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CORRELATION OF SERUM CRP & LACTATE AS AN EARLY PREDICTOR OF STRANGULATION IN ACUTE ABDOMEN

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ABSTRACT

Strangulation in acute abdomen is one of the dangerous complication in patients of acute abdomen and early diagnosis is necessary for prevention of mortality. Present study was aimed to find whether serum C-Reactive Protein (CRP) and Serum Lactate can be used as early predictor for strangulation in cases of acute abdomen. A total of 75 patients with acute abdomen were included in the study. The serum CRP and Lactate values were measured preoperatively and correlated with intraop findings postoperatively. ROC curve was drawn and cutoff value for prediction of strangulation and mortality based on which diagnostic value was calculated. At cutoff level of 45.5 mg/L, CRP was 85.0% sensitive and 85.7% specific with positive and negative predictive values of 87.2% & 83.3% for prediction of strangulation in acute abdomen while sensitivity, specificity, PPV and NPV of Serum lactate was 100.0%, 91.4% 93.0% & 100.0% respectively using cutoff value ≥23.5mg/dl. Serum CRP and Lactate could be useful markers in predicting strangulation in cases of acute abdomen.

KEYWORDS: C-reactive protein, Strangulation, Serum lactate.

INTRODUCTION

Acute abdominal pain (AAP) (1) which is also known as acute abdomen in common parlance is one of the most frequent medical emergencies requiring immediate surgery (3). It is one of the most common reason for referral to emergency department (ED) (2) and the second most common reason after chest pain in patients above 15 years of age..

Strangulation in acute abdomen is a threatening condition and is associated with a high mortality. Strangulation in acute abdomen causes intestinal obstruction, and is also associated with obstruction of blood supply which in turn causes necrosis, resulting in other complications like perforation with diffuse soiling of the peritoneal cavity, which in turn causes gangrenous bowel that needs to be resected (4).

In view of the dire consequences associated with strangulation in acute abdomen, it is essential that strangulation should be identified early. Diagnosis of strangulation in acute abdomen is primarily clinical, with sudden onset of pain, i.e, continuous rather than coliky, early appearance of shock, presence of fever, tachycardia, marked abdominal tenderness, guarding, rigidity, rebound tenderness are all in favor of diagnosis of strangulation (5).

Incidentally, systemic inflammatory response syndrome (SIRS) has been recognized as one of the independent predictors of strangulation in acute abdomen (6). Encouraged by this finding, some studies have focused on inflammatory markers as useful predictors of strangulated bowel obstruction. In the recent past a lot of such inflammatory markers have been investigated for their potential as predictors of strangulation in acute abdomen cases, *viz.,* such as procalcitonin (7-8), intestinal fatty acid-binding protein (9), C-reactive protein (CRP) and lactate levels (10-11) .

Unfortunately, all these predictive models depend upon multiple investigations and as such there is no single predictor of strangulation in acute abdomen and hence, its diagnosis is often delayed and missed, more so, when all these factors are not correlated properly. Thus, there is need for simple methods that can predict the strangulation in acute abdomen.

Among various inflammatory markers studied for their predictive role in preoperative prediction of intestinal strangulation in acute abdomen cases C-reactive protein and lactate levels are some of the routinely performed tests that have shown high diagnostic efficacy (10-11) either alone or in combination. Hence, the present study was conducted to see the usefulness of Serum CRP level and lactate levels for prediction of strangulation in acute abdomen cases.

MATERIAL & METHODS

It was a hospital based prospective observational study conducted between January 2017 to December 2019. This study was performed on 75 patients of acute abdominal pain and admitted in emergency as well as opd basis in various surgical units in era lucknow medical college and hospital underwent exploratory laparotomy.

INCLUSION CRITERIA

- Aged >18 years
- All the patients with acute abdomen, suspected as a case of strangulation undergoing laparotomy, presenting in Surgery OPD and Emergency Unit at ELMC&H, Lucknow.

EXCLUSION CRITERIA

- Patients with co-existing medical illness such as chronic kidney disease, cardiac ailment, uncontrolled diabetes mellitus, upper respiratory tract infection, urinary tract infection.
- Age <18 years
- Not giving consent for inclusion in the study.

