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A Prospective Study of Venous Lactate Level as a Marker to Identify Patients with Acute Intestinal Obstruction Suitable For Early Total Care Vs Damage Control Surgery

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Abstract:
Background: *Acute intestinal obstruction is an emergency condition with an estimated 2-8% of the cases presenting at emergency room. Surgical intervention is preferred when the clinical signs do not resolve with medical management alone or when there is evidence suspicious of vascular compromise of bowel or hemodynamic instability of the patient. Elevated levels of lactate in venous blood has been considered as one of the markers for acute intestinal ischemia.*
Materials and Methods: *The material for the study is taken from the cases admitted in the emergency ward in the Department of General Surgery, GMKMCH, Salem with clinical diagnosis of acute intestinal obstruction. Between October 2018 and October 2020, 50 patients with clinical diagnosis of acute intestinal obstruction were recruited. Diagnosis of acute intestinal obstruction is made by clinical and radiological methods. Venous lactate levels estimated at the time of admission using Radiometer ABL 9 machine with 2 mL venous blood drawn in fluoride container delivered within 30 min to laboratory. Other routine blood investigations are sent. Patient shifted to Emergency Operation Theatre after resuscitation for emergency laparotomy (Time of admission to shifting EOT – 1 to 2 hours). Bowel viability assessed intraoperatively by visual means. Early Total Care or Damage Control Surgery is performed based on serum lactate level and bowel viability which is assessed intra-operatively. Biopsy sent in all cases. Biopsy report analyzed based on Park / chiu grade of bowel ischemia. Surgical complications assessed post-operatively. Patient discharged on postoperative day 10-14 and followed up at 1-week interval for any complications. Data were collected in excel and analyzed using SPSS v23.*
Results: *The mean age of the participants was 50.8 years, ranging between 21-88 years with standard deviation of 15.57, and a median age of 50 years. Majority of them were male (60%, n=30) while the rest were female (40%, n=20). Most common etiology among the participants was adhesive intestinal obstruction (40%, n=20). The mean venous lactate level among the participants was 3.18 mmol/L ranging between 1.6 and 6.9 mmol/L. Intra-operatively majority of them had doubtful viability (56%, n=28) with Park/Chiu histopathological grade 3 and 4 (52%, n=26). Early total care was given to 32 patients (64%) and damage control surgery was done in 18 patients (36%).*
Conclusion: *In this study, it is found out that the comparison of venous lactate levels across intraoperative bowel viability was highly significant for gangrenous cases and significant for doubtful and normal bowel viability cases. Also, comparison of venous lactate levels across surgical procedure performed and complications were highly significant. Hence, venous lactate levels can be used as a reliable indicator for assessing the viability of the bowel intraoperatively and thereby determining the surgical procedure to be performed in acute intestinal obstruction whenever the bowel viability is questionable. Venous lactate estimation is an economical, minimally invasive and commonly available diagnostic modality. Therefore, it is helpful in areas where the diagnostic facilities are restricted.*
Key word: *Acute Intestinal Obstruction, Serum Lactate Level, Early Total Care. Damage Control surgery.*

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I. Introduction

Acute intestinal obstruction is an emergency condition with an estimated 20% of the cases presenting at emergency room[1-4]. The most common causes are intraabdominal such as adhesions, malignancy, inflammation and herniation. The general mechanism of this condition is that there is an interruption or impairment of forward flow of contents of the intestine. It presents with varying clinical severity and combination of the following

symptoms; colicky abdominal pain, nausea, vomiting, abdominal distension and obstipation. On examination, there may be abdominal distension with tenderness, tympanic percussion and high-pitched bowel sounds in majority of cases. Complete blood count, serum electrolytes, renal and liver function test, venous lactate levels and other metabolic parameters are evaluated along with x-ray abdomen and CT abdomen and pelvis.

Uncomplicated obstructions can be managed by intravenous fluid administration, nasogastric decompression, correcting metabolic alterations and bowel rest. Antibiotic coverage is suggested in cases of leucocytosis and fever, targeted against gram-negative organisms and anaerobic infections. Surgical intervention is preferred when the clinical signs do not resolve with medical management alone or when there is evidence suspicious of vascular compromise of bowel or hemodynamic instability of the patient[5].Intraoperative decision-making regarding bowel viability is the challenging part of management of acute intestinal obstruction. Over the years, there has been a considerable reduction in the mortality due to acute intestinal obstruction but intra-operative decision making is still inconclusive at various levels[6].

