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Blood Lactate Levels Following Vascular Resection in Borderline Resectable Pancreatic Cancer

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Abstract

Postoperative complications (POCs) remain a significant challenge in surgical practice, affecting patient outcomes and healthcare costs. Monitoring lactate levels has shown promise in predicting outcomes in critically ill patients but its utility in patients undergoing elective major abdominal surgery remains underexplored. This prospective study assessed the relationship between early postoperative lactate levels and portal circulation integrity in twenty patients undergoing pancreaticoduodenectomy with portal vein resection and reconstruction for pancreatic cancer. Intraoperative blood lactate levels were measured before and one hour after portal vein declamping. Intraoperative liver duplex was performed to assess portal flow, with adjustments made for diminished flow. Elevated lactate levels (>8 mmol/L) one-hour post-portal vein declamping were associated with diminished portal flow requiring redo of the venous anastomosis. However, limitations including patient heterogeneity, surgical variables, and small sample size were acknowledged. Early postoperative lactate levels may serve as a predictive biomarker for assessing portal circulation integrity following pancreaticoduodenectomy with portal vein resection and reconstruction. Further studies with larger sample sizes and controlled variables are warranted to validate these findings and establish reference values.

Keywords: Pancreatic cancer, Vascular resection-borderline resectable, blood lactate.

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1. Introduction

The global count of major surgeries performed each year is estimated to reach hundreds of millions [1]. Despite advancements in surgical techniques, anesthesia, and perioperative care, postoperative complications (POCs) persist as a primary contributor to postoperative morbidity, mortality, and healthcare expenditure [2-3]. Prompt identification of POCs is essential to mitigate morbidity and enhance short- and long-term patient outcomes [4]. Research indicates that compromised microvascular blood flow before and after major abdominal surgery is associated with increased POC rates [5]. Additionally, monitoring lactate levels at the conclusion of surgery indirectly reflects the impact of major surgery on tissue perfusion [6]. Elevated lactate levels are commonly observed in critically ill patients and often align with disease severity. Due to its prognostic significance, lactate serves as a widely utilized biomarker for screening, diagnosis, risk assessment, and monitoring in critically ill patients. Furthermore, lactate levels offer predictive value for outcomes and serve as a surrogate endpoint for guiding treatment decisions [7].

The rationale for lactate monitoring in critically ill patients stems from its association with tissue hypoperfusion and heightened anaerobic glycolysis. Elevated lactate may also result from increased aerobic glycolysis, triggered by cytokine release, elevated circulating catecholamines, or leukocyte accumulation at inflammatory sites [7]. Regardless of the underlying cause, early detection of hyperlactatemia proves beneficial, as lactate levels strongly correlate with Sequential Organ Failure Assessment (SOFA) scores and patient outcomes in critical care settings [8-9]. Numerous studies have investigated lactate's prognostic value in diverse groups of critically ill patients within intensive care units (ICUs) and emergency departments, primarily focusing on individuals with sepsis, trauma, shock, or severe respiratory failure [10-12]. However, data regarding the significance of lactate monitoring in a relatively homogenous cohort of patients undergoing elective major abdominal surgery are limited. The aim of this study was to evaluate the ability of early postoperative lactate levels, measured one hour after declamping of the resected and reconstructed Portal Vein-Superior mesenteric vein axis, to detect portal circulation integrity.

1.1. Aim of work

To evaluate the utility of blood lactate as a predictive biomarker of the flow in the portal venous assess post its resection and reconstruction during pancreaticoduodenectomy.

2. Materials and methods

Twenty patients underwent pancreaticoduodenectomy in addition to portal vein resection at our hospital for pancreatic cancer. Patients with pancreatic heads masses were assessed clinically, laboratory and radiologically. Vascular involvement anticipated prior to surgical intervention radiologically was encountered in all patients and vascular resection and reconstruction were performed by the same operating surgical team. The variable surgical techniques of the vascular resection were recorded, operation time, intraoperative blood loss as well as any possible intraoperative complication. Blood lactate levels were obtained intraoperatively twice, first prior to PVSMV clamping and later one hour post PVSMV declamping after vascular resection and reconstruction. Intraoperative liver duplex was performed for patients who underwent falciform patching or end to end anastomosis of the portal vein and flow in the portal axis was assessed, and if diminished flow is proven redoing the vascular anastomosis is done using internal jugular vein grafting.