CLEARANCE AND APPROVALS

All participants were explained about the purpose of the study. Confidentiality was assured to them along with informed written consent. The study was approved by the Institutional Ethical Committee. There was no interference or influence of research process on the treatment of the patient. There was no financial support from any source for this study.

METHODOLOGY

Socio-demographic information, clinical features were noted on a separate case sheet for every individual after obtaining an informed consent. All the patients were clinically examined and necessary laboratory/radiographic investigations (sonography) were done before treatment, thereafter these patients were subjected to laparotomy, preoperative CRP and serum lactate levels were measured. Intraoperative findings noted and correlated with preoperative CRP and Lactate. Data collected was recorded on computer which was used for analysis.

Biochemical Investigations

- Serum CRP was estimated using Vitros 5600 by dry chemistry method.
- Serum lactate was estimated using kit by spectrophotometry method.

STATISTICAL TOOLS EMPLOYED

The collected data was transformed into variables, coded and entered in Microsoft Excel. Data was analyzed and statistically evaluated using SPSS-PC-19 version. Quantitative data was expressed in mean±standard deviation or and difference between two comparable groups were tested by student's t-test (unpaired) or Mann Whitney 'U' test while qualitative data were expressed in percentage. Statistical differences between the proportions were tested by chi square test or Fisher's exact test. ROC curve was drawn to know the cutoff value of CRP and serum lactate to predict strangulation in acute abdomen and mortality and based on that Sensitivity, specificity, PPV, NPV and accuracy was calculated. 'P' value less than 0.05 was considered statistically significant

RESULT

PATIENT CHARACTERISTICS

75 patients presented with acute abdomen and suspected with strangulation were included in the study. Out of 75 cases of acute abdomen, strangulation was observed in 40 (53.3%) cases. Out of 75 cases of acute abdomen, majority of the cases survived (88.0%), rate of mortality in cases of acute abdomen was 12.0%. Proportion of cases of strangulation in acute abdomen was significantly higher for signs & symptoms of fever (95.0% vs. 54.3%), Tachycardia (100.0% vs. 60.0%), Guarding and rigidity (90.0% vs. 62.9%) while were significantly lower for presence of Bowel sound (12.5% vs. 62.9%) table 1.

SN	Characteristic	Strangulation (n=40)		No strangulation (n=35)	
		Mean	SD	Mean	SD
1	Age	49.20	14.89	45.51	15.17
		No.	%	No.	%
2	Sex				
	Male	27	67.5	21	60.0
	Female	13	32.5	14	40.0
3	Intractable pain	39	97.5	30	85
4	Tenderness	39	97.5	26	74

Table 1: Association Of Strangulation With General And Clinical Profile Of Patients

5	Abdominal distension	39	97.5	33	94.3
6	Fever	38	95.0	19	54.3
7	Tachycardia	40	100.0	21	60.0
8	Guarding and rigidity	36	90.0	22	62.9
9	Bowel sound (present)	5	12.5	22	62.9
		Mean	**SD**	**Mean**	**SD**
10	TLC	12935.00	4930.88	10491.43	3703.29
11	CRP (mg/L)	76.22	19.61	32.55	19.03
12	Lactate (mg/dl)	47.76	26.42	18.23	4.91

Cont. Table 1: Association Of Strangulation With General And Clinical Profile Of Patients