Whenever there is a limited supply of oxygen in tissues of the human body, anaerobic glycolysis takes place. The end product of this anaerobic cycle is lactate. Among the most sensitive tissues to ischemia, intestine is one of the important organs. Following acute intestinal obstruction, there develops an elevated pressure within bowel wall due to dilatation of bowel from gas and fluid accumulation. This in turn compromises the venous return, resulting in elevated capillary pressure thereby causing tissue ischemia. Intestinal ischemia even to a minor degree results in cellular hypoxia at molecular level paving way to anaerobic glycolysis generating lactate. Another source of elevated lactate in intestinal ischemia is from anaerobic gut microbes. These organisms normally generate an isomer of lactate called D-lactate following their metabolism. Following intestinal ischemia, there occurs a disruption of mucosal barrier[18] as a result of which D-lactate gets translocated into portal circulation. D-lactate is not metabolised in the liver and hence remains elevated in venous blood following ischemic insult. The normal level of serum lactate is $\leq$ 2mmol/L[7]. Thus, elevated level of venous lactate is considered as a marker of intestinal ischemia, an event occurring to varying degree in almost all cases of acute intestinal obstruction. Hence, venous lactate level can be used as a marker for determining the intra-operative bowel viability thereby determining surgical procedure between early total care and damage control surgery whenever the intraoperative procedure to choose is questionable.

Early total care involves the definitive management of the underlying aetiology of the obstruction after a period of resuscitation such as resection of the pathological segment of bowel followed by anastomosis. Damage control surgery describes simultaneous resuscitation with rapid lifesaving surgery for the acute obstruction such as exteriorization of bowel with or without resection thereby providing a temporary relief of the acute pathology. The main aim is to avoid the time-consuming definitive surgery till the patient's physiological status improves thereby preventing adverse outcomes such as anastomotic leak or faecal fistula.

II. Materials and methods

STUDY AREA:
Government Mohan Kumaramangalam Medical College Hospital (GMKMCH), Salem, Tamil Nadu.
STUDY POPULATION:
Patients admitted in GMKMCH surgical emergency ward with clinical diagnosis of acute intestinal obstruction.
STUDY PERIOD:
October 2018 to October 2020 (2 years)
INCLUSION CRITERIA:
All patients with clinical diagnosis of acute intestinal obstruction

EXCLUSION CRITERIA:
1. Age < 14 years and > 80 years
2. Pregnant women
3. Patients with potential causes of lactic acidosis such as diabetic ketoacidosis, severe hypotension, renal and hepatic failure
4. Patients on antiretroviral drugs, especially stavudine
5. Patients who died or whose symptoms resolved just before surgery

SAMPLE SIZE:
Fifty patients.
STUDY DESIGN:
A Prospective cohort study including all patients eligible by inclusion and exclusion criteria.
Informed consent has been taken from each respondent.
Institutional ethical clearance has been obtained and adhered.

STUDY ENDPOINT:
The patients were followed up to the 14th post-operative day after surgery.

III. Methods:

Patients admitted in accident and emergency ward, GMKMCH, Salem (50 Patients b/w October 2018 to October 2020)

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Diagnosis of acute intestinal obstruction made by clinical and radiological methods

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Venous lactate levels estimated at the time of admission using Radiometer ABL 9 machine with 2 mL venous blood drawn in fluoride container delivered within 30 min to laboratory. Other routine blood investigations are sent.

⇩

Patient shifted to Emergency Operation Theatre after resuscitation for emergency laparotomy (Time of admission to shifting EOT – 1 to 2 hours)

⇩

Bowel viability assessed intraoperatively – by visual means

	VIABLE BOWEL	**NON-VIABLE BOWEL** (Findings persistent even after 100% O2 with warm pad over bowel)
1	Pink, glistening	Dark or black
2	Normal peristalsis	Absence of peristalsis
3	Normal arterial pulsation	Absent arterial pulsation
	Bowel having overlapping findings – Doubtful viability	

⇩

Procedure performed as below

SERUM LACTATE LEVEL (MMOL/L)	**BOWEL VIABILITY**	**PROCEDURE PERFORMED**
<3	Normal or doubtful viability or gangrenous bowel	Resection and anastomosis (ETC)
≥3	Normal or doubtful viability or gangrenous bowel	Resection and Stoma creation (DCS)

Biopsy sent in all cases

⇩

Biopsy report analysed based on Park / chiu grade[27] of bowel ischemia

GRADE	**HPE FINDINGS**
0	Normal mucosa
1	Subepithelial space at villus tips
2	Extension of subepithelial space with moderate lifting
3	Massive lifting down sides of villi, some denuded tips
4	Denuded villi, dilated capillaries
5	Disintegration of lamina propria

6	Crypt layer injury
7	Transmucosal infarction
8	Transmural infarction

Surgical complications assessed.

