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Short Communication

Plasma Exchange as A Rescue Therapy for Acute Liver Failure Due to Acetaminophen Toxicity: A Rare Case Report

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Abstract:

Acetaminophen-induced acute liver failure is a serious medical emergency with a high risk of complications and mortality, particularly when treatment is not administered early and promptly. N-acetylcysteine (NAC) is typically the primary treatment, but patients who are at a risk of progressing to multi-organ failure or present late may benefit from therapeutic plasma exchange (TPE). We present a case of a 32-year-old male patient who presented with acute liver failure caused by late present of acetaminophen toxicity, but made significant clinical progress through the use of high-volume plasma exchange, thus by passing the need for liver transplantation. This report examines the underlying causes, diagnostic methods, treatment options, and supporting evidence derived from relevant case studies.

Key words: acute liver failure; acetaminophen; plasma exchange; high-volume plasmapheresis; n-acetylcysteine; liver transplantation

Introduction

Acetaminophen (paracetamol) overdose-induced acute liver failure is a common medical emergency encountered worldwide. The mechanism behind acetaminophen toxicity stems from an overproduction of a toxic metabolite, N-acetyl-p-benzoquinone imine (NAPQI), that rapidly depletes glutathione, the liver's primary antioxidant, resulting in severe liver cell necrosis. The first and most vital treatment for an acetaminophen overdose is administering N-acetylcysteine (NAC) early in a timely manner. NAC replenishes the liver's glutathione stores, which in turn neutralizes NAPQI and stops the progression of liver damage. In cases where patients are late presenters following an overdose, usually more than 8-10 hours after ingestion, and show signs of severe liver damage, with a high risk of multi-organ failure, NAC treatment alone may be inadequate to prevent disease progression and due to lack of available transplant resources in our setting, therapeutic plasma exchange emerges as a vital supplementary treatment option in these situations. It helps to effectively remove the circulating toxins and inflammatory mediators, addressing life-threatening blood clotting disorders, and providing a crucial pathway to either spontaneous liver recovery or, if required, liver transplantation. This case highlights the successful use of high-volume plasma exchange in a very rare instance of acetaminophen-induced acute liver failure, which led to significant clinical improvement and prevented the need for a liver transplant.

Case Presentation and Clinical Findings

A 32-year-old man who was previously unevaluated was admitted to the emergency department 24 hours after taking around 60 grams of acetaminophen in a deliberate overdose .On presentation he had right sided abdominal pain with nausea, and recurrent vomiting that included one episode of blood stained vomitus. On Examination he was drowsy with a GCS of 14/15, with mild pallor and icterus, and he had no flaps. His BP-110/60mmhg, PR 92, Spo2 -98% on RA with mild right hypochondrial tenderness and rest of the systemic examinations were normal.

Laboratory and Diagnostic Evaluation

Upon initial examination, urgent blood samples were drawn and it revealed extremely high levels of liver enzymes, with an Aspartate Aminotransferase (AST) reading of 13,600 IU/L and an Alanine Aminotransferase (ALT) reading of 3500 IU/L, along with an International Normalized Ratio (INR) of 3.16. Furthermore, the total bilirubin level was significantly elevated at 72 micromol/L (Normal range of 3.4-17.1) with elevated unconjugated bilirubin, blood gas analysis showing metabolic acidosis characterized by a low pH of 7.30 and an elevated lactate level of 4.8 mmol/L fraction therefore indicating severe liver cell death impairing its conjugating, metabolic and synthetic functions. His serum creatinine levels were also elevated at 122 micromol/L(53-88). An NCCT of the brain showed no evidence of cerebral edema, and chest X-rays and abdominal ultrasounds were performed and found to be normal. The patient's severe coagulopathy,

high bilirubin levels, and hepatic encephalopathy, among other critical laboratory parameters, qualified the patient for liver transplantation according to the King's College Criteria. A decision was made to begin high-volume plasma exchange (HVPE) as a life-saving bridging therapy due to the immediate unavailability of a donor organ and the limited resources in our setting.