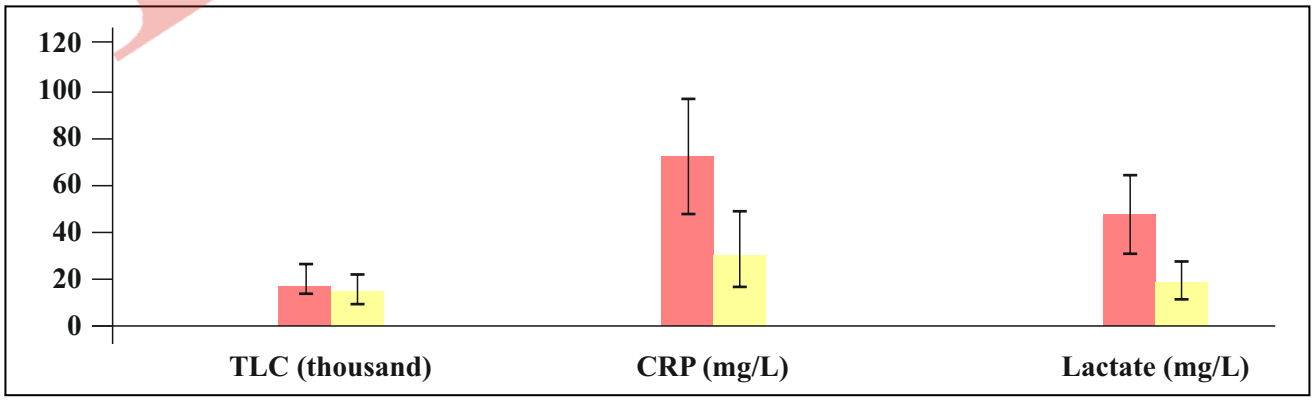
All the cases of Volvulus, Intussusception, Ovarian torsion, Mesentric ischemia and Omental strangulation had strangulation. Majority of the cases of adhesion (52.6%) and Strictures (54.5%) had strangulation. Out of 6 cases of Bands, 3 (50.0%) had strangulation. Incidence of strangulation was minimum among cases of hernia (37.9%). Table 2

SN	Operative findings	Strangulation (n=40)		No Strangulation (n=35)	
		No.	%	No.	%
1	Adhesions (19)	10	52.6	9	47.4
2	Bands (6)	3	50.0	3	50.0
3	Strictures (11)	6	54.5	5	45.5
4	Hernia (29)	11	37.9	18	62.1
5	Volvulus (5)	5	100.0	0	0.0
6	Intussusception (2)	2	100.0	0	0.0
7	Ovarian torsion (1)	1	100.0	0	0.0
8	Mesentric ischemia (1)	1	100.0	0	0.0
9	Omental strangulation (1)	1	100.0	0	0.0

Table 2: Comparison Of Operative Findings

COMPARISON OF LABORATORY MARKERS-

Cases of strangulation in acute abdomen had significantly higher TLC (12935.00±4930.88 vs. 10491.43±3703.29), CRP levels (76.22±19.61 vs. 32.55±19.03 mg/dl) and Lactate levels (47.76±26.42 vs. 18.23±4.91 mg/dl).



Graph 1: Significant Hematological/Biochemical Parameters Associated With Strangulation

Parameter	Area under the curve±SE	Projected cut-off	Sens	Spec	PPV	NPV	Accuracy
CRP	0.915±0.034 (p<0.001)	≥45.5	85.0	85.7	87.2	83.3	85.3
Lactate	0.994±0.005 (p<0.001)	≥23.45	100	91.4	93.0	100	96.0

Table 3: Receiver-operator Characteristic (ROC) Analysis For Selection Of Cut-off Values Of CRP And Lactate For Detection Of Strangulation