SURGICAL PROCEDURE DONE	COMPLICATIONS ANTICIPATED
Resection and anastomosis cases	Anastomotic leak
Resection and ostomy cases	Stoma gangrene

Patient discharged on postoperative day 10-14 and followed up at 1-week interval for any complications.

Privacy/confidentiality of study subjects:
Privacy of the subjects shall be maintained.

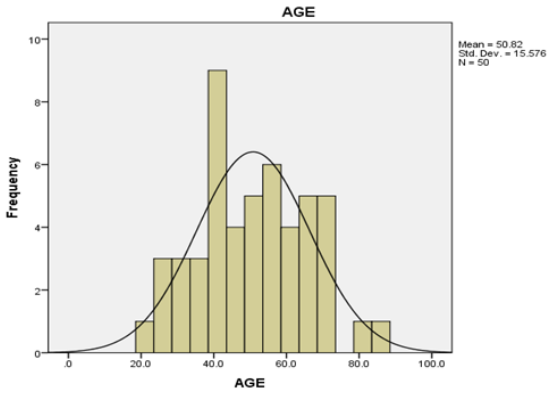
Statistical analysis

All data were recorded in structured questionnaires, coded and entered in Microsoft Excel. The data was then cleaned, checked for inconsistencies, missing values and prepared for analysis using SPSS v23. The data was then analysed for descriptive statistics and inferential statistics. The tests for significance were run to statistically validate the data. The results were then tabulated and visualised in Microsoft word.

IV. Result:

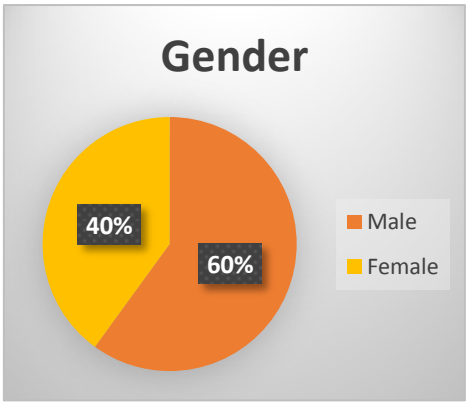
Age Distribution: The mean age of the participants was 50.8 years with standard deviation of 15.57, ranging between 21-88 years and a median age of 50 years. The following table and figure show the age distribution of the participants.

S.NO	MEASURES	AGE IN YEARS
1	Mean	50.820
2	Median	50.500
3	Mode	39.0
4	Standard Deviation	15.5756
5	Minimum	21.0
6	Maximum	88.0



Gender distribution: Majority of the participants (60%, n=30) were males while the rest (40%, n=20) were females. The following table and figure show the gender distribution of the participants.

S.NO	GENDER	FREQUENCY	PERCENTAGE
1	Male	30	60
2	Female	20	40
	Total	50	100

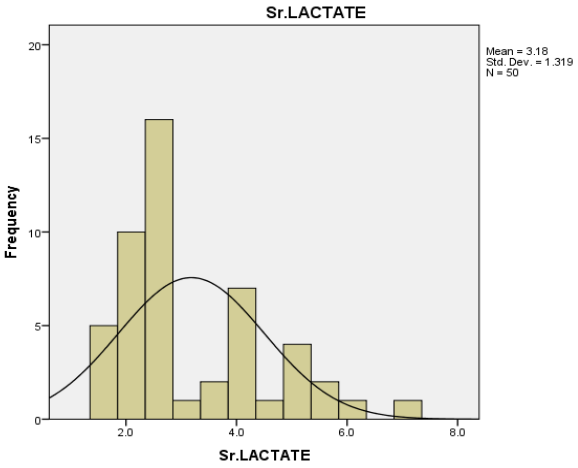


Diagnosis: Majority of the participants (40%, n=20) had Adhesive Intestinal Obstruction as the underlying etiology. The following table shows the diagnosis among the study participants.

S.NO	DIAGNOSIS	FREQUENCY	PERCENTAGE
1	Adhesive Intestinal Obstruction	20	40
2	Intestinal Malrotation	2	4
3	Intussusception	3	6
4	Strangulated Femoral Hernia	1	2
5	Strangulated Inguinal Hernia	18	36
6	Superior Mesenteric Artery Syndrome	2	4
7	Superior Mesenteric Vein Syndrome	2	4
8	Sigmoid Volvulus	2	4
	Total	50	100.0

Serum lactate levels: The mean level of venous lactate was 3.18 mmol/L ranging between 1.6-6.9 mmol/L among the study participants. The following table and figure show the serum lactate levels the study population.

