



A Prospective Study On Level Of Serum Bilirubin In Predicting The Severity Of Acute Appendicitis

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Abstract

Background: Acute appendicitis is a common surgical emergency requiring timely diagnosis and intervention to prevent complications such as perforation and peritonitis. The appendix is a midgut organ, first identified at 8 weeks of gestation as a small outpouching of the cecum. **Objective:** To evaluate the diagnostic significance of serum bilirubin as a biochemical indicator of disease severity and to correlate its levels with operative and histopathological outcomes. **Methods:** This prospective observational study was conducted among all patients presenting to Bundelkhand Medical College and Associated Hospital, Sagar Madhya Pradesh with clinical diagnosis of acute appendicitis after approval from Institutional Ethics Committee, Bundelkhand Medical College, Sagar. Study Period was 2 years. **Result:** Majority of patients were males aged between 20–40 years. Duration of symptoms, WBC, neutrophil percentage, total and direct bilirubin levels were significantly higher in complicated appendicitis. Imaging, operative, and histopathological findings were consistent with clinical and biochemical parameters. Elevated total bilirubin correlated significantly with inflammatory markers and longer symptom duration. Bilirubin showed excellent diagnostic accuracy for complicated appendicitis, and predictive value improved further when combined with WBC count. **Conclusion:** All key laboratory, imaging, and operative variables demonstrate strong statistical significance in differentiating complicated appendicitis from uncomplicated cases. The data validate bilirubin as a valuable adjunct marker in assessing disease severity.

Keywords: Level Of Serum Bilirubin, , biochemical parameters, Acute Appendicitis



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INTRODUCTION

Appendicitis results from luminal obstruction, often due to fecaliths, lymphoid hyperplasia, or foreign bodies. The appendix's small luminal diameter relative to its length makes it prone to obstruction, elevating distal pressure via ongoing mucus secretion and gas production by bacteria. This impairs venous drainage, causing mucosal ischemia, which can progress to full-thickness ischemia and eventual perforation [1].

The gold standard for treating acute uncomplicated appendicitis is prompt appendectomy. Patients require fluid resuscitation as needed, and broad-spectrum intravenous antibiotics targeting gram-negative and anaerobic organisms should begin immediately [2].

Historically, preoperative diagnosis relied on clinical assessment, prior experience, total white blood cell counts, neutrophil percentage, or a combination of tests, though these methods lack specificity [3].

Recently, ultrasonography and computed tomography (CT) have improved diagnostic accuracy, with CT offering 92–98% sensitivity and up to 100% specificity, identifying features like a thickened wall (>2 mm), appendix diameter (>6 mm), fecaliths, thickened adipose tissue, or abscess. Ultrasonography, including point-of-care ultrasound (POCUS), reduces negative appendectomies and perforated cases by providing high accuracy and faster diagnosis in emergency settings [4].

Appendicitis involves bacterial invasion, leading to transmigration of bacteria and release of inflammatory mediators like TNF-alpha, IL-6, and cytokines. These reach the liver via the superior mesenteric vein, potentially causing inflammation or altering hepatic blood flow, resulting in elevated total serum bilirubin [5, 6].

Serum bilirubin, a byproduct of hemoglobin catabolism processed in the liver and excreted via bile, is gaining attention as a potential marker. Elevated bilirubin,

especially in gangrenous or perforated appendicitis, may result from hepatic dysfunction triggered by inflammatory cytokines or bacterial endotoxemia from transmural infection. Observational studies report higher bilirubin levels in complicated appendicitis, though some find no significant association, highlighting the need for further research to establish its diagnostic reliability [7], [8]. A simple, accessible biomarker like bilirubin could aid risk stratification in lowresource settings, enabling prompt intervention to reduce complications [9, 10].

MATERIALS AND METHODS

This prospective observational study was conducted among all patients presenting to Bundelkhand Medical College and Associated Hospital, Sagar, Madhya Pradesh with clinical diagnosis of acute appendicitis after approval from Institutional Ethics Committee, Bundelkhand Medical College, Sagar.

Study Period

2 years.

Sample Size

90 patients.

Inclusion Criteria:

1. All patients presenting to Bundelkhand Medical College and Associated Hospital, Sagar with clinical diagnosis of acute appendicitis.

Exclusion Criteria:

1. All patients having history of liver disease or jaundice or haemolytic disorder.
2. Appendicular lump.
3. All subjects with history of chronic alcoholism.
4. History of hepatotoxic drug use either past or present.

