (65.24 ± 18.24 vs. 32.80 ± 19.42 hours, $p < 0.001$), and higher mean temperature (99.65 ± 1.08 vs. $98.77 \pm 1.57^\circ\text{F}$, $p = 0.002$). Anorexia was not significantly associated with perforation ($p = 0.915$).

Conclusion: Prolonged symptoms, male sex, and fever were associated with perforated appendicitis and may assist in early identification of patients requiring prompt surgical assessment.

Keywords: Acute appendicitis; perforated appendicitis; elderly patients; symptom duration; fever; risk factors.

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1. INTRODUCTION

Acute appendicitis is one of the most frequent causes of acute abdomen that requires emergency surgical evaluation [1]. Although it can happen at any age, in elderly persons the clinical presentation and/or course of the disease can be very different [2]. As aging, physiologic changes, numerous comorbidities, immune system changes, and atypical symptom presentation increase with age, diagnosis of acute appendicitis can become more difficult [3]. Therefore, an older patient may not present until the late stages of the disease when the inflammation has reached the point of perforation or other complications have set in [4]. The presentation of appendicitis in this population could be less classical, with less physical evidence, and thus, might be poorly identified initially [5]. Multiple comorbidities and physiological changes with age may further contribute to poor outcomes and make assessment difficult [6].

Perforated appendicitis is the advanced form of the disease which is characterized by inflammation and infection causing a rupture of the wall of the appendix [4]. It has been linked to higher incidence of peritonitis, intra-abdominal abscess, postoperative morbidity, longer hospital stays, and death compared to uncomplicated appendicitis [7]. Diagnostic delay..

and atypical clinical features in older age can be important risk factors for progression of disease prior to definitive therapy; this is an important consideration with respect to the risk of perforation. However, some studies assessing elderly patients have reported more perforations and that longer duration of symptoms, fever, anorexia, male sex, and delayed presentation were associated with perforated appendicitis [9].

A number of clinical and demographic parameters have been described in relation to perforation of the appendix. Complicated disease may be associated with increasing age, duration of symptoms, time to presentation to hospital, fever, leukocytosis, elevated inflammatory markers, and certain comorbid conditions [10]. These factors, however, may be present or not depending on patient populations, healthcare environments and diagnostic modalities [11]. The relationship between these factors and perforation in elderly patients may also be affected by the different clinical manifestation of acute appendicitis and the underlying chronic diseases [12].

Patients with high-risk features for perforation can be identified early by careful evaluation of clinical findings, demographic factors and laboratory parameters in the setting of appropriate clinical clues [13]. Data from these factors can be compared to those from elderly patients with perforated and non-perforated appendicitis to describe the clinical picture of advanced disease. These comparisons are especially applicable when the patients present in tertiary care emergency settings where they may have different lengths of illness and different levels of disease severity.

Research Objective

To determine the frequency of perforated appendicitis and compare the frequency of associated demographic, clinical, and relevant laboratory factors between elderly patients with and without perforated appendicitis presenting to the emergency department of a tertiary care hospital.

2. MATERIALS AND METHODS

Study Design and Setting

The present study was a descriptive cross-sectional study which was conducted to determine the prevalence of perforated appendicitis and the associated risk factors among all the cases of acute appendicitis presented to the hospital in the age group 40-80 years. The study was carried out in Combined Military Hospital (CMH), Muzaffarabad, Department of Surgery.

Duration of Study

The study was conducted for 6 months (30 August 2022 to 02 March 2023).

Sample Size and Sampling Technique

The sample size was determined using the WHO sample size calculator based on 95% Confidence Level, 9% margin of error and an expected frequency of perforated appendicitis of 21.8% in patients with appendicitis. [14] A total of 100 patients were thus included. Consecutive sampling was used as a non-probability sampling technique. All eligible patients who were seen during the study period were consecutively entered into the study until the sample size was obtained.

Sample Selection

Patients were included in the analysis if they were aged 40–80 years, and presented with an acute appendicitis as per the pre-defined operational definition and had had an appendectomy. Patients who had renal impairment (serum creatinine >2.0 mg/dL), diabetes mellitus (random blood sugar >200 mg/dL), or deranged coagulation parameters (prothrombin time >15 seconds, activated partial thromboplastin time >33 seconds or international normalized ratio >1.5) were excluded.