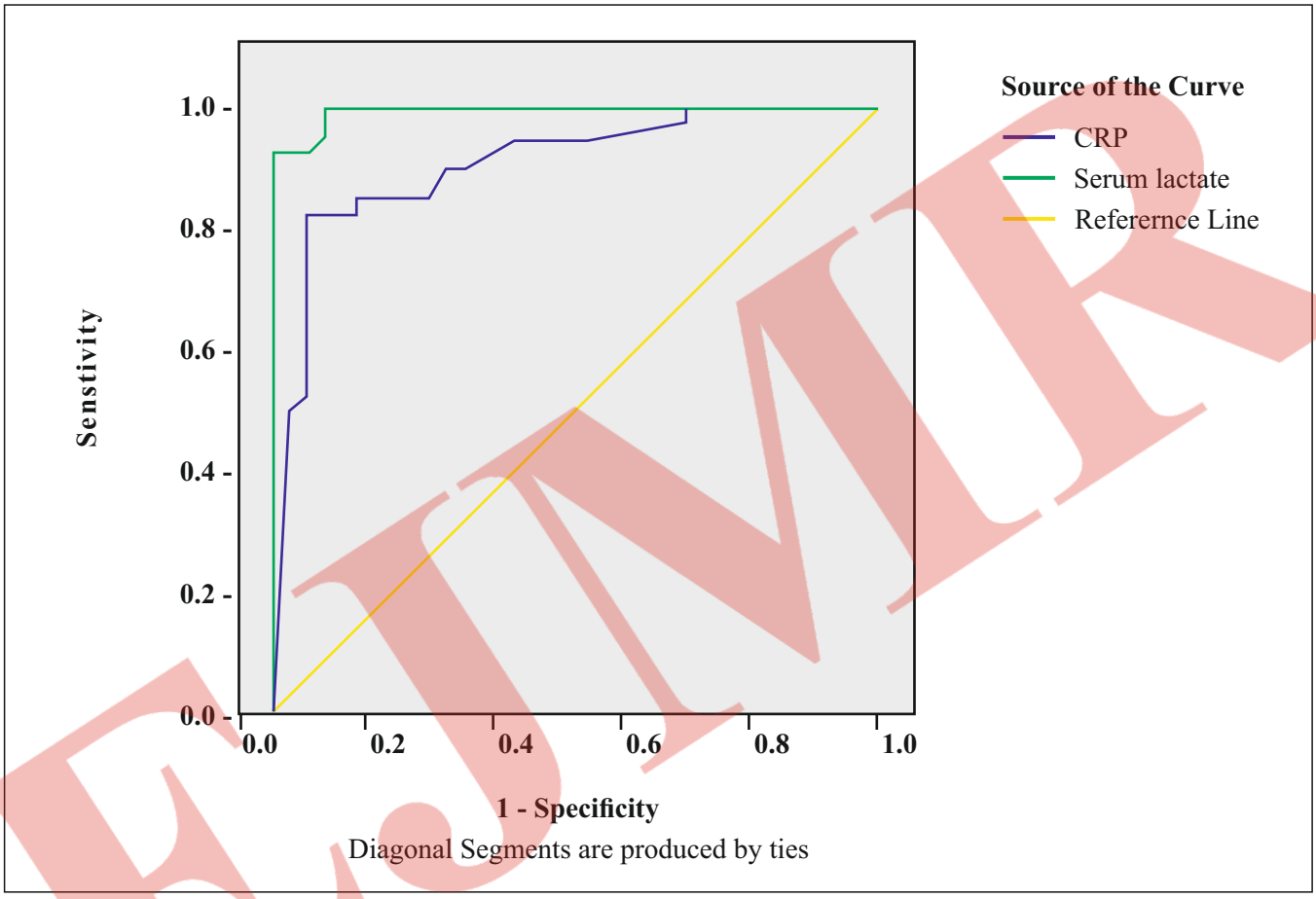


Fig. 1: ROC Curve For Prediction Of Strangulation

Serum lactate and CRP levels were evaluated for prediction of Strangulation in acute abdomen using ROC curve, at a cut-off with a larger value indicating Strangulation. Area under curve was 0.994±0.005 and 0.915±0.034.

On evaluating ROC, a cut-off value of CRP levels ≥45.5 mg/dl was predicted to be 85.0% sensitive and 85.7% specific with positive and negative predictive values of 87.2% & 83.3%. Overall accuracy of model at this cut-off was 85.3%.

On evaluating ROC, a cut-off value of Serum lactate ≥23.45 mg/dl was predicted to be 100.0% sensitive and 91.4% specific with positive and negative predictive values of 93.0% & 100.0%. Overall accuracy of model at this cut-off was 96.0%.

SN	Parameters	Survived (n=66)		Expired (n=9)		Student 't' test	
		Mean	SD	Mean	SD	't'	'p'
1	CRP	51.19	28.00	90.00	0.00	4.134	<0.001
2	Lactate	29.87	17.09	64.14	44.78	4.545	<0.001

Table 4: Association Of CRP And Lactate Levels With Mortalit

Expired cases of acute abdomen had significantly higher levels of CRP (90.00±0.00 vs. 51.19±28.00 mg/dl) as well as lactate (64.14±44.78 vs. 29.87±17.09 mg/dl).

