

## Albumin-Based Dialysis as an Effective Treatment for Severe Traumatic Hepatic Necrosis

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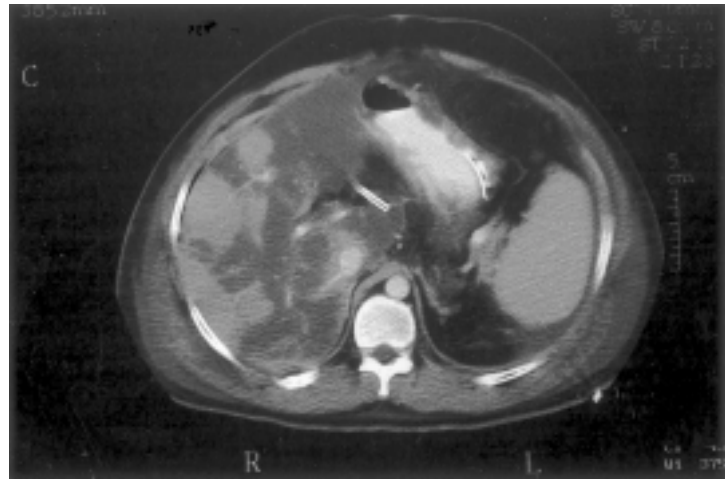
Injuries to the liver caused by severe blunt trauma are fairly common due to the large size of the organ and its vulnerable anatomic location. Motor vehicle accidents and domestic trauma are the most common causes of blunt liver injury in urban settings. The current clinical experience strongly supports the non-operative treatment of complex liver injuries as the best therapeutic choice for most patients with blunt liver trauma [1].

The case reported here presents a new perspective in the treatment of severe liver trauma – the Molecular Adsorbent Recirculating System, a new albumin-based blood purification technology.

### Patient Description

A 33 year old worker was referred to our intensive care unit from a community hospital 4 days after sustaining an isolated extensive blunt trauma to the liver as a result of a fall of 8 meters. After the fall the patient remained conscious but suffered a severe hemorrhagic shock (systolic blood pressure 70, heart rate 150). Laparotomy revealed an extensive hepatic injury with massive bleeding from a transected portal vein and left hepatic artery. The right and main portal veins were reconstructed, but the vascularization to the left hepatic and caudate lobes could not be regenerated. In spite of suturing and packing, the patient continued to bleed and another three laparotomies were performed in the following 72 hours. On the third day post-injury, the patient deteriorated into a comatose state. Computed tomography scan revealed diffuse cerebral edema and extensive hepatic necrosis mainly of the left and caudate lobe. The prominent laboratory findings at that time were: ammonia 186

Biochemical profile of the patient. Initially, high ammonia, lactate, bilirubin and INR values together with low level of Factor V corresponded to severe liver failure and hepatic coma. Following the treatment with the MARS, a gradual improvement in the biochemistry profile was observed



together with the remarkable clinical recovery: awakening from hepatic encephalopathy. Black bar = aspartate aminotransferase, AST, white bar = alanine aminotransferase.

mg/dl, direct bilirubin 36 g/dl, lactate 6 mg/dl, aspartate aminotransferase 2,000 u/L, alanine aminotransferase 3,500 u/L, lactate dehydrogenase 22,000 u/L, Factor V 16% and INR 3. The diagnosis of fulminant hepatic failure due to massive necrosis was made and the patient was transferred to our unit where, despite maximal conventional medical therapy (lactulose enemas, per os neomycin, intravenous glucose and fresh frozen plasma), he continued to deteriorate. An intracranial pressure monitor revealed ICP of 30–50 mmHg, which did not respond to treatment with hyperventilation and mannitol. At that state the patient was connected to a blood purification system based on the dialysis of blood with a double-sided, albumin-impregnated hollow fiber dialysis membrane. Three treatment sessions were administered, each lasting 8 hours within a 72 hour

period. During the first hours of the MARS session, ICP normalized, the patient regained full consciousness and extubation was performed. A continued steady improvement in secretory (bilirubin, ammonia) as well as synthetic (prothrombin time, Factor V, INR) liver function tests was observed [Figure] and the patient was discharged for further care in the surgical ward.