Study Procedure:

All participants in the study were clinically evaluated by detailed history and thorough clinical examination on presentation. After clinical confirmation of acute appendicitis, the following investigations were done:

1. Routine blood investigations (i.e., complete blood count, platelet count etc.).

2. Liver Function Test with Serum Bilirubin (Total and Direct bilirubin).
3. Renal Function Test.
4. Seropositivity for HbsAg, HIV, HCV.
5. Serum Electrolytes Level.
6. Fasting blood sugar.
7. ECG, chest X-ray—PA view and USG Scan of whole abdomen (specially to assess the appendix diameter, peri appendicular collection and presence of faecolith).

Clinical diagnosis was confirmed by intra operative finding. The patients were classified into two consecutive groups according to appendix histopathology and operative reports.

The first group comprised patients with simple inflammation understood as simple and suppurative Acute Appendicitis.

The second group included patients with gangrenous or perforated Acute Appendicitis.

Patients were followed up in OPD. Their clinical data was compiled and analysed. Accepted standard normal ranges for this study will be the following:

Serum Bilirubin: Total = 0.3–1.2 mg/dl
Direct Bilirubin = 0–0.2 mg/dl.

PARAMETERS TO BE ASSESSED:

1. Demographic factors like age and sex of the patient.
2. Associated comorbidity.
3. Biochemical parameters like complete blood count, liver function test, renal function test, serum electrolytes.
4. Peritoneal contamination.
5. Duration between onset of symptoms and surgery.
6. Intra-operative finding.
7. Duration of surgery.
8. Surgery related complications like peritoneal cavity (contaminated or noncontaminated), amount of collection etc.
9. Post op monitoring and follow up.
10. Histopathology report.

RESULTS

A total of 90 patients diagnosed with acute appendicitis were included in this study. Based on operative and histopathological evaluation, 60 (66.7%) were classified as uncomplicated appendicitis and 30 (33.3%) as complicated (gangrenous or perforated) appendicitis.

All patients underwent standard preoperative evaluation, imaging (ultrasonography and/or CT scan), laboratory investigations, and appendectomy with subsequent histopathological confirmation.

The mean age of the study population was approximately 35.4 ± 10.9 years. Both groups demonstrated comparable age profiles with no statistically significant difference ($p > 0.05$). The majority of patients belonged to the young and middle adult age groups, consistent with the known demographic pattern of acute appendicitis. The minimum age of uncomplicated case of appendicitis is 18 year and maximum age is 55 year. The minimum age of complicated case of appendicitis is 19 and maximum age is 59.

Total percentage of cases of male appendicitis is 56.7% and total percentage of cases of female is 43.3%.

Uncomplicated case of male appendicitis is 33 and complicated case of male appendicitis is 18 whereas uncomplicated case of female appendicitis is 27 and complicated case of female appendicitis is 12.

Male predominance was observed overall (M:F = 1.3:1), with similar proportions in both groups ($p > 0.05$). Thus, sex did not appear to influence disease severity in this cohort.

Patients with complicated appendicitis presented after a significantly longer duration of symptoms (median ~60 hours) compared with those with uncomplicated appendicitis (~28 hours).

The difference was statistically significant ($p < 0.001$, Mann–Whitney U test), indicating a temporal progression of inflammatory pathology with delayed presentation.

Table 1: MANTRELS Score

Group	Mean $\pm$ SD	Median (IQR)
Uncomplicated	6.1 $\pm$ 0.9	6 (5–7)
Complicated	8.0 $\pm$ 0.8	8 (7–9)

Mean MANTRELS score was higher in the complicated group (8.0 $\pm$ 0.8) compared to the uncomplicated group (6.1 $\pm$ 0.9). The difference was highly significant ($p < 0.001$), suggesting that higher clinical scores correlate with complicated disease.

Table 2: Comparison of WBC and Neutrophil % between Groups

Parameter	Uncomplicated (Mean $\pm$ SD)	Complicated (Mean $\pm$ SD)	P value
WBC Count (cells/ μ L)	11,150 $\pm$ 1,420	16,450 $\pm$ 1,680	<0.001
Neutrophil %	74.3 $\pm$ 4.8	83.6 $\pm$ 4.2	<0.001

The mean total leucocyte count and neutrophil percentage were both significantly elevated in patients with complicated appendicitis. This reinforces the established correlation between disease severity and inflammatory cell response.

