

# Haemodynamic Management in Liver Surgery

AKADEMISK AVHANDLING

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av

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Avhandlingen baseras på följande delarbeten:

- I. Sand L, Rizell M, Houltz E, Karlén K, Wiklund J, Odenstedt Hergès H, Stenqvist O, Lundin S.  
**Effect of patient position and PEEP on hepatic, portal and central venous pressures during liver resection.**  
*Acta Anaesthesiol Scand* 2011; 55: 1106–1112
- II. Sand L, Lundin S, Rizell M, Wiklund J, Stenqvist O, Houltz E.  
**Nitroglycerine and patient position effect on central, hepatic and portal venous pressures during liver surgery.**  
*Acta Anaesthesiol Scand* 2014; 58: 961-967
- III. Sand Bown L, Ricksten S-E, Houltz E, Einarsson H, Söndergaard S, Rizell M, Lundin S.  
**Vasopressin-induced changes in splanchnic blood flow and hepatic and portal venous pressures in liver resection.**  
*Acta Anaesthesiol. Scand.* 2016, *In Press*
- IV. Sand Bown L, Wolmesjö N, Ricksten S-E, Rizell M, Lundborg C, Lundin S, Söndergaard S.  
**Goal-directed haemodynamic bundled therapy reduces bleeding in liver resection.**  
*Submitted manuscript*



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## ABSTRACT

**Background:** Liver resection surgery is a potentially curative treatment for liver tumours. The liver is a highly vascular organ, and substantial intra-operative blood loss is common. Increased blood loss negatively impacts both postoperative outcome and long-term survival.

A low central venous pressure (CVP) has been suggested in order to reduce blood loss during liver surgery. The rationale is that low CVP reflects lower pressure in the hepatic venous system, which in turn reduces the driving force causing bleeding when the liver tissues are transected. Together with fluid restriction, strategies to achieve a low CVP (LCVP) include patient tilt (head up or down), zero PEEP, nitroglycerine, diuretics and neuraxial anaesthesia. Vasopressin reduces portal pressure in patients with portal hypertension and has been shown to reduce blood loss in liver transplantation. LCVP management in liver surgery is associated with reduced blood loss and may increase the risk of organ of hypo-perfusion.

**Aims:** To investigate the effect of patient position (tilt), nitroglycerine, PEEP and vasopressin on portal and hepatic venous pressures and systemic haemodynamics. To assess the effect of vasopressin on portal and hepato-splanchnic blood flows. To determine whether pressure changes in the superior vena cava are reflected in the hepatic venous system. To retrospectively evaluate the effects of a new anaesthetic management protocol involving low CVP and goal directed therapy (GDT/LCVP) in liver resection surgery.

**Methods:** We used tip-manometer catheters to directly measure changes in hepatic venous and portal pressures during 10° tilt (head up and down), nitroglycerine infusion, and alterations in PEEP. The effect of low-to-moderate doses of vasopressin on hepatic venous and portal flow and pressure was assessed with conventional fluid-filled catheters in these vessels, collection of samples for blood gas analysis and the application of Fick's principle. The effects on systemic haemodynamics were also assessed. Patient data were obtained and compared from two cohorts, before and after the introduction of GDT/LCVP.

**Results:** Patient tilt led to substantial changes in CVP and mean arterial pressure (MAP), but only minor effects on hepatic pressures. Increased PEEP resulted in small increases in hepatic and central venous pressures. Nitroglycerine caused a parallel decrease in systemic and hepatic venous pressures. Cardiac output decreased. With the addition of head down tilt, MAP, cardiac output and CVP increased. Hepatic venous pressure increased marginally, but did not return to baseline. Vasopressin had no effect on hepatic pressures, but led to decreases in portal and hepato-splanchnic blood flow. After the introduction of LCVP/