Treatment and Outcome

Due to the severity of his condition and the fact that a liver donor was unavailable at the time, he started receiving an aggressive high-volume plasma exchange treatment in conjunction with standard supportive care. N-acetylcysteine administered intravenously was given at a dose of 200 mg/kg/day following an initial bolus injection, and this treatment was continued until three consecutive cycles of plasmapheresis had been completed. A considerable improvement in the patient's mental condition was seen following only the second plasma exchange treatment, suggesting a decrease in the severity of hepatic encephalopathy. His clinical improvement was accompanied subsequently normalization of his laboratory parameters, including her kidney function tests. Following a significant enhancement in his clinical condition, the patient was released from the hospital after a 7-day stay, with his liver function tests nearly returning to normal. This positive result highlighted the life-saving capabilities of HVPE, enabling the avoidance of an immediate liver transplant for a patient who was initially in need of one.

Discussion: The Role and Efficacy of Plasma Exchange in ALF

This case highlights the significant potential of plasma exchange in treating acetaminophen-induced acute liver failure, particularly when early treatment is unsuccessful or delayed, and a liver transplant is not an immediate option. Acetaminophen toxicity causes cell damage through several mechanisms, primarily by disrupting normal mitochondrial function, triggering oxidative stress, and ultimately resulting in a large number of liver cell deaths. N-acetylcysteine (NAC) is most effective when given at an early stage, but its effectiveness declines substantially in cases where treatment is delayed. Therapeutic plasma exchange is a vital treatment approach that offers a broad detoxification solution in complex cases. This substance successfully eliminates circulating toxins, including direct liver poisons, inflammatory cytokines, and other hazardous metabolites that accumulate in liver failure, resulting in a reduction of systemic inflammation and preventing additional organ damage. TPE directly addresses the severe coagulopathy commonly associated with ALF by replenishing crucial clotting factors that are lacking due to impaired hepatic production, thus lowering the risk of serious bleeding complications. The relevant literature offers considerable evidence in support of the effectiveness of plasma exchange in cases of severe acute liver failure that are comparable in severity. A 2021 study by Ranasinghe et al. found that an 18-year-old patient who had fulminant hepatic failure fully recovered after undergoing plasmapheresis. In 2002, Ash et al. showed that sorbent-based extracorporeal therapy was effective for 10 patients suffering from acetaminophen-induced liver failure. According to a study by Oettl et al. published in 2008, single-pass albumin dialysis played a crucial role in facilitating the recovery of a 41-year-old patient. Recent research, including a 2021 study by Amin et al., has found that high-volume plasmapheresis can stabilise a non-transplant candidate with acute liver failure, whereas a 2022 study by Menon et al. showed that HVPE allows for safe liver transplantation in a COVID-19 positive patient with acute liver failure, thereby highlighting its adaptability. Pan et al. noted a full recovery in two elderly residents of an assisted living facility who suffered from hypertensive pupillary escape, thereby broadening the potential uses of this treatment across various age brackets as initially reported in 2013. A 2020 systematic review by Tan et al. found that TPE considerably enhanced survival rates in liver failure, while a 2023 study by Senzolo et al. underscored the significance of undertaking plasma exchanges both promptly and repeatedly in managing liver disease. Wellness Health (2022) also recommends TPE as an additional treatment option in severe hepatitis cases. Established by O'Grady et al. in 1993, the King's College Criteria continue to play a crucial role in identifying patients who need liver transplants; this particular instance however, shows that HVPE can act as a vital link or even a viable substitute for transplantation when donor organs are not readily available. The collective evidence strongly suggests that plasma exchange is a highly effective yet underutilized treatment option that could be lifesaving in the treatment of severe liver failure, particularly when the liver damage is caused by acetaminophen overdose.

Conclusion and Future Directions

Our patient's dramatic and swift clinical and biochemical recovery, resulting in full remission and the prevention of a necessary liver transplant, demonstrates incredible potential of plasma exchange especially in situations where liver transplantation is not immediately accessible due to donor unavailability or other logistical constraints, timely initiation of plasma exchange can serve as a vital life-saving bridge, allowing for spontaneous liver regeneration or providing valuable time for transplant arrangements to be made. The success of this intervention depends on several key factors, including the early identification of severe acute liver failure, the prompt start of plasma exchange, and comprehensive supportive care when managing patients with multi-organ failure. Evidence from this case report and various smaller studies, including systematic reviews, strongly suggests that plasma exchange is effective in treating ALF, but further research in the form of larger, well-designed randomized trials is still required. This case serves as a potent reminder for clinicians to consider plasma exchange as a reliable and effective treatment option in the critical care of severe acetaminophen-induced advanced liver failure, resulting in improved patient outcomes and potentially allowing them to avoid the need for urgent liver transplantation.

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