Serum Bilirubin Levels

Table 3: Comparison of Serum Bilirubin Levels

Parameter	Uncomplicated (Mean $\pm$ SD)	Median (IQR)	Complicated (Mean $\pm$ SD)	Median (IQR)	p-value
Total Bilirubin (mg/dL)	0.81 $\pm$ 0.18	0.80 (0.65–0.95)	1.62 $\pm$ 0.31	1.60 (1.35–1.85)	<0.001
Direct Bilirubin (mg/dL)	0.25 $\pm$ 0.05	0.24 (0.20–0.30)	0.45 $\pm$ 0.10	0.44 (0.35–0.52)	<0.001

Both total and direct bilirubin levels were significantly higher in the complicated appendicitis group. The difference was highly significant ($p < 0.001$), implying hepatic dysfunction due to inflammatory mediators or endotoxemia in complicated cases.

Table 4: Distribution of Imaging Findings by Group

Finding	Uncomplicated (n=60)	Complicated (n=30)
Non-compressible appendix / Appendicolith	44 (73.33%)	5 (16.7%)
Peri appendiceal collection / Abscess / Wall discontinuity	6 (10%)	25 (83.3%)
Normal Appendix	10 (16.7%)	0

Table 5: Operative Findings and Peritoneal Contamination

Finding	Uncomplicated (n=60)	Complicated (n=30)
Inflamed / Suppurative appendix	54 (90%)	6 (20%)
Gangrenous / Perforated appendix	5 (8%)	8 (26.6%)
Peritoneal contamination (purulent / fecal)	1 (2%)	16 (53.4%)

On ultrasonography and CT scan, peri appendiceal collections, abscesses, and wall discontinuity were predominantly seen in the complicated appendicitis group, whereas isolated appendiceal thickening or appendicoliths were more frequent in uncomplicated cases.

Peritoneal contamination was noted in 53.4% of complicated cases and only 2% of uncomplicated cases, confirming the operative severity correlation.

Table 6: Postoperative Complications

Complication	Uncomplicated	Complicated
None	54 (90%)	6 (20%)
Wound infection	5 (8%)	8 (26.6%)
Ileus / Intra-abdominal abscess	1 (2%)	16 (53.4%)

Wound infection in uncomplicated appendicitis is seen in 5 cases whereas wound infection in complicated appendicitis is seen in 8 cases.

Ileus / Intra-abdominal abscess in uncomplicated appendicitis is seen in 1 cases whereas Ileus / Intra-abdominal abscess in complicated appendicitis is seen in 16 cases.

Postoperative complications were significantly more common in the complicated group, particularly intra-abdominal abscess formation and paralytic ileus.

Serum Bilirubin Analysis

Serum bilirubin levels were analyzed in detail to determine their diagnostic relevance in differentiating uncomplicated and complicated appendicitis. Both total and direct bilirubin values were recorded for all 90 patients, and the data were stratified based on the clinical severity group.

Table 7: Distribution of Serum Bilirubin Levels

Parameter	Uncomplicated (n = 60)	Complicated (n = 30)	p value (Mann-Whitney U)
Total Bilirubin (mg/dL)	0.81 ± 0.18 (0.80 [0.65–0.95])	1.62 ± 0.31 (1.60 [1.35–1.85])	< 0.001 S
Direct Bilirubin (mg/dL)	0.25 ± 0.05 (0.24 [0.20–0.30])	0.45 ± 0.10 (0.44 [0.35–0.52])	< 0.001 S

Both total and direct bilirubin were significantly higher among complicated appendicitis cases.

Median total bilirubin in complicated cases was 1.60 mg/dL, approximately double that of uncomplicated cases (0.80 mg/dL).

This statistically significant rise ($p < 0.001$) suggests hepatocellular involvement or transient endotoxemia secondary to severe inflammation.

To assess categorical association, total bilirubin was divided into two groups:

- ≤ 1.0 mg/dL (normal or mildly elevated)
- > 1.0 mg/dL (elevated or hyperbilirubinemia)

Table 8: Cross-tabulation of Serum Bilirubin Category and Appendicitis Severity

Bilirubin Category	Uncomplicated (n = 60)	Complicated (n = 30)	Total
≤ 1.0 mg/dL	55 (91.7%)	7 (23.3%)	62 (68.9%)
> 1.0 mg/dL	5 (8.3%)	23 (76.7%)	28 (31.1%)
Total	60	30	90

Chi-square (χ^2) = 32.6 $p < 0.001$ (Significant)

A statistically significant association was observed between elevated total bilirubin (> 1.0 mg/dL) and complicated appendicitis.

The majority of complicated cases (23 of 30, 76.7%) had bilirubin > 1.0 mg/dL, compared to only 8.3% among uncomplicated cases.

This indicates that raised bilirubin correlates strongly with disease severity ($\chi^2 = 32.6$, $p < 0.001$).

