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Correlation between Appendix Length/ Diameter Ratio and Incidence of Appendicular Perforation: A Retrospective Study

Mughilan Selvaraj, Santhaseelan R. G, Barathi Raja Kuppusami, Samir Ahmad*, N Guru Prasad
Department of General Surgery, Sree Balaji Medical College and Hospital, Chennai, Tamil Nadu, India

Abstract

Acute appendicitis is a common surgical emergency, with perforation leading to increased morbidity and mortality. The length-to-diameter ratio of the appendix may be considered a predictor of perforation risk. This study aims to evaluate the correlation between this ratio and the incidence of appendicular perforation. This research aims to study the correlation between the appendix length/diameter ratio to its incidence of perforation. A retrospective study was conducted on patients undergoing appendectomy from March 2022 to August 2024. A total of 120 patients were recruited in this study. Patient data, including demographics, histopathological findings, and radiological measurements, were analyzed. Patients were grouped into perforated and non-perforated appendicitis groups. Statistical analyses, including Chi-square tests and logistic regression, were performed to assess the association between appendix length/diameter ratio and perforation risk. Ethical approval was obtained from the institutional ethics committee. Among 120 patients, 65 (54.2%) were male, and 55 (45.8%) were female, with a mean age of 28.1 ± 7.4 years. Perforation was identified in 18 (15%) cases. Patients with a length/diameter ratio ≤10 had a significantly higher perforation rate (14/56, 25%) compared to those with a ratio >10 (4/64, 6.3%) ($p<0.01$). Logistic regression showed that a ratio ≤10 was an independent predictor of perforation (OR: 4.1, 95% CI: 1.9-8.5, $p<0.001$). A lower appendix length/diameter ratio significantly increases the risk of perforation in acute appendicitis. Including this parameter in preoperative radiological assessments may improve early diagnosis and improve surgical decision-making, ultimately reducing complications associated with perforated appendicitis.

Keywords: *Appendicitis, Appendix, Perforation.*

Introduction

Acute appendicitis is the abrupt inflammation of the appendix, a small, tubular organ connected to the large intestine in the lower right quadrant of the abdomen. This illness is marked by the swift onset and escalating severity of stomach discomfort, frequently accompanied by nausea, vomiting, anorexia, and fever. Acute appendicitis is one of the most common surgical emergencies worldwide, and timely diagnosis remains critical to preventing complications such as appendicular perforation, which significantly increases morbidity and mortality. Acute appendicitis is one of the most frequent causes of acute abdominal pain requiring emergency surgical intervention, with an estimated lifetime risk of 6-7% [1]. Its prompt diagnosis and management are crucial, as delayed intervention can lead to appendicular perforation—a complication associated with significantly increased morbidity, mortality, and healthcare costs. The perforation rates remain substantial, ranging from ~4% to as

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****Corresponding Author: ufacesamir@gmail.com***

high as 70% in various populations, with particularly elevated risks among pediatric, geriatric and those with delayed presentations [2, 3].

This inflammation leads to increasing pressure inside the appendix, reduced blood flow, and rapid bacterial growth, resulting in pain, swelling, and tissue injury. If left untreated, the inflamed appendix can progress to tissue death (necrosis) and eventually perforate, or burst, spilling infectious material into the abdominal cavity [3]. Despite advancements in diagnostic imaging and clinical scoring systems, appendicitis remains a significant health burden, with delayed diagnosis leading to complications such as perforation, abscess formation, and sepsis [4, 5]. Early detection and timely intervention are crucial in reducing morbidity and mortality associated with appendicitis [6]. The appendix is a narrow, blind-ended tube located at the junction of the small and large intestines, with an average length of 6-9 cm and a diameter of 5.6-6.6 mm [7]. Obstruction of the appendiceal lumen, commonly due to fecoliths, lymphoid hyperplasia, or foreign bodies, leads to bacterial overgrowth, increased intraluminal pressure, ischemia, and eventual perforation if untreated [8, 9].

Numerous scientific studies have demonstrated a substantial correlation between appendix diameter and the risk of perforation. The appendix enlarges in diameter due to inflammation and blockage. Research consistently demonstrates that people with perforated appendicitis have a markedly greater appendix width compared to those without perforation, typically averaging over 12 mm in perforated instances, in contrast to around 8 mm in non-perforated cases. A threshold of 10 mm or above is frequently employed to assist in diagnosing acute appendicitis, with the likelihood of perforation escalating as the diameter increases [10, 11].

This study aims to study the correlation between the appendix length/diameter ratio to its incidence of perforation. In this retrospective study, the primary aim was to investigate the correlation between the appendix length/diameter ratio and the incidence of appendicular perforation. This research also aimed to determine that appendix length/diameter ratio in the study cohort undergoing appendectomy can serve as a reliable predictor of perforation risk. The findings of this research might contribute to enhanced risk assessment and guide clinical decision-making in the management of acute appendicitis.