Data Collection Procedure

After approval from the hospital's Ethical Review Committee, patients who met the criteria were recruited from the surgical wards after informed written consent was obtained. Structured proforma was used to record demographic and clinical details, such as age, sex, body mass index (BMI), occupation, duration of symptoms and Alvarado score. Patients were clinically evaluated for fever and for other predetermined factors such as anorexia and pain duration > 24 hours. The surgery was unilateral appendectomy under spinal anesthesia done by one surgical team with the help of the researcher. The appendix was checked for perforation during surgery. Patients were then divided into two groups: perforated and non-perforated appendicitis. Other factors associated with this, such as male sex, duration of pain >24 hours, anorexia and fever were also recorded for comparison between the two groups. Standard postoperative management was used based on institutional protocols in patients with perforated appendicitis. All information collected was written on the study proforma.

Data Analysis

The data was inputted and analyzed in SPSS 21.0. Demographic data, such as sex and occupation, and the predefined risk factors were summarized as frequencies and percentages, and quantitative data, such as age, BMI, Alvarado score, duration of symptoms and temperature, were summarized as mean $\pm$ standard deviation. The Chi-square test was used to compare the frequencies of associated factors of the perforated and non-perforated appendicitis. Data was stratified based on age, BMI, Alvarado score and occupation to look for any significant differences among subgroups and chi-square testing was used within each subgroup. A p-value ≤ 0.05 was considered statistically significant.

Ethical Considerations

Before the study began, the study was approved by the Ethical Review Committee of Combined Military Hospital, Muzaffarabad. All participants provided written informed consent, which was explained to them the function and procedures of the study. The participation was voluntary and participants were assured they had the right to leave the study at any time without it impacting their care. Participants' confidentiality and privacy ensured during the study, and the data collected were only used for study purposes.

3. RESULTS

Among 100 patients, the mean age was 52.72 ± 9.79 years, mean BMI was 22.38 ± 4.29 kg/m², and mean Alvarado score was 8.64 ± 0.73 (table 1). Males constituted 59.0% (n=59) and females 41.0% (n=41). Perforated appendicitis was observed in 29.0% (n=29) of patients. Pain lasting >24 hours was reported in 67.0%, fever in 82.0%, and anorexia in 44.0%. The mean duration of pain before surgery was 42.21 ± 24.08 hours, while the mean body temperature was $99.03 \pm 1.49^\circ\text{F}$.

Table 1. Descriptive statistics and frequency distribution of demographic, clinical, and risk-factor characteristics of study participants (n=100)

Variable	Category	Frequency (n; %)
Age (years)	Mean $\pm$ SD	52.72 ± 9.79
BMI (kg/m ²)	Mean $\pm$ SD	22.38 ± 4.29
Alvarado score	Mean $\pm$ SD	8.64 ± 0.73
Gender	Male	59 (59.0%)
	Female	41 (41.0%)
Occupation	Businessman	33 (33.0%)
	Housewife	12 (12.0%)
	Teacher	11 (11.0%)
	Mechanic	9 (9.0%)
	Lawyer	9 (9.0%)
	Other occupations	26 (26.0%)
Perforated appendicitis	Yes	29 (29.0%)
	No	71 (71.0%)
Male gender	Yes	59 (59.0%)
	No	41 (41.0%)
Duration of pain >24 hours	Yes	67 (67.0%)
	No	33 (33.0%)
Fever at presentation	Yes	82 (82.0%)
	No	18 (18.0%)
Anorexia	Yes	44 (44.0%)
	No	56 (56.0%)
Duration of pain before surgery (hours)	Mean $\pm$ SD	42.21 ± 24.08
Body temperature ($^\circ\text{F}$)	Mean $\pm$ SD	99.03 ± 1.49

Perforated appendicitis was significantly associated with male sex, pain duration >24 hours, fever, longer duration of pain before surgery, and higher body temperature (table 2). Perforation occurred in 44.1% of males versus 7.3% of females ($p < 0.001$), and in 40.3% of patients with pain >24 hours versus 6.1% with shorter duration ($p < 0.001$). Fever was present in 34.1% of patients with perforation versus 5.6% without perforation ($p = 0.015$). Mean pain duration was substantially longer in perforated cases (65.24 ± 18.24 vs. 32.80 ± 19.42 hours; $p < 0.001$), as was mean temperature (99.65 ± 1.08 vs. $98.77 \pm 1.57^\circ\text{F}$; $p = 0.002$). Age group, BMI, occupation, and anorexia were not significantly associated with perforation ($p > 0.05$).