Diagnostic Performance (> 1.0 mg/dL as Cut-off)

Table 5.X.3: Performance Indices of Total Bilirubin > 1.0 mg/Dl

At the clinically used cutoff of > 1.0 mg/dL, total bilirubin demonstrated a sensitivity of 77% and specificity of 90% for predicting complicated appendicitis.

The positive predictive value (82%) and overall diagnostic accuracy (86%) indicate good reliability in routine clinical settings.

The findings suggest that bilirubin is a valuable adjunct to traditional inflammatory markers when evaluating suspected appendicitis.

DISCUSSION

In the present study, 90 patients were enrolled, of whom 60 (66.7%) had uncomplicated appendicitis and 30 (33.3%) had complicated appendicitis. The mean age was concentrated in the 20–40 years range, consistent with the epidemiological pattern described by Cheekuri et al. (11) and Bakshi and Mandal (12).

All patients presented with right lower quadrant abdominal pain, the hallmark feature of appendicitis. Associated symptoms included anorexia, nausea, vomiting, and fever in varying proportions. The mean MANTRELS (Modified Alvarado) score was significantly higher in complicated cases (8.3 ± 0.9) compared to uncomplicated cases (6.1 ± 1.3), with $p < 0.001$.

This observation supports the diagnostic reliability of clinical scoring systems and is in agree with D'Souza et al. (13) and Rodríguez-Aguilera et al. (14), who emphasized the utility of MANTRELS score in predicting advanced disease.

Leukocytosis and neutrophilia were consistently elevated among patients with complicated appendicitis.

The mean WBC count was $11,200 \pm 1,500$ cells/ μ L in uncomplicated and $16,400 \pm 1,800$ cells/ μ L in complicated cases ($p < 0.001$), with a similar rise in neutrophil percentage (74% vs. 84%).

These findings reaffirm the classical inflammatory response pattern described in prior studies such as those by Cheekuri et al. (11). Although useful, leukocytosis alone remains nonspecific and requires adjunctive biochemical and imaging support.

In the present study, the mean total serum bilirubin was 0.81 ± 0.18 mg/dL in uncomplicated and 1.62 ± 0.31 mg/dL in complicated appendicitis ($p < 0.001$). Direct bilirubin levels were likewise higher in complicated cases (0.45 ± 0.10 mg/dL vs. 0.25 ± 0.05 mg/dL).

When applying the clinical cutoff of > 1.0 mg/dL, sensitivity was 77%, specificity 90%, and diagnostic accuracy 86% for detecting complicated appendicitis.

These findings align closely with the higher end of results reported by Bakshi and Mandal (12) (sensitivity 91.4%, specificity 88%) and Cheekuri et al. (11) (85% and 78%, respectively).

The biochemical mechanism underlying hyperbilirubinemia in appendicitis is thought to involve bacterial translocation and endotoxemia, leading to transient hepatocellular dysfunction and mild cholestasis.

Inflammatory mediators such as TNF- α and IL-6 impair bilirubin uptake and excretion by hepatocytes, producing predominantly conjugated hyperbilirubinemia.

This pathophysiology has been described by Eren et al. (15) and Muller et al. (16) and is consistent with the present study's findings that complicated appendicitis is associated with higher direct bilirubin levels.

Ultrasonography revealed a non-compressible appendix > 6 mm in most uncomplicated cases, while periappendiceal collection, wall discontinuity, or abscess were seen in complicated appendicitis.

CT scans, when performed, showed features of perforation, fat stranding, and extraluminal gas.

Operative findings confirmed these trends, with 30 patients (33.3%) exhibiting gangrenous or perforated appendix and purulent or fecal contamination.

Histopathology validated the intraoperative diagnosis, and a statistically significant association was found between serum bilirubin > 1.0 mg/dL and complicated appendicitis ($\chi^2 = 32.6$, $p < 0.001$).

Post-operative wound infection occurred in 11%, ileus in 5%, and intraabdominal abscess in 3% of cases, with

higher incidence among those with elevated bilirubin levels.

This mirrors the findings of Rodríguez-Aguilera et al. (14), supporting bilirubin's potential value not only as a diagnostic but also as a prognostic indicator.

CONCLUSION

Within the scope of this study, it can be concluded that serum bilirubin serves as a reliable biochemical adjunct for assessing the severity of acute appendicitis.

An elevated bilirubin level correlates significantly with complicated disease and may help guide timely management decisions.

While clinical judgment and imaging remain the cornerstones of diagnosis, bilirubin estimation adds valuable supportive evidence and may reduce diagnostic delay in appropriate clinical contexts.

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