2.1. Statistical analysis

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Kruskal-Wallis and Mann-Whitney tests [27]. For comparing categorical data, Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5 [28]. P-values less than 0.05 were considered statistically significant.

3. Results and Discussion

3.1. Demographic data

Twenty (20) patients underwent pancreaticoduodenectomy with vascular resection for borderline pancreatic head adenocarcinoma during the period from January 2019 to December 2020 with a marginal male predominance. Median age at the time of surgery was 57 years (range, 42-71 years).

3.2. Preoperative status was evaluated by ASA classification

- Five patients were classified ASA I.
- Thirteen patients were classified ASA II (4 patients with controlled hypertension and 9 patients with controlled diabetes).
- Two patients were classified ASA III (2 patients with history of coronary artery disease for which stents were inserted).

3.3. Intraoperative data

Eight (8) patients had partial venous excision with direct closure (venorraphy) by suture closure (type 1 PV resection), another eight (8) patients had partial venous excision and vascular reconstruction using a falciform patch (type 2 PV resection). Four (4) patients had segmental resection with primary veno-venous anastomosis (type 3 PV resection). Blood lactate levels were obtained prior to PVSMV clamping with median levels of 1.3 [0.6-2.2] mmol/L. Another blood lactate sampling was obtained one hour after PVSMV de-clamping with median levels of 4.2 [2.6-8.7] mml/L. Two (2) patients (10%), one with type 2 and another patient with type 3 PV resection, had diminished liver portal flow on intraoperative duplex for which internal jugular vein grafting was done. The median lactate levels for these two patients post venous reconstruction were 8.6 [8.4-8.7] mml/L which was statistically significantly higher than the median lactate levels of those who had patent portal venous axis post reconstruction, 3.7 [2.6-5.2] mml/L ($p < 0.001$). Several studies have documented hyperlactatemia post major surgery, often linked to oxygen debt stemming from tissue hypoxia [13-18]. Nevertheless, hyperlactatemia can stem from various other factors, including disruptions in glucose metabolism and the influence of circulating catecholamines, which may have significant implications during and after major surgery [19]. A recent study indicated that microcirculatory alterations post major abdominal surgery may not significantly correlate with lactate levels or clinical outcomes [20]. However, given the heightened surgical stress accompanying abdominal procedures especially pancreaticoduodenectomy, it's unsurprising to observe postoperative hyperlactatemia. Lactate has been deliberately studies as a marker for acute mesenteric ischemia. Prompt and accurate detection of intestinal ischemia holds significance, with a persistent need for readily available biomarkers [21-22]. L-lactate assays, utilizing enzymatic reactions involving either L-lactate oxidase or L-lactate dehydrogenase, both highly specific to the substrate, are commonly accessible for point-of-care testing, even in resource-constrained environments [23]. Yamamoto et al., (2005) presented similar outcomes, where lactate levels exceeding 15 mg/dl demonstrated a sensitivity, specificity, positive predictive value, and negative predictive value (NPV) of 93%, 90%, 68%, and 98%, respectively, in predicting strangulation in cases of bowel obstruction [23-24]. Kintu-Luwaga et al., (2013) similarly concluded that lactate was indicative of bowel ischemia in instances of mechanical bowel obstruction, with an NPV of 93% for irreversible ischemia [25]. Nuzzo et al., (2017) found that serum lactate levels >2 mmol/l were significantly linked to bowel necrosis in multivariate analysis (hazard ratio: 4.1 (95% CI: 1.4-11.5); p=0.01), serving as a predictive factor for irreversible ischemia in mesenteric ischemia cases [26]. In this study we tried to correlate early blood lactate levels to the patency of resected and reconstructed portal -superior mesenteric vein axis, assessed by intrahepatic portal duplex intraoperatively. Lactate levels above 8 mml/L one hour after de-clamping of the portal venous system was associated with diminished portal flow and re-do of the venous anastomosis was performed.

