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Original Research Article

Observational study to predict gut gangrene from raised serum C reactive protein levels in intestinal obstruction cases

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ABSTRACT

Background: Intestinal obstruction can progress to bowel gangrene, increasing morbidity and mortality. Early diagnosis and decision taking for intervention remains challenging. This study evaluated serum C-reactive protein (CRP) as a predictive marker for gangrene in intestinal obstruction.
Methods: A prospective observational study was conducted on 110 patients with surgically managed intestinal obstruction at SMS Hospital, Jaipur. Serum CRP levels at admission were recorded and correlated with intraoperative findings. Statistical analysis included ROC curve for determining predictive value.
Results: Bowel gangrene was found in 30% of cases. Mean CRP levels were significantly higher in gangrene cases (121 mg/l) vs. non-gangrene (12 mg/l) ($p<0.001$). A CRP cut-off of 43.05 mg/l showed 93.9% sensitivity and 96.1% specificity. Delays >48 hours from symptom onset to surgery significantly increased gangrene risk ($p=0.008$).
Conclusions: Serum CRP is a valuable, accessible biomarker for early detection of gut gangrene in intestinal obstruction, aiding timely surgical intervention. Further studies with serial CRP measurements are recommended.

Keywords: C reactive protein, Gut gangrene, Strangulated obstruction, Predictive biomarkers

INTRODUCTION

Intestinal obstruction is a frequent surgical challenge characterized by impaired bowel movement due to mechanical or functional blockage. Causes include adhesions, hernias, volvulus, and tumors, leading to symptoms like abdominal pain, vomiting, and distension.[1] Without intervention, obstruction can progress to ischemia, necrosis, gangrene, and perforation. Gut gangrene significantly increases mortality (30%) compared to simple obstruction (3%), and is associated with higher rates of stoma formation, short gut syndrome, and sepsis.[2,3] Strangulating obstruction, often from hernias or volvulus, can lead to rapid gangrene due to compromised blood flow.[4]

Current diagnostic methods, including abdominal CT scans, may not always detect early gangrenous changes or microperforations, complicating timely decision-making between conservative and surgical management.[5] Physical examination remains crucial, but is limited by variability in symptom presentation. C-reactive protein (CRP), an acute-phase reactant elevated in response to inflammation and ischemia, could provide a more objective marker for identifying bowel ischemia and gangrene. Normal levels are below 10mg/l.[6,7] This study aimed to evaluate whether elevated serum CRP levels can predict gut gangrene in intestinal obstruction cases, potentially guiding more effective and timely surgical intervention.

METHODS

This hospital-based observational study was conducted in the Department of General Surgery at SMS Hospital, Jaipur. The study commenced following approval from the review board ethical committee in April 2023 and continued until January 2024.

The primary objective was to determine the presence of gut gangrene based on independent factors (age, sex, time interval between onset of symptoms and surgical intervention) and elevated serum C-reactive protein (CRP) levels in cases of intestinal obstruction. The secondary objective was to study the mortality outcome in these patients.

The study included patients with intestinal obstruction who were managed operatively at SMS Hospital, older than 18 years of age, and who provided written, informed consent. Patients excluded were those with connective tissue disorders, known malignancy, rheumatoid arthritis or fever, tuberculosis, myocardial infarction, patients on oral contraceptive pills and cases of gut gangrene secondary to mesenteric ischemia, cardiac or thromboembolic events, or vascular pathologies. Informed consent was obtained from all patients. This study was approved by Hospital's Institutional Ethics Committee (781/MC/EC/2023). All cases of intestinal obstruction managed operatively in the Department of General Surgery at SMS Hospital were included in the study after applying the inclusion and exclusion criteria. Evaluation involved assessing age, sex, clinical findings, hematological parameters (complete blood count, serum creatinine, serum lactate), and serum C-reactive protein levels upon admission. Peroperative findings were recorded to identify the presence of ischemia or gangrene and its etiology. Postoperative outcomes, including mortality, were also assessed.

Sample size calculation

A sample size of 110 cases was determined based on a 95% confidence level and 80% power to predict gangrene, considering four independent factors: age, sex, time interval between the onset of symptoms and surgical intervention, and elevated serum CRP levels. The calculation was based on the following formula,

for the first independent factor: 50 patients,

for each additional factor (three factors): 20 patients,

total sample size=50+(20×3)=110.