Parameter	Area under the curve±SE	Projected cut-off	Sens	Spec	PPV	NPV	Accuracy
CRP	0.924±0.030 (p<0.001)	≥88.0	100	84.8	47.4	100	86.7
Lactate	0.841±0.059 (p<0.001)	≥36.85	77.8	72.7	28.0	96.0	73.3

Table 5: Receiver-operator Characteristic (ROC) Analysis For Selection Of Cut-off Values Of CRP And Lactate For Prediction Of Mortality

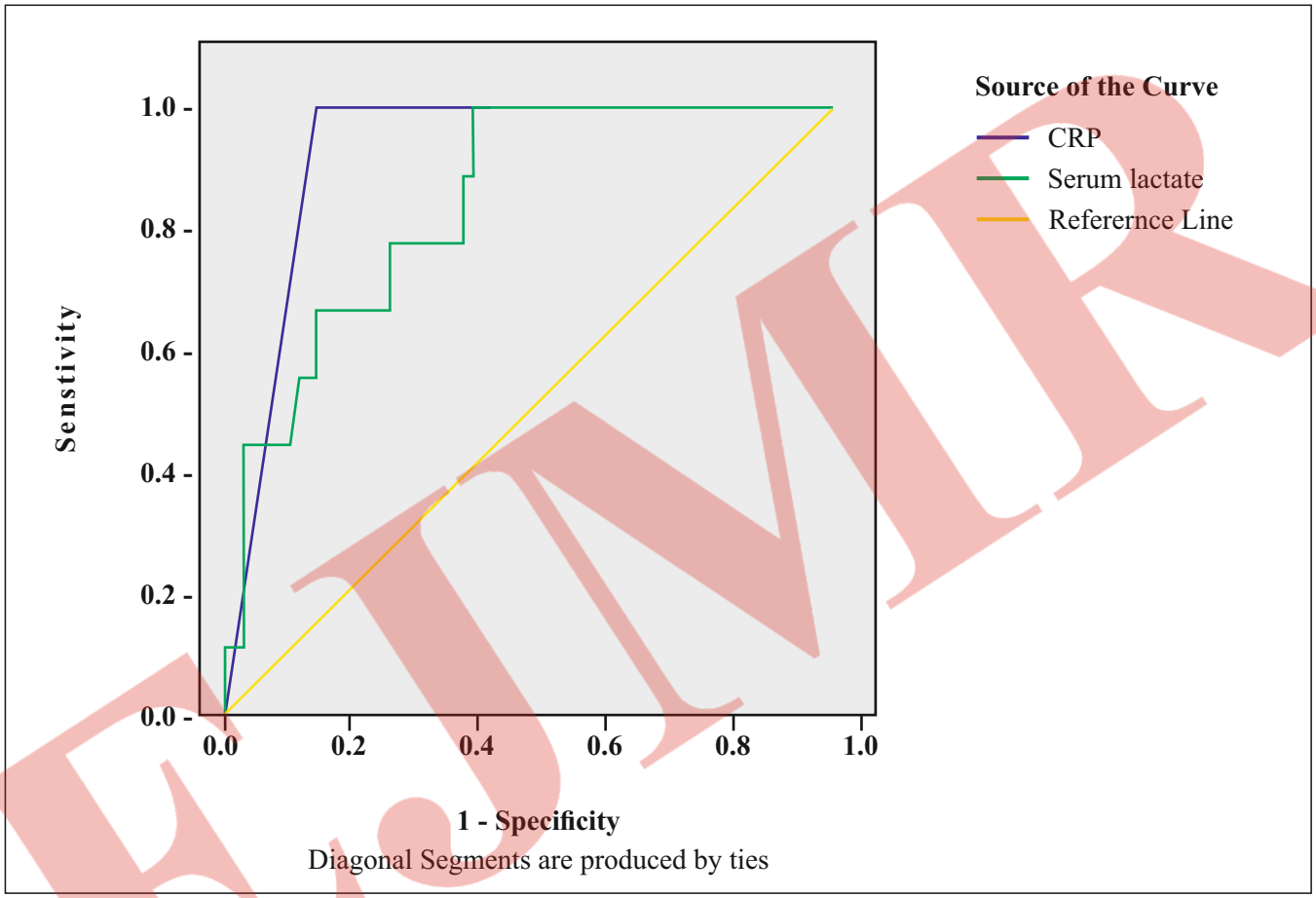


Fig. 2: ROC Curve For Prediction Of Mortality

Serum lactate and CRP levels were evaluated for prediction of Mortality among cases of acute abdomen using ROC curve, at a cut-off with a larger value indicating Strangulation. Area under curve was 0.841±0.059 and 0.924±0.030.