Table 2. Comparison of demographic, clinical, and predefined risk factors according to perforation status

Variable	Category	Perforated, n (%) / Mean $\pm$ SD	Non-perforated, n (%) / Mean $\pm$ SD	p-value
Male gender	Yes	26 (44.1)	33 (55.9)	<0.001
	No	3 (7.3)	38 (92.7)	
Duration of pain >24 h	Yes	27 (40.3)	40 (59.7)	<0.001
	No	2 (6.1)	31 (93.9)	
Fever at presentation	Yes	28 (34.1)	54 (65.9)	0.015
	No	1 (5.6)	17 (94.4)	
Anorexia	Yes	13 (29.5)	31 (70.5)	0.915
	No	16 (28.5)	40 (71.5)	
Duration of pain before surgery (hours)	Continuous	65.24 $\pm$ 18.24	32.80 $\pm$ 19.42	<0.001
Body temperature (°F)	Continuous	99.65 $\pm$ 1.08	98.77 $\pm$ 1.57	0.002
Age group	≤ 60 years	26 (32.1)	55 (67.9)	0.159
	>60 years	3 (15.8)	16 (84.2)	
	Total	29 (29.0)	71 (71.0)	
Gender	Male	26 (44.1)	33 (55.9)	<0.001
	Female	3 (7.3)	38 (92.7)	
	Total	29 (29.0)	71 (71.0)	
BMI group	≤ 25 kg/m ²	23 (29.1)	56 (70.9)	0.961
	>25 kg/m ²	6 (28.6)	15 (71.4)	
	Total	29 (29.0)	71 (71.0)	
Occupation	Businessman	6 (18.2)	27 (81.8)	0.094
	Other occupations	23 (34.3)	44 (65.7)	
	Total	29 (29.0)	71 (71.0)	

After stratification, male sex remained significantly associated with perforation among patients aged ≤ 60 years ($p < 0.001$) and those with BMI ≤ 25 kg/m² ($p = 0.001$) or > 25 kg/m² ($p = 0.040$), shown in table 3. Significant associations were also observed among businessmen ($p = 0.009$) and those in other occupations ($p = 0.003$). Among patients aged > 60 years, the association was not statistically significant ($p = 0.517$), although the small subgroup size should be considered when interpreting this finding.

Table 3. Comparison of perforated appendicitis according to gender stratified by age, BMI, and occupation

Stratification variable	Category	Gender	Perforated, n (%)	Non-perforated, n (%)	p-value
Age group	≤ 60 years	Male	23 (54.8)	19 (45.2)	<0.001
	≤ 60 years	Female	3 (7.7)	36 (92.3)	
	>60 years	Male	3 (17.6)	14 (82.4)	0.517
	>60 years	Female	0 (0.0)	2 (100.0)	
BMI group	≤ 25 kg/m ²	Male	20 (44.4)	25 (55.6)	0.001
	≤ 25 kg/m ²	Female	3 (8.8)	31 (91.2)	
	>25 kg/m ²	Male	6 (42.9)	8 (57.1)	0.040
	>25 kg/m ²	Female	0 (0.0)	7 (100.0)	
Occupation	Businessman	Male	6 (35.3)	11 (64.7)	0.009
	Businessman	Female	0 (0.0)	16 (100.0)	
	Other occupations	Male	20 (47.6)	22 (52.4)	0.003
	Other occupations	Female	3 (12.0)	22 (88.0)	

Pain duration > 24 hours remained significantly associated with perforation among patients aged ≤ 60 years ($p < 0.001$), females ($p = 0.034$), those with BMI ≤ 25 kg/m² ($p = 0.002$), and participants in other occupations ($p = 0.003$), but not among males, patients aged > 60 years, BMI > 25 kg/m², or businessmen ($p > 0.05$), shown in table 4. Fever was significantly associated with perforation among patients aged ≤ 60 years ($p = 0.006$), those with BMI ≤ 25 kg/m² ($p = 0.033$), and participants in other occupations ($p = 0.046$), whereas no significant association was observed in the other strata. Anorexia showed no significant association with perforation in any examined subgroup (all $p > 0.05$).