S.NO	MEASURES	SERUM LACTATE MMOL/L
1	Mean	3.182
2	Median	2.600
3	Mode	2.5
4	Std. Deviation	1.3187
5	Minimum	1.6
6	Maximum	6.9



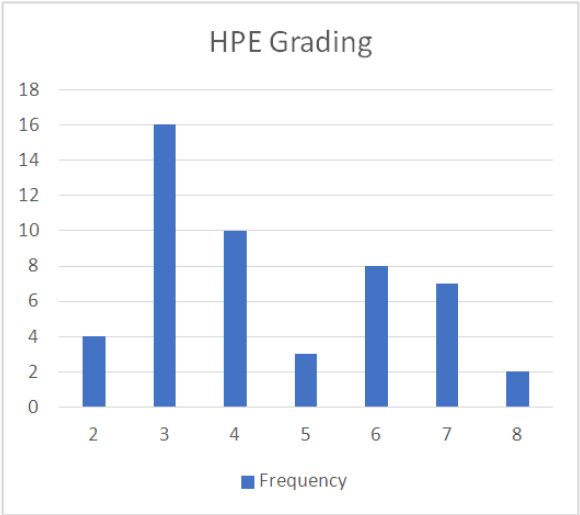
The entire sample was divided into two groups based on serum lactate levels.
Group 1: Serum lactate level <3 mmol/L – 32 members
Group 2: Serum lactate level ≥3mmol/L – 18 members

Intraoperative viability: Majority of the study population had doubtful intra-operative bowel viability (56%, n=28).

S.NO	INTRAOPERATIVE VIABILITY	FREQUENCY	PERCENTAGE
1	Normal	10	20
2	Doubtful	28	56
3	Gangrene	12	24

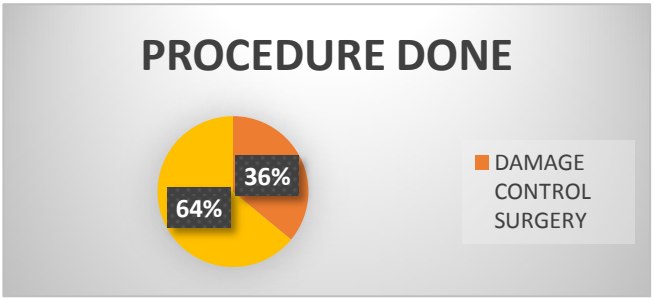
HPE Grading: Majority of the study population had (52%, n=26) grade 3 and 4 bowel ischemia in HPE.

S.NO	HPE GRADING	FREQUENCY	PERCENTAGE
1	2	4	8
2	3	16	32
3	4	10	20
4	5	3	6
5	6	8	16
6	7	7	14
7	8	2	4
	Total	50	100.0



Procedure done: The following table and figure show the procedure done. Early total care (resection and anastomosis) was done in 32 patients (64%) and damage control surgery (resection ± exteriorization) was done in 18 patients (36%).

PROCEDURE DONE	FREQUENCY	PERCENT
Damage control surgery	18	36
Early total care	32	64
Total	65	100.0



Complications: In the study population, none of the patients who received damage control surgery developed expected stoma related complication. Among the participants who received early total care, one developed

PROCEDURE DONE	STOMA RELATED COMPLICATION	ANASTOMOSIS RELATED COMPLICATION
Early total care	Not applicable	1
Damage control surgery	None	Not applicable

anastomotic leak.

Comparison of serum lactate levels across gender: The following table shows the comparison of serum lactate levels across gender. Chi-square analysis is not significant.

		SERUM LACTATE LEVELS		TOTAL	CHI-SQUARE TEST	P-VALUE	INTERPRETATION
		Serum lactate level <3 mmol/L	***Serum lactate level >=3mmol/L***				
SEX	Female	14	6	20	.521	>0.05	Not significant
	Male	18	12	30			
Total		32	18	50			

Comparison of serum lactate levels across diagnosis: The following table show the comparison of serum lactate levels across diagnosis. Chi-square analysis is not significant.