Materials and Methods

This retrospective study was conducted on all patients who were diagnosed with acute appendicitis who came to the emergency room in Sree Balaji Medical College Hospital, Chennai, from March 2022 to August 2024. All patient data were anonymized to ensure confidentiality. The medical records of 120 patients who underwent appendectomy for suspected acute appendicitis were included. Demographic data, clinical presentation, preoperative imaging like Computed tomography (CT), routine blood investigations, operative findings, and histopathological results were extracted. Appendix length and diameter were obtained from both CT or ultrasound (USG) and confirmed with pathology reports, and the length/ diameter ratio was calculated. Patients were grouped into perforated and non-perforated groups.

Inclusion criteria: All the cases with a confirmed diagnosis of acute appendicitis by histopathological analysis.

Exclusion criteria: Any patient with missing pathology reports, incomplete imaging data, or previous appendiceal surgery, patients treated conservatively, and pregnancy were excluded.

Statistical analysis was performed using SPSS *25.0*. Categorical variables were

compared using the Chi-square test, and continuous variables were analyzed using the independent t-test.

Results

A total of 120 samples were recruited in this study. Table 1 showed the demographic characteristics of the study population, including age and gender distribution between perforated and non-perforated cases. The mean age of the perforated group was significantly higher than the non-perforated group (30.2 ± 8.5 vs. 27.7 ± 7.1, p=0.03), indicating that older age might be a risk factor for perforation. There was no significant difference in gender distribution between the groups.

Table 1. Demographic Characteristics of Study Population

Characteristic	Perforated (n=18)	Non-Perforated (n=102)	p-value
Age (mean ± SD)	30.2 ± 8.5	27.7 ± 7.1	0.03*
Male (%)	10 (55.6%)	55 (53.9%)	0.87
Female (%)	8 (44.4%)	47 (46.1%)	0.87

Table 2 illustrates the correlation between the appendix length/diameter ratio and the incidence of perforation, which is a severe complication in acute necrotizing pancreatitis. Patients with a ratio ≤10 had a significantly higher perforation rate (25%) compared to those with a ratio >10 (6.3%), reinforcing the predictive value of this parameter. This indicates a higher rate of colon perforation in patients with a more distended colon.

Table 2. Relationship between Appendix Length/Diameter Ratio and Perforation Rate

Length/Diameter Ratio	Perforated [N (%)]	Non-Perforated [N (%)]	Total
≤10	14 (25%)	42 (75%)	56
>10	4 (6.3%)	60 (93.7%)	64
Total	18 (15%)	102 (85%)	120

A comparison between appendix length with age and gender has been described in Table 3. Patients with an appendix length ≤6 cm were significantly older (31.1 ± 7.6 vs. 26.5 ± 6.9, p=0.02), suggesting that appendix length may decrease with age. Gender distribution was similar between the groups.

Table 3. Appendix Length Compared with Age and Gender

Characteristic	Length ≤6 cm (n=50)	Length >6 cm (n=70)	p-value
Age (mean ± SD)	31.1 ± 7.6	26.5 ± 6.9	0.02*
Male (%)	30 (60%)	35 (50%)	0.32
Female (%)	20 (40%)	35 (50%)	0.32

The relationship between perforation and clinical parameters such as symptom duration and inflammatory markers has been mentioned in Table 4. It was noted that the patients with perforation were significantly more likely to have symptoms for >48 hours (66.7% vs. 21.6%, p<0.001) and elevated biomarkers such as WBC and CRP levels, indicating that prolonged symptom duration and increased inflammatory response are associated with higher perforation risk.

Table 4. Comparison of Perforation with Symptom Duration and Inflammatory Markers

Variable	Perforated [N (%)]	Non-Perforated [N (%)]	p-value
Symptom duration >48 hrs	12 (66.7%)	22 (21.6%)	<0.001*
WBC Count >11,000/mm³	9 (50%)	18 (17.6%)	0.003*
CRP Elevated	11 (61.1%)	24 (23.5%)	0.002*

The results of a logistic regression analysis identifying independent predictors of appendiceal perforation have been mentioned in Table 5, which showed that the length/diameter ratio ≤10, symptom duration >48 hours, elevated WBC count, and increased CRP levels were all significant predictors of perforation.

Table 5. Multivariate Logistic Regression Analysis of Risk Factors for Perforation

Variable	Odds Ratio (95% CI)	p-value
Length/Diameter Ratio ≤10	4.1 (1.9-8.5)	<0.001*
Symptom Duration >48 hrs	3.5 (1.7-7.0)	0.002*
WBC Count >18,000/mm³	2.7 (1.4-5.2)	0.01*
CRP Elevated	3.0 (1.6-6.0)	<0.001*