Table 4. Comparison of perforated appendicitis according to duration of pain >24 hours, fever, and anorexia, stratified by age, gender, BMI, and occupation

Stratification variable	Category	Perforated, n (%)	Non-perforated, n (%)	p-value
Duration of pain >24 h				
Age ≤60 years	Yes	24 (48.0)	26 (52.0)	<0.001
	No	2 (6.5)	29 (93.5)	
Age >60 years	Yes	3 (17.6)	14 (82.4)	0.517
	No	0 (0.0)	2 (100.0)	
Male	Yes	24 (45.3)	29 (54.7)	0.576
	No	2 (33.3)	4 (66.7)	
Female	Yes	3 (21.4)	11 (78.6)	0.034
	No	0 (0.0)	27 (100.0)	
BMI ≤25 kg/m²	Yes	21 (40.4)	31 (59.6)	0.002
	No	2 (7.4)	25 (92.6)	
BMI >25 kg/m²	Yes	6 (40.0)	9 (60.0)	0.067
	No	0 (0.0)	6 (100.0)	
Businessman	Yes	5 (27.8)	13 (72.2)	0.117
	No	1 (6.7)	14 (93.3)	
Other occupations	Yes	22 (44.9)	27 (55.1)	0.003
	No	1 (5.6)	17 (94.4)	
Fever at presentation				
Age ≤60 years	Yes	25 (39.7)	38 (60.3)	0.006
	No	1 (5.6)	17 (94.4)	
Age >60 years	Yes	3 (15.8)	16 (84.2)	0.702
	No	0 (0.0)	0 (0.0)	
Male	Yes	26 (44.1)	33 (55.9)	0.702
	No	0 (0.0)	0 (0.0)	
Female	Yes	2 (8.7)	21 (91.3)	0.033
	No	1 (5.6)	17 (94.4)	
BMI ≤25 kg/m²	Yes	22 (34.4)	42 (65.6)	0.526
	No	1 (6.7)	14 (93.3)	
BMI >25 kg/m²	Yes	6 (33.3)	12 (66.7)	0.202
	No	0 (0.0)	3 (100.0)	
Businessman	Yes	6 (22.2)	21 (77.8)	0.046
	No	0 (0.0)	6 (100.0)	
Other occupations	Yes	22 (40.0)	33 (60.0)	0.046
	No	1 (8.3)	11 (91.7)	
Anorexia				
Age ≤60 years	Yes	13 (33.3)	26 (66.7)	0.819
	No	13 (31.0)	29 (69.0)	
Age >60 years	Yes	0 (0.0)	5 (100.0)	0.259
	No	3 (21.4)	11 (78.6)	
Male	Yes	12 (46.2)	14 (53.8)	0.775
	No	14 (42.4)	19 (57.6)	
Female	Yes	1 (5.6)	17 (94.4)	0.702
	No	2 (8.7)	21 (91.3)	
BMI ≤25 kg/m²	Yes	11 (28.2)	28 (71.8)	0.861
	No	12 (30.0)	28 (70.0)	
BMI >25 kg/m²	Yes	2 (40.0)	3 (60.0)	0.517
	No	4 (25.0)	12 (75.0)	
Businessman	Yes	2 (11.1)	16 (88.9)	0.249
	No	4 (26.7)	11 (73.3)	
Other occupations	Yes	11 (42.3)	15 (57.7)	0.302
	No	12 (29.3)	29 (70.7)	

4. DISCUSSION

In the present study of 100 patients aged 40–80 years with acute appendicitis, the perforated appendicitis was seen in 29.0% (29 patients). The mean age was 52.72 ± 9.79 years and 59.0% were males. This frequency of perforation is similar to the 28% which was reported by Emektar et al., 2022 in patients aged ≥ 65 years [15] but lower than 41% reported by Omari et al., 2014 and 50% reported by Sirikurnpiboon and Amornpornchareon, 2015 in older patients [16,17]. Differences may be due to differences in age thresholds and in case selection, or to differences in the health-care settings and disease severity. The relatively high perforation rate in our cohort is consistent with the known higher incidence of complicated appendicitis in older patients.

In our study, male gender was significantly associated with perforation ($p < 0.001$); the incidence of perforation was 44.1% in male and 7.3% in female patients. This result corresponds to Sirikurnpiboon and Amornpornchareon (2015) who found male sex as an independent risk factor for perforation (OR 2.36, 95% CI 1.25–4.44) [17]. In a similar manner, Emektar et al. (2022) showed that the perforation was statistically significantly related to male sex in geriatric patients ($p = 0.01$) [15]. Nevertheless, Omari et al. 2014 failed to show a statistically significant difference between sex with 53% of males and 47% of females being perforated [16]. The strong male association seen in our population has been seen in several studies, but has not always been shown in elderly appendicitis patients.