		SERUM LACTATE LEVELS		TOTAL	
		Serum lactate level <3 mmol/L	***Serum lactate level >=3mmol/L***		***Chi-square test p-value Interpretation***
DIAGNOSIS	Adhesive Intestinal Obstruction	14	6	20	11.034 (>0.05) Not significant
	Intestinal Malrotation	1	1	2	
	Intussusception	2	1	3	
	Strangulated Femoral Hernia	0	1	1	
	Strangulated Inguinal Hernia	13	5	18	
	SMA Syndrome	0	2	2	
	SMV Syndrome	0	2	2	
	Sigmoid Volvulus	2	0	2	
Total		32	18	50	

Comparison of serum lactate levels across intraoperative viability: The following table shows the comparison of serum lactate levels across intraoperative viability. Chi-square analysis is significant for gangrene and normal cases.

Intraoperative viability	Serum lactate Levels		Total	Chi-square test	p-value	Interpretation
	Serum lactate level <3 mmol/L	***Serum lactate level >=3mmol/L***				
Normal	10	0	10	7.031	<0.05	Significant
Doubtful	19	9	28	2.301	<0.05	Significant
Gangrene	3	9	12	10.424	<0.005	Highly Significant
Total	32	18	50			

Comparison of serum lactate levels across HPE grade: The following table shows the comparison of serum lactate levels across HPE grade. Chi-square analysis is highly significant

		SERUM LACTATE LEVELS		TOTAL	CHI-SQUARE TEST	P-VALUE	INTERPRETATION
		Serum lactate level <3 mmol/L	***Serum lactate level >=3mmol/L***				
HPE GRADE	2.0	4	0	4	47.106	<0.005	Highly significant
	3.0	16	0	16			
	4.0	10	0	10			
	5.0	2	1	3			
	6.0	0	8	8			
	7.0	0	7	7			
	8.0	0	2	2			
Total		32	18	50			

Comparison of serum lactate levels across Procedure done: The following table and figure show the comparison of serum lactate levels across procedure done. Chi-square analysis is highly significant.

PROCEDURE DONE	SERUM LACTATE LEVELS		TOTAL	CHI-SQUARE TEST	P-VALUE	INTERPRETATION
	Serum lactate level <3 mmol/L	*Serum lactate level >=3mmol/L*				
DAMAGE CONTROL SURGERY	0	18	18	50.000	<0.005	Highly significant
EARLY TOTAL CARE	32	0	32			
Total	32	18	50			

Correlation of serum lactate levels with complications: It is evident that serum lactate level is a useful marker to choose the procedure and when done it has less complications postoperatively($P<0.05$)

SR. LACTATE LEVEL (MMOL/L)	BOWEL VIABILITY ASSESSED INTRAOPERATIVELY	PROCEDURE PERFORMED	HPE	INFERENCE	
			PARK/CHIU Grade		*Chi-square test* *p-value and interpretation*
All patients with less than 3	Have normal or doubtful viability intraoperatively No frank gangrenous changes seen in any case	Resection and anastomosis (Early Total Care)	0 to 4	Only 1 case with anastomotic leak	4.218 P<0.05 (Significant)
All patients with more than or equal to 3	All have either doubtful viability or frank gangrenous change	Resection and stoma creation [Damage control surgery]	5 to 8	No stoma gangrene	

V. Discussion

The mean age of the participants was 50.8 years, ranging between 21-88 years with standard deviation of 15.57, and a median age of 50 years. Majority of them were male (60%, n=30) while the rest were female (40%, n=20). Most common aetiology among the participants was adhesive intestinal obstruction (40%, n=20). The mean venous lactate level among the participants was 3.18 mmol/L ranging between 1.6 and 6.9 mmol/L. Intra-operatively majority of them had doubtful viability (56%, n=28) with Park/Chiu histopathological grade 3 and 4 (52%, n=26). Early total care was given to 32 patients (64%) and damage control surgery was done in 18 patients (36%). Comparison of venous lactate levels across intraoperative bowel viability was highly significant for gangrenous cases, significant for doubtful and normal bowel viability cases. Comparison of venous lactate levels across HPE grade and surgical procedure performed were highly significant. Hence it is evident that serum lactate level is a useful marker to choose the procedure between early total care and damage control surgery whenever intraoperative bowel viability is questionable and when done it has less complications postoperatively

VI. Conclusion

In this study, it is found out that the comparison of venous lactate levels across intraoperative bowel viability was highly significant for gangrenous cases and significant for doubtful and normal bowel viability cases. Also, comparison of venous lactate levels across surgical procedure performed and complications were highly significant. Hence, venous lactate levels can be used as a reliable indicator for assessing the viability of the bowel intraoperatively and thereby determining the surgical procedure to be performed in acute intestinal obstruction whenever the bowel viability is questionable. Venous lactate estimation is an economical, minimally invasive and commonly available diagnostic modality. Therefore, it is helpful in areas where the diagnostic facilities are restricted.

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