### Comment

Our patient suffered a grade V liver injury according to the Organ Injury Scale (I–VI) described by the American Association for the Surgery of Trauma [2]. This type of liver injury is defined as an extensive parenchymal disruption involving >75% of the hepatic lobe together with juxtahepatic venous injuries. The liver is capable of responding to parenchymal injury by heal-

ICP = intracranial pressure

MARS = Molecular Adsorbent Recirculating System

ing and regeneration. The regenerative capacity of the liver allows for up to 70% of normal liver tissue to be resected without the development of hepatic failure. This is partly due to the abundant dual blood supply (from both the portal vein and hepatic artery). Indeed, hepatic insufficiency has been rarely described following even extensive liver injury [1]. Nevertheless, our patient suffered a severe hepatic vascular injury (combined portal vein and hepatic artery lacerations) which, together with the prolonged state of hemorrhagic shock, probably explains the clinically manifested severe post-traumatic hepatic insufficiency.

This non-surgical treatment is guided by the ability to preserve an acceptable hemodynamic stability while waiting for the liver to regenerate. It is expected that almost complete functional resolution can occur 3 to 4 months after extensive liver injury [3]. However, less data are available as to the medical management of immediate liver insufficiency induced by extensive hepatic necrosis due to severe post-traumatic anoxic liver damage.

The present case demonstrates a remarkable neurologic recovery following the use of the MARS for blood purification [4]. The patient, suffering from a massive hepatic necrosis with grade IV hepatic encephalopathy, began to regain full consciousness shortly after the MARS treatment was begun. The increased ICP was reduced. In addition, synthetic as well as excretory liver functions improved [Figure].

The MARS blood purification technology, originally described by Stange et al. [3], is a new non-biological hepatic support system. Its beneficial role in the treatment

of patients with acute decompensation of liver failure was recently reported [5]. In contrast to the regular methods of hemodialysis, this system was designed to remove both low and middle molecular weight water-soluble substances (ammonia and bilirubin) as well as albumin-bound molecules. Indeed, serum levels of ammonia and bilirubin were significantly reduced after the treatment with the MARS. The system is based on the dialysis of blood against a special membrane that is coated with albumin but impermeable to it [4,5]. The albumin compounds with the free binding sites on the membrane surface compete with the carrier proteins for the toxins in the bloodstream. The membrane transiently adsorbs and holds the toxins normally carried by albumin molecules in the blood (i.e., bilirubin and bile acids), which are released upon contact with the membrane according to the concentration gradient. After the toxins are trapped, they are carried to the other side of the membrane where dialysis against a fluid rich in albumin completely separates the toxins. The dialysis is recirculated against a charcoal column for the removal of lipophilic toxins such as bile acids, and against anion exchange resin for the removal of bilirubin. The albumin-containing dialysate is then completely renewed by dialysing it against a normal dialysis solution.

To the best of our knowledge, this is the first documented case of the clinical use of the MARS system for the treatment of post-traumatic hepatic necrosis. In view of the severity of the initial hepatic injury and the favorable outcome, we presume that MARS treatment in the presenting case might have shortened the duration of supportive treatment, thus preventing secondary com-

plications. The use of the MARS system in this patient enabled the severely damaged liver to recuperate and slowly recover its synthetic functions. The MARS system basically purifies the blood by replacing excretory functions of the failing liver and serves as a supporting bridge that keeps the patient alive until adequate synthetic functions of the liver are restored.

Our experience with the MARS system points to its future potential as an additional therapeutic strategy in the treatment of post-traumatic massive hepatic necrosis, bridging patients through the time needed for liver regeneration.

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