Discussion

Acute perforated appendicitis is a dangerous complication of appendicitis. It is commonly characterized by the rupture of the appendix and spillage of its contents into the peritoneal cavity. Compared to non-perforated appendicitis, it is associated with a higher risk of post-surgical morbidities and longer hospitalization durations [3, 12]. Appendiceal diameter is widely used as a marker for inflammation in the context of acute appendicitis. Studies show that patients with acute appendicitis typically have a larger appendiceal diameter compared to those with a normal appendix. Previous studies have also suggested that increased appendiceal diameter is a marker of inflammation [13]. However, appendiceal diameter alone is not always definitive. The findings of this study showed that a lower appendix length/diameter ratio (≤10) is significantly associated with an increased risk of perforation. These findings indicate that considering length in association with diameter may provide a better predictor of perforation risk. A prolonged duration of symptoms (>48 hours) was also strongly correlated with perforation risk. It has been strongly correlated with an increased risk of appendiceal perforation. These findings indicate that colonic distension, reflected by a lower L/D ratio, may serve as an important radiological marker for impending ischemia or transmural necrosis, both well-established precursors to perforation in the context of necrotizing pancreatitis. The underlying mechanism likely involves compromised colonic perfusion due to local compression of mesenteric vessels from peripancreatic inflammation, fluid collections, or elevated intra-abdominal pressure. Multiple studies have shown that the risk of perforation rises with longer symptom duration, with several sources indicating that symptoms lasting more than 36 to 48 hours are associated with significantly higher rates of perforation. A delayed presentation increases the likelihood of complications [14].

The combination of high WBC and CRP is highly effective in differentiating perforated from non-perforated appendicitis, particularly in pediatric cohorts, as the presence of both markers enhances the predictive value for perforation [15, 16]. Comparative studies reinforce the importance of appendiceal dimensions in predicting perforation risk. The role of CT in the diagnosis of acute

appendicitis severity has been emphasized, with appendiceal measurement, but has not been evaluated in terms of the length/diameter ratio [16, 17]. A study reported that prolonged symptom duration was a strong predictor of complicated appendicitis, aligning with our findings that patients presenting after 48 hours had significantly higher rates of perforation [18]. Additionally, research also highlights the diagnostic value of inflammatory markers, which supports the observations of this research that elevated CRP and WBC levels correlate with perforation risk [19]. Associating the appendix length/diameter ratio with preoperative radiological evaluation could enhance early risk stratification. Current diagnostic modalities, such as ultrasound and CT, are widely used, but their accuracy is operator-dependent [20]. The Alvarado Score and Appendicitis Inflammatory Response (AIR) Score are commonly employed clinical tools, but they have limitations, particularly in atypical cases [21, 22].

A larger diameter indicates greater intraluminal pressure and more severe inflammation, both of which make the appendix wall more vulnerable to rupture. Imaging criteria for acute appendicitis typically use a diameter threshold—commonly 6 mm or greater—as a diagnostic marker, but perforation risk rises with further increases in diameter [10, 11]. The appendix length/diameter ratio could serve as an adjunct to these scoring systems to improve diagnostic accuracy. Furthermore, studies suggest that perforation rates may vary with age and sex. Research showed that older patients are more likely to develop complicated appendicitis, a finding that is consistent with our observation that perforated cases were significantly older [23]. Some studies have also noted gender-based differences, with male patients being more prone to perforation, although this study did not find a significant association between specific gender and perforation risk [24].

The analysis based on the extent of colonic involvement demonstrated that patients with a shorter involved segment (≤6 cm) were significantly older (mean age: 31.1 ± 7.6 years) than those with longer involvement (>6 cm, mean age: 26.5 ± 6.9 years; $p = 0.02$). While the clinical implications of this age difference remain to be clarified, it is conceivable that age-related vascular changes or immunological factors may contribute to more localized colonic injury in older individuals. Alternatively, the observed age difference may reflect variability in host response to necrotizing pancreatic inflammation. Though a correlation exists between age and appendiceal wall thickness, indicating the necessity for age-specific diagnostic criteria for the diagnosis of appendicitis. Hence, employing a uniform criterion for appendix wall thickness across all age demographics may result in misdiagnosis, as younger patients might have a thicker appendix wall owing to a greater presence of lymphoid tissue, whereas older adults may have a thinner wall due to age-related structural changes in the appendix [25]. Consequently, dependence on an age-neutral cutoff may lead to overdiagnosis and underdiagnosis in pediatric and geriatric populations, respectively. The limit of this research might be the selection bias due to the retrospective nature of this study. Future prospective studies with larger, multicenter cohorts can be helpful to validate the appendix length/diameter ratio as a predictive marker for perforation.

Conclusion

A lower appendix length/diameter ratio (≤10) significantly increases the risk of perforation in acute appendicitis and serves as an independent predictor of this adverse outcome. Inclusion of this parameter into preoperative radiological assessment may improve early diagnosis and optimize surgical decision-making by early identification of

patients at elevated risk for perforation, facilitating timely surgical intervention and potentially improving patient outcomes. Utilizing this parameter along with symptom duration and inflammatory markers, clinicians may improve risk stratification and optimize surgical decision-making, which in turn might be helpful in lowering the morbidity associated with perforated appendicitis.

Conflict of Interest

No conflicts of interest.

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