Table 1: Showing demographic variables, operative details and lactate levels in patients that underwent vascular resection with pancreaticoduodenectomy.

Age	T stage	Vascular resection	Vascular reconstruction	Blood lactate prior to PVSMV clamping mml/L	Blood lactate 1 hrs post PVSMV declamping mml/L	Complication related to vascular resection	Operation time	Intraoprative blood loss
57	4 x 3 T2N0	Side wall of Portal vein	Falciform peritoneal patching	1.2	8.4	Deminished intrahepatic portal flow on intraoperative duplex --> IJV grafting	10hrs	2500cc
71	4 x 5 T3N0	side wall of Portal vein	falciform peritoneal patching	0.8	2.6	_____	6hrs	500cc
61	4 x 3 T2N1	side wall of Portal vein	falciform peritoneal patching	1.5	3.5	_____	7hrs	500cc
53	3.5 x 2.5 T2N2	segment of SMV	End to end Anastmosis	0.6	2.7	_____	8hrs	1500cc
59	3x3 T2N1	side wall of Portal vein	Primary closure	1.1	4.7	_____	5hrs	500
65	6.5 x 6 T3N1	segment of Portal vein	End to end Anastmosis	1.3	8.7	Deminished intrahepatic portal flow on intraoperative duplex --> IJV grafting	9hrs	2000cc
69	3 x 3.5 T2N0	side wall of SMV	falciform peritoneal patching	0.8	2.9	_____	7hrs	750cc
42	3.5 x 2 T2N1	side wall of Portal vein	primary closure	1.4	3.3	_____	6hrs	500cc
44	3x3.5 T2N1	side wall of Portal vein	primary closure	1.6	3.8	_____	8hrs	1000cc
66	3.5 x 2.5 T2N1	side wall of Portal vein	primary closure	1	4	_____	5hrs	500cc
66	4.5 x 5 T3N0	side wall of Portal vein	primary closure	0.9	2.9	_____	6hrs	750cc
55	4 x 3.5 T2N0	side wall of SMV	falciform peritoneal patching	1.3	3.1	_____	7hrs	1500cc
42	3.5 x 2.5 T2N0	side wall of SMV	falciform peritoneal patching	1.9	4.1	_____	6hrs	750cc
47	3.5 x 3 T2N0	side wall of Portal vein	primary closure	1.2	3.8	_____	6hrs	500cc
45	4.3 x 3 T3N0	segment of Portal vein	end to end Anastmosis	1.6	5.2	_____	8hrs	2000cc
52	3.5 x 2 T2N1	side wall of Portal vein	primary closure	1.4	4.4	_____	5hrs	250cc
54	3.5 x 3 T2N1	side wall of Portal vein	falciform peritoneal patching	0.8	2.8	_____	7hrs	1500cc
64	8.5 x 4 T3N0	segment of Portal vein	end to end Anastmosis	1.7	4.8	_____	7hrs	1500cc
60	3.5 x 2.5 T2N0	side wall of Portal vein	primary closure	1.9	3.7	_____	6hrs	1000cc
60	5x3 T3N0	side wall of SMV	Falciform peritoneal patching	2.2	4.7	_____	7hrs	1000cc

Significant limitation of this study is the lack of homogeneity in the patients' comorbidities, duration of the surgery and the intraoperative blood loss which affects the elevation rate of the lactate blood levels as well as the sample size which needs to me multiplied in order to reach a reference value for diminished portal flow following its reconstruction.

4. Conclusions

This study evaluating the utility of blood lactate as a predictive biomarker of the flow in the portal venous assess post its resection and reconstruction during pancreaticoduodenectomy. Out of twenty cases, two cases had diminished portal flow post reconstruction by intaoperative duplex with lactate levels of more than 8 mml/L. at one hour post de-clamping of the portal vein. Due to the lack of homogeneity of comorbidities, surgical details and small sample in this study population, further studies are required to support this conclusion.

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