Statistical analysis

Statistical analysis was performed using Epi info version 7.2.1.0 software. Continuous data were presented in terms of means and standard deviation.

Categorical data were presented as absolute numbers and proportions. Continuous variables were analysed using the independent student's t-test, and categorical variables were analysed using Chi-square/Fischer's exact test as applicable. The receiver operating characteristic (ROC) curve was drawn to evaluate both scores for predicting mortality. Area under the curve (AUC) was calculated along with its 95% confidence interval, and Youden's index was used to determine the critical cut-of value of the scores. Sensitivity and specificity were calculated along with their 95% confidence interval at the critical cut-of values. Comparison of sensitivity and specificity between two tests was done using Mc Nemar test. P value ≤0.05 was taken as statistically significant.

RESULTS

During study period total of 110 patients were included and their details were filled in proforma. After study period a master chart was made and then statistical tests were applied. Out of 110 patients, 99 (90%) survived and 11 (10%) died during hospitalization.

Out of the total 110 patients of intestinal obstruction observed, 33 (30%) were found to have gangrene intra operatively and 77 (70%) had viable bowel.

Table 1: Association of bowel gangrene with duration of surgery.

Duration of surgery (in hours)		Bowel gangrene		Total	P value
		Yes	No		
<24	Count	3	17	20	0.006
	%	9.1	22.1	18.2	
24-48	Count	2	20	22	
	%	6.1	26.0	20.0	
>48	Count	28	40	68	
	%	84.8	51.9	61.8	

Table 2: Association of bowel gangrene with serum CRP.

Group	N	Mean±SD	t value	P value
Bowel gangrene	33	121±35.87	t=22.348 at 108 df	<0.001[s]
No bowel gangrene	77	12.42±12.98		

Note: S-significant.

Table 3: ROC analysis of serum CRP in predicting bowel gangrene.

Optimal Cut off for CRP	43.05
Sensitivity (95% CI)	93.9% (81.4, 98.4)
Specificity (95% CI)	96.1% (89.2, 98.7)
Positive predictive value (95% CI)	91.7 (78.2, 97.1)
Negative predictive value (95% CI)	97.4 (90.9, 99.3)

*CI = confidence interval, ROC=0.971 (95% CI = 0.921, 1.0, p<0.001 (S)

There was no significant association between the development of bowel gangrene and age (p=0.483). The highest incidence of intestinal obstruction however, was found in the age group of 40-60 years. There was no significant association between the development of bowel gangrene and sex (p=1.0). Increased time lag from the onset of symptoms to operative management of obstruction (our third independent factor) by more than 48 hours had a significant increase in the incidence and development of gangrene with 84.8% cases developing gangrene after 48 hours as opposed to 9.1% at less than 24 hours and 6.1% between 24-48 hours-a significant p value of 0.008 was derived (Table 1).

Mean serum CRP levels in patients who had bowel gangrene were found to be 121 mg/l as opposed to 12 mg/l in those with viable bowel, hence deriving a significant p<0.001 showing a high degree of correlation between the two, with a sensitivity of 93.9%, specificity of 96.1%, positive predictive value of 91.2% and negative predictive value of 97.2% (Table 2). Using the ROC analysis curve, a cut off value of serum CRP levels beyond which chances of gut gangrene were high were derived at a level of 43.05 (Table 3).

Out of 110 cases, twelve patients suffered mortality and belonged solely to the group which had bowel gangrene, while no mortality was observed in cases which did not have bowel gangrene.

However, with a p value of 1.0 there was no significant association between the development of bowel gangrene and mortality. A larger sample size would be beneficial in evaluation of this aspect.

DISCUSSION

Gangrene affecting the gastrointestinal (GI) tract, can be challenging to diagnose because its symptoms can mimic those of other conditions, and it often requires a combination of clinical evaluation, imaging studies, and sometimes even exploratory surgery to confirm. Symptoms of gut gangrene can include severe abdominal pain, nausea, vomiting, fever, and changes in bowel habits. However, these symptoms can overlap with many other GI conditions, making diagnosis challenging. Gut gangrene is considered a medical emergency, and delays in diagnosis can have serious consequences, including increased risk of complications and mortality.[8]

The serum C reactive protein levels is simple, cheap, rapid, minimally invasive and easy to perform test and doesn't require complicated equipment or laboratory tests. In cases of gut gangrene, CRP levels can be significantly elevated due to the inflammatory response triggered by the tissue death and potential infection.