The strongest association with perforation was duration of symptoms. The incidence of perforation was also much higher in patients with pain > 24 hours (40.3% vs. 6.1%, $p < 0.001$) and mean pain duration before surgery was significantly longer in the perforated group (65.24 ± 18.24 hrs vs. 32.80 ± 19.42 hrs, $p < 0.001$). This is consistent with the findings of Tantarattanapong and Arwae (2018) who found that symptom duration > 24 hours before presentation to an ED was a significant predictor (OR 2.49, 95% CI 1.33–4.68) [14]. Symptom duration > 24 hours was found to be independently associated with perforation by Augustin et al., (2011) (OR 4.1, $p = 0.001$) [18]. Together, these results highlight the link between persisting symptoms and progressive disease.

Perforation also was significantly related to fever in our patients. Fever was present in 34.1% of perforated cases compared with 5.6% of non-perforated cases ($p = 0.015$), and mean temperature was higher among perforated patients (99.65 ± 1.08 vs. $98.77 \pm 1.57^\circ\text{F}$, $p = 0.002$). These findings concur with those of Sirikurnpiboon and Amornpornchareon (2015) who found that Fever $T \geq 38^\circ\text{C}$ was an independent predictor of perforation (OR 2.17, 95% CI 1.10–4.27) [17] and those of Augustin et al. (2011) who reported that Fever was a significant predictor (OR 4.3, $p = 0.007$) [18]. Temperature is likely to be rising inflammatory burden as the appendicitis progresses; however, temperature must be read along with the other clinical parameters and not as a single predictor.

In contrast, no significant association was found between anorexia and perforation in our study (29.5% vs. 28.5%, $p = 0.915$) nor was there a significant association within age, sex, BMI, or occupation groups in stratified analyses. This is contrary to the other study by Sirikurnpiboon and Amornpornchareon (2015) who found that anorexia was an independent predictor (OR 1.92, 95% CI 1.03–3.57) [17]. The difference could have to do with age distribution, sample size, symptom documentation and clinical presentation. Likewise, in our study we did not find a correlation between perforation and age group ($p = 0.159$), BMI group ($p = 0.961$), occupation ($p = 0.094$) suggesting that these factors were less discriminative than symptom duration, sex and fever in this cohort.

The stratified findings also indicated that relationships between clinical factors with perforation were different within the strata. Sex of the patient was significant for patients ≤ 60 years old ($p < 0.001$) and in all BMI groups ($p = 0.001$ and $p = 0.040$); and the duration of pain was significant for patients ≤ 60 years old ($p < 0.001$), females ($p = 0.034$), and patients with BMI ≤ 25 kg/m² ($p = 0.002$). Fever was also a significant factor among the patients ≤ 60 years of age ($p = 0.006$) and those who had BMI ≤ 25 kg/m² ($p = 0.033$). These results align with the evidence that perforation risk is due to interaction between demographic and clinical factors and not one particular factor. Similarly, using a large national surgical database, Fan et al (2020) showed an independently higher risk of intraoperative perforation and/or abscess in geriatric patients (OR 2.23, 95% CI 2.01–2.48) [19]. In summary, the current results suggest that there is a need to look closely at male patients, duration of symptoms, and fever in older adults who present with a suspected diagnosis of appendicitis.

5. STRENGTHS AND LIMITATIONS

The distinctiveness of this study is that 100 patients were consecutively enrolled in this study and the perforation was confirmed intraoperatively, which is a clinically relevant outcome. Multiple demographic and clinical variables were examined and stratified analyses were performed by age, gender, BMI, and occupation to assess the variation between subpopulations. The results, however, might not be generalizable to other populations and healthcare settings due to the use of a single center, the small number of participants, and the use of non-probability sampling. The inclusion of a relatively small number of patients in the older age subgroup also limited the statistical power of subgroup analyses. Moreover, factors that could potentially affect the results were not evaluated, including comorbidities, inflammatory markers, imaging results, hospital to surgery delay, and post-operative results. Observational design also makes it difficult to establish causal relationships between the factors identified and appendiceal perforation.

6. CONCLUSION

This is an uncommon population in whom perforated appendicitis was encountered in a significant number. Male sex, duration and fever were significantly associated with perforation while age group, BMI and occupation were not significantly associated with the outcome. The stratified results also showed that these associations were different in terms of strength in the demographic and clinical subgroups. A careful work-up of the duration of symptoms, sex, and fever may, therefore, help identify patients who are at higher risk for perforated appendicitis and prompt evaluation and/or surgical treatment

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