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Commentary

Elevated Liver Enzyme after Cardiac Surgery by on Pump Method

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I want to highlight a crucial issue affecting many cardiac surgery patients: elevated liver enzymes after cardiac surgery using the on-pump method. Elevated liver enzymes following cardiac surgery can have several clinical implications, including delayed recovery, increased risk of complications such as infection and coagulopathies, and potential long-term liver damage or dysfunction in severe cases [1].

The on-pump method utilizes a heart-lung machine to temporarily perform the heart's function during surgery. While it has saved many lives, it carries risks, including elevated liver enzymes that may signal liver injury or dysfunction. This complication can lead to prolonged hospital stays and heightened health risks [1-2].

Increased liver enzymes after on-pump cardiac surgery can result from various causes and risk factors. Recognizing these is essential for healthcare providers to effectively manage this common issue [1-3].

The use of the heart-lung machine during cardiopulmonary bypass (CPB) can trigger a systemic inflammatory response syndrome (SIRS). Recent studies indicate that the heart-lung machine may trigger a systemic inflammatory response, impacting multiple organs, including the liver. Several of the key contributing factors that lead to these complications are rooted in the systemic inflammatory response syndrome, which is a significant reaction typically triggered by the heart-lung machine utilized during surgical procedures [1]. This response is initiated by several factors, including mechanical stress, ischemia-reperfusion injury, and hemolysis. Mechanical stress occurs when blood contacts the artificial surfaces of the CPB circuit, activating complement pathways and inducing the formation of microemboli, which can occlude small vessels and cause tissue injury [2-3]. Ischemia-reperfusion injury results from the interruption and subsequent restoration of blood flow to organs during surgery, leading to the release of reactive oxygen species (ROS) and inflammatory cytokines. The initial trigger leads to the release of various inflammatory mediators, including cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-1 (IL-1), and interleukin-6 (IL-6). These cytokines can induce hepatocyte injury and stimulate the production of acute-phase proteins. Additionally, chemokines are released, recruiting and activating leukocytes, which further amplify the inflammatory response. The inflammatory mediators and reactive oxygen species (ROS) can directly injure hepatocytes, leading to cell death and the release of liver enzymes into the bloodstream. Reactive oxygen species (ROS) are generated, directly damaging cellular components like lipids, proteins, and DNA, leading to hepatocellular injury. Hemolysis, another factor, is caused by the CPB process, releasing free hemoglobin and other toxic

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substances that can exacerbate inflammation and directly injure hepatocytes. This syndrome results in the release of various cytokines and other inflammatory mediators into the bloodstream. Such a cascade of inflammatory responses can potentially lead to hepatocellular injury and is often associated with elevated liver enzyme levels, indicating stress on the liver. Key liver enzymes that are commonly elevated include alanine aminotransferase (ALT), primarily found in the liver, with elevated levels serving as a sensitive indicator of hepatocellular injury. Aspartate aminotransferase (AST) is found in various tissues, including the liver, heart, and muscles, and elevated AST levels can indicate liver injury but are less specific than ALT. Alkaline phosphatase (ALP) is another enzyme, with elevated levels indicating biliary obstruction or cholestasis, which can also occur as a result of the inflammatory response. Gamma-glutamyl transferase (GGT) is often elevated in conjunction with ALP, indicating liver injury or biliary dysfunction [2,4-5].

Another critical concern is the occurrence of ischemia-reperfusion injury. This condition arises from the temporary interruption of blood flow during the surgical process, followed by its eventual restoration. The act of resuming blood flow can lead to the liberation of reactive oxygen species, which are highly reactive molecules that contribute to oxidative stress and subsequent inflammation, compounding the risks to hepatic health [3-4].

The cardiopulmonary bypass (CPB) process itself can significantly disrupt the delicate microcirculation of the liver. This disruption is detrimental because it impairs the liver's essential functions by diminishing the supply of vital oxygen and nutrients to hepatocytes, the primary functional cells of the liver. Moreover, mechanical hemolysis—a condition arising from the use of the heart-lung machine—results in the release of free hemoglobin and other potentially toxic substances into the bloodstream. These elements can be directly hepatotoxic, meaning they can harm liver cells, or they may overwhelm the liver's natural detoxification mechanisms, leading to additional stress on the organ [1,4-5].