Our study suggests that intestinal gangrene is a significant complication in cases of intestinal obstruction, occurring in approximately 30% of patients observed. Adhesions, particularly in previously operated cases, were identified as the leading cause of obstruction along with strangulated hernias. Since tuberculosis and malignancies were excluded, they were not reported in etiology, although they are prominent causes of obstruction in literature.

In a study by Demir et al done for identifying factors predicting the need for surgery, elevated CRP was significantly associated with bowel gangrene and an underlying predictive value for the need of surgery.[9] Another study by Lin et al for evaluation of risk factors for intestinal gangrene identified that elevated serum CRP was associated with bowel gangrene.[10]

CRP levels emerged as a potentially valuable diagnostic marker for gangrene, with markedly higher levels observed in patients with gangrenous bowel compared to those with viable bowel. S. CRP levels in patients who had bowel gangrene were found to be 121 mg/l as opposed to 12 mg/l mean in those with viable bowel, in a study conducted by Singh et al the values were 20.1 mg/l and 12.8 mg/l respectively.[11] We derived a cut off value of 43.05 mg/l from ROC analysis indicating that gut gangrene was highly likely above this value. The sensitivity (93.9%) and specificity (96.1%) were particularly high, indicating its potential use not just as a screening but also as a confirmatory test for the same. A

similar study by Dhoon et al derived a cut off value of 60 mg/l, sensitivity 85.00% and specificity 80.67%.[12] The mortality outcome was 12 cases out of a total 110 (11%). Mortality was seen only in the subgroup detected with gut gangrene but the p value was still insignificant at 1.0. A larger sample size may be able to provide a more accurate correlation between gut gangrene and mortality as random sampling errors may be contributory here. While age and sex were not found to have any bearing on the development of gangrene, there was a definite positive correlation in cases where there was a prolonged delay between the onset of symptoms and operative intervention. A delay of more than 48 hours developed gangrene in 84.8% cases as opposed to 9.1% at less than 24 hours and 6.1% between 24-48 hours. In a study conducted by Spring et al the rate of gangrene was high (29%) among those who underwent delayed surgery and surgery after failed non operative management was associated with a mortality of 14% versus 3% for those who underwent immediate surgery.[13] Recently, a retrospective study has shown that increase in I-FABP (fatty acid binding proteins) levels in patients with small bowel obstruction can be used to predict strangulation.[14] The I-FABP can be increased with dynamic recycling of enterocytes during ischemia or strangulation, but I-FABP measurement requires a long period of time, while measurement of serum CRP and serum D-lactate can be done in a short span of time. Another study evaluating procalcitonin as a marker for strangulation in cases of acute small bowel obstruction found it to have a PPV of 95% and an NPV of 90%. Hyponatremia is also being considered as a potential indicator.[8]

Overall, the findings underscore the importance of prompt surgical management in cases of intestinal obstruction to reduce the risk of gangrene development and the significant association between elevated CRP levels and gangrene suggests the potential utility of CRP as a diagnostic tool in gut gangrene.

The strength of this study is that the use of a simple and quick test like serum C reactive protein levels can be used as an objective predictor of bowel gangrene in patient with intestinal obstruction and hence initiate an early operative management in them which shall in turn reduce the postoperative mortality and morbidity.

The limitations of this study is that first, there are many confounders such as latent malignancies or rheumatological disorders or tuberculosis for which the patient may be clinically asymptomatic but shall lead to a high CRP value in them nevertheless. Second, we have only measured a single value at the time of presentation – a serial estimation in a larger group of patients would give more information regarding the cut off values for pre gangrenous and gangrenous bowel changes which develop over time.

CONCLUSION

It is a prospective study with applicability in an emergency setting in a developing country, where availability of computed tomography (CT) and other costly biomarkers is difficult in peripheries and for poor patients. Also, the patients in our study included those with both small and large bowel obstruction. Serum CRP levels appear to be an objective predictor of intestinal gangrene in patients with acute intestinal obstruction. Its measurement could help guide management of inpatients where there are no clear indications for a surgical intervention but strangulation might be suspected. A larger study with serial quantitative measurement of serum CRP is further required to prove the results and determine the range.

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