Molecular Absorbent Recirculating System for the Treatment of Acute Liver Failure in Surgical Patients

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The Molecular Adsorbent Recirculating System (MARS) represents an attractive artificial liver support system for the treatment of liver insufficiency. However, neither indications for MARS treatment (i.e., after extended liver resection) nor criteria for discontinuation of therapy have been evaluated. Therefore, we analyzed the clinical data of all our surgical patients who received MARS treatment for acute liver failure (n = 7). The aim of the study was to identify prognostic indicators for survival. Four of 174 patients resected for hepatic malignancy at our institution received a total of 13 MARS treatments. Two additional patients were successfully bridged to orthotopic liver transplantation with seven MARS treatments and one patient was MARS supported after liver transplantation of a steatotic graft with three MARS treatments. Five of the seven patients survived and were dismissed an average of 31 days, ranging from 17 to 47 days, after the final MARS treatment. No technical complications or adverse effects were observed during the MARS treatments. Important prognostic factors for hepatic recovery and survival were indocyanin green plasma disappearance rates greater than 5%/min and an increase in clotting factor V levels after each MARS treatment. We conclude that MARS therapy can be an effective treatment of postoperative liver insufficiency in the surgical hepatobiliary unit. (J GASTROINTEST SURG 2005;9:1155–1162)

KEY WORDS: Artificial liver support, liver surgery, acute liver failure, molecular adsorbent recirculating system, MARS, indocyanin green plasma disappearance rate

Intense liver regeneration follows hepatic resections that are required for removal of primary or secondary liver tumors in humans. Excellent hepatic regeneration and an uncomplicated recovery can be expected with a 50% or greater remnant of total liver mass that corresponds to at least 1.2% of body weight (BW).[1–3] More extensive hepatectomies, such as resections of 50–70% of total liver mass, that leave smaller liver remnants can result in impaired regeneration. The minimum liver remnant needed for survival in patients is currently considered to be 0.8% of BW.[1,4–6]

Synthetic activity and detoxification capacity of the regenerating liver may fail, typically on the third to fourth day after surgery, when extended hepatic resections result in critically low remnant liver mass.[6] In these clinical circumstances the Molecular Adsorbent Recirculating System (MARS; Gambro Rostock AG, Rostock, Germany) represents an attractive artificial liver support system for the treatment of the acute liver insufficiency.[7–10] MARS uses a hollow-fiber dialysis module containing an albumin-impregnated polysulfone membrane that separates the patient's blood and the 20% albumin dialysate in the extracapillary compartment. The albumin dialysate is cleansed from water-soluble toxins by passage through a hemodialysis module, and albumin-bound toxins are removed by perfusion over activated charcoal and resin.[11]

Reports on the use of MARS for the treatment of hepatic failure after major liver resection are scarce and only 12 patients from five different groups have

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so far been described.[9,12–15] The reported patient mortality rate was 75% (9/12). Similarly, reports on the outcome of MARS therapy in the liver transplant setting, such as bridging to orthotopic liver transplantation (OLT), treatment of primary nonfunction after OLT, or therapy of delayed graft function after OLT, are limited to single reports.[9,11,16–21]

Neither clear indications for the postoperative initiation of MARS treatment, such as after major hepatic resections, nor criteria for discontinuation of therapy have been evaluated. Therefore, we prospectively analyzed clinical data from all of our surgical patients who received MARS treatment. The aim of the study was to identify prognostic parameters for survival during MARS therapy.

MATERIAL AND METHODS

The clinical data obtained from the surgical patients (n = 7) who were included in the study are summarized in Table 1. Informed consent for MARS treatment was obtained from the patients or an immediate family member (institutional approval: 1.05.01.30.-17). Indications for the initiation of

Table 1. Patient Characteristics, Diagnosis, Surgical Treatment, and Outcome After MARS Treatment

Patient (Gender, Age [yr])	Group	Diagnosis	Surgical Intervention (Resected Couinaud Liver Segments)	Indication for Initiation of MARS Treatment	MARS Cycles (n)	MARS-Responder? Comment on Clinical Course
1 (F, 30)	**Group A**	Cholangiocarcinoma	Extended left hepatectomy (I, II, III, IV, V, VIII) Hepatic vein reconstruction	Factor V <30%	3	Yes; discharged 17 days after MARS
2 (M, 65)	**Group A**	Cholangiocarcinoma	Extended left hepatectomy (II, III, IV, part. V, part. VIII) Hepatic artery reconstruction	Factor V <30%	3	Yes; discharged 31 days after MARS
3 (M, 48)	**Group B**	Gallbladder carcinoma	Extended left hepatectomy (I, II, III, IV, V, part. VIII)	Asterixis	2	No; died 1 day after discontinuation of MARS
4 (M, 64)	**Group B**	Hepatocellular carcinoma in cirrhosis (hemochromatosis)	Extended right hepatectomy (part. IV, V, VI, VII, VIII)	Asterixis	5	No; died 2 days after discontinuation of MARS
5 (F, 66)	**Group B**	Late-onset hepatic failure in autoimmune hepatitis	OLT	Asterixis	6	No; bridge to OLT. discharged 45 days after OLT
6 (M, 34)	**Group B**	Primary non-function after OLT	Re-OLT	Factor V<30%	1	No; bridge to re-OLT. discharged 17 days after re-OLT
7 (F, 65)	**Group A**	Delayed graft function after OLT (steatotic graft)	OLT	Asterixis	3	Yes; discharged 47 days after MARS

OLT = orthotopic liver transplantation; Part. = partially resected liver segment.
Group A includes all MARS responding and surviving patients. Group B contains all MARS nonresponding patients (nonsurvivors and patients successfully bridged to orthotopic liver transplantation).