Perioperative medications can contribute to liver enzyme elevation. It is crucial to recognize that perioperative medications, which often include anesthetics, antibiotics, and cardioprotective agents administered during surgery, can further complicate matters. These drugs have the potential to induce drug-induced liver injury or may cause elevations in liver enzyme levels, further contributing to the overall risk faced by the liver during and after surgical interventions. Anesthetics, some of which can cause hepatotoxicity, are one such category. Broad-spectrum antibiotics used prophylactically can also affect liver function. Additionally, cardioprotective agents, including statins and beta-blockers, which are used to protect the heart during surgery, can potentially cause liver injury [2,5].

Cannulating the upper and lower vena cava during heart surgery for a bypass pump can worsen liver congestion and accelerate liver damage, constituting a surgical technique error. Improper cannula placement may disrupt hepatic blood flow, increasing the risk of ischemic injury and metabolic disturbances that impair liver function and protein synthesis. Additionally, poor positioning or prolonged obstruction of blood flow can heighten the risk of hepatic venous outflow obstruction, leading to sinusoidal congestion and liver dysfunction. Surgeons must consider any existing liver conditions, as underlying hepatic issues can exacerbate the effects of cannulation. A skilled surgical team should employ precise techniques to minimize collateral effects on the liver and other vital organs [3-5].

Several risk factors are associated with liver enzyme elevation during and after cardiac surgery. Longer durations of cardiopulmonary bypass (CPB) increase the risk due to prolonged exposure to various mechanisms. Patients with pre-existing liver conditions such as cirrhosis or steatosis are at a higher risk of significant liver enzyme abnormalities. Older patients may be more susceptible due to reduced hepatic reserve and a higher prevalence of comorbidities. Obesity, a risk factor for non-alcoholic fatty liver disease, can exacerbate liver enzyme elevation. Diabetes mellitus can impair liver metabolism, making diabetic patients more vulnerable. Preoperative renal dysfunction can affect liver metabolism and reduce the clearance of hepatotoxic substances, increasing the risk. Additionally, a history of chronic alcohol consumption can lead to alcoholic liver disease, further heightening susceptibility to liver injury during and after surgery [2, 4, 6].

Managing and preventing elevated liver enzymes involves optimizing cardiopulmonary bypass (CPB) techniques by minimizing CPB duration, using biocompatible circuits, and employing strategies to reduce hemolysis and inflammation. This includes carefully selecting patients for the on-pump method, considering the potential risks and benefits, and striving to minimize the duration of cardiopulmonary bypass to reduce exposure to inflammatory and ischemic insults. Additionally, preoperative optimization involves addressing and optimizing pre-existing conditions such as diabetes, hypertension, and renal dysfunction to improve liver function and reserve. Post-surgery, close monitoring of liver function and providing supportive care as needed are crucial to manage and mitigate liver enzyme elevation. Postoperative support involves close monitoring of liver function and providing supportive care, such as nutritional support and pharmacological interventions to modulate the inflammatory response [4-6].

In conclusion, the systemic inflammatory response triggered by the on-pump method during cardiac surgery can lead to hepatocellular injury and the elevation of liver enzymes. Elevated liver enzymes after cardiac surgery using the on-pump method, also known as cardiopulmonary bypass (CPB), can be attributed to several common causes and underlying mechanisms. These factors contribute to hepatocellular injury and the subsequent release of liver enzymes into the bloodstream. By understanding and addressing these common causes and mechanisms, healthcare providers can enhance patient outcomes and reduce the incidence of elevated liver enzymes after cardiac surgery using the on-pump method. While the on-pump method remains a lifesaving procedure, it is essential to acknowledge and address the complications it may entail, particularly the elevation of liver enzymes. By fostering a dialogue on this topic, we can work towards better patient care and outcomes.

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