On evaluating ROC, a cut-off value of CRP levels ≥88.0 mg/dl was predicted to be 100.0% sensitive and 84.8% specific with positive and negative predictive values of 47.4% & 100.0% respectively. Overall accuracy of model at this cut-off was 86.7%.

On evaluating ROC, a cut-off value of Serum lactate ≥36.85 mg/dl was predicted to be 77.8% sensitive and 72.7% specific with positive and negative predictive values of 28.0% & 96.0%. Overall accuracy of model at this cut-off was 73.3%.

DISCUSSION

Acute abdomen patients are generally associated with a high mortality and morbidity. The management of acute abdomen becomes difficult when strangulation is present in cases of acute abdomen. Strangulation is a major cause of intestinal obstruction, ischemia, necrosis and perforation (12) all of which are associated with a poor outcome. The diagnosis of strangulation is difficult clinically and it is often diagnosed intraoperatively. However, intraoperative diagnosis is often delayed and leaves limited management options for the surgeon. Hence, it is attempted that techniques and methods that could assess strangulation in acute abdomen cases should be predicted pre-operatively.

In the recent years, role of inflammatory markers has been emphasized in planning management strategies for acute abdomen. Markers like C-reactive protein, lactate, procalcitonin, platelet distribution width, intestinal fatty acid binding protein, interleukin-6, interleukin-10 and leukocyte counts have been identified for assessing the conditions associated with ischemia and other complications (13-16). Considering strangulation to be a highly prioritized complication from the point of view of surgical attention, the present study was conducted with an aim to assess the usefulness of two inflammatory markers, Serum C-reactive protein and lactate as a marker of strangulation in acute abdomen.

In present study a total of 75 patients were enrolled with mean age of 47.49±15.02 years. Majority of patients were males (64%). The mean age of acute abdomen patients in different studies from Indian subcontinent has been reported to be between 30 and 50 years with a dominance of males. Souvik *et al.*(17) reported the mean age as 41.27 years and 75.2% males. Malik *et al.*(18) in their study reported the mean age of patients as 43.1 years and proportion of males as 74%. The findings of present study with respect to mean age are in close proximity with the observations of Hussain *et al* (19) who reported the mean age of patients 47 years. Akrami *et al.*(20) and Bhaskar *et al.*(21) reported the mean age of patients as 48.2.

In present study, intractable pain, tenderness and abdomen distension were the major presenting signs and symptoms affecting 96% to 98.7% patients., Total Leucocyte Count were raised ($11.79x10^3/mm^3$) and CRP and lactate levels were raised.

In our study, total of 40 (53.3%) cases reported strangulation in acute abdomen. Compared to present study, McConkey (12) in their study reported strangulation in 26.0% of their cases, however,. Kotiso B et al (22) on the other hand reported the obstruction/strangulation rate of 26% while Memon *et al.*(23) reported strangulation in 28.5% cases. In the study by Pal *et al* (11) strangulation occurred in 28% of cases while Dhoon R *et al* (10) reported in 40% of cases in their series. Compared to these studies, the number of patients who had strangulation was higher in present study.

On evaluating the predictors of strangulation, we did not find any significant association of demographic characteristics like age and sex. The signs and symptoms also did not show a significant association with strangulation except for fever. tachycardia and guarding and rigidity. Presence of Bowel sound on the other hand was found to be significantly less common in patients with strangulation.

In present study found that mean serum CRP and lactate levels were significantly higher in group of patients with strangulation as compared to those not having strangulation. As such usefulness of inflammatory markers like CRP and lactate for diagnosis of complicated acute abdomen is widely accepted (7-9,13-16). Shi et al.(24) in their study found the mean D-lactate levels of patients with acute abdominal ischemia to be significantly higher as compared to those patients of acute abdomen who did not have abdominal ischemia as well as healthy controls. Lange *et al*. (25) in their study also reported that 50% of cases of strangulated intestinal obstruction have elevated lactate levels. In two prospective studies, Pal et al. (11) and Dhoon R et al. (10) also found mean lactate and CRP levels to be elevated in strangulated acute abdomen as compared to non-strangulated acute abdomen cases.

In present study, hernia (38.7%), adhesions (25.3%) and strictures (14.7%) were found to be the most common diagnoses among patients with strangulation. In low resource settings the trend consists of hernias, malignancies, adhesions and the unique presence of tuberculosis strictures at a frequency of 14.7% in India (17), while in West Africa the leading aetiological factor noted was obstructed inguinal hernia (45.7%) with an increased proportion of obstruction due to tumours (26). Thus, the spectrum of diagnoses associated with acute abdomen cases requiring surgical intervention is quite wide and variable from one place to the other place. Compared to present study, Pal *et al.*(11) in their study reported postoperative adhesions and tuberculosis as the two major diagnoses affected 40% patients each.

In present study, among three major diagnoses (hernia, adhesions and strictures) the incidence of strangulation was 37.9%, 52.6% and 54.5% respectively. A total of 50% cases with bands had strangulation. Though the cases of volvulus, intussception, ovarian torsion and omentum involvement were few in number but they all had strangulation.

In present study, we assessed the diagnostic utility of CRP and lactate levels for pre-operative diagnosis of strangulation using receiver operator characteristic curves. The need for ROC was because of absence of established cut-off values specifically for the purpose of diagnosis of strangulation in acute abdomen cases. As such both these markers are generally elevated in acute abdomen and the routinely defined normal values are less relevant from the point of view of diagnosing strangulation. In present study we found the area under curve values for CRP and Lactate to be 0.915 and 0.995 respectively. Compared to present study, Pal et al.(11) found the area under curve value to

be 0.785 and 0.775 respectively for CRP and lactate. Thus, in their study the area under curve value of CRP was higher as compared to present study where it was higher for lactate levels. Contrary to our study, Dhoon *et al.*(10) in their study used predefined values only.

In present study we projected a cut-off value of ≥45.5 mg/dl for CRP and ≥23.45 mg/dl for lactate and found CRP to be 85% sensitive and 85.7% specific whereas lactate was found to be 100% sensitive and 91.4% specific. Compared to present study, Pal *et al.*[11] derived 60 mg/dl and 4.5 mmol/L as the cut-off values for CRP and Lactate respectively and correspondingly reported the sensitivity and specificity as 87.5% and 58.3% for CRP and 75% and 69.4% for lactate. Dhoon*et al.*(10) also used the values derived by Pal *et al* (10) and found CRP to be 85% sensitive and 80.7% specific whereas sensitivity and specificity of Lactate was reported to be 80% and 86.7% respectively.

The sensitivity of CRP in present study was in agreement with the sensitivity of CRP obtained by Dhoon R *et al.*(10) but was higher than that obtained by Pal *et al.*(11). As far as specificity is concerned, we had a higher value as compared to both these workers(10,11) .

However, for lactate, both sensitivity and specificity values obtained by us were higher than both these workers (10,11).

In present study, we found that both CRP as well as lactate could be successfully used as predictors of outcome (mortality) in acute abdomen cases. It was found that both CRP and lactate levels were significantly higher in cases who died as compared to those who survived. On ROC analysis, the area under curve value of CRP and Lactate were 0.924 and 0.824 thus indicating a high discriminant potential. In present study, we derived a cut-off value of ≥88 mg/dl for CRP and ≥36.85 mg/dl for lactate levels for prediction of mortality and found the sensitivity and specificity of CRP to be 100% and 84.8% as compared to 77.8% and 72.7% for serum lactate. Preoperative CRP and lactate levels have been considered to be good predictor of mortality in emergency abdominal surgery cases in previous studies too (27,28) .

The findings in present study, endorse the usefulness of CRP and lactate as predictors of complications and outcome in acute abdomen cases. The findings in present study are in concordance with the previous literature. CRP and lactate thus open up new doors to predict strangulation in acute abdomen cases. Being non-invasive procedures that could be quickly performed that could be collected from bedside, they offer a convenient route for appropriate surgical management strategies. Further studies on the issue are recommended.

CONCLUSION

From the above findings, it was observed that CRP and Lactate levels can be used as possible markers for predicting strangulation as well as mortality among cases of acute abdomen. It is also recommended to carry out similar studies with larger sample size to make these possible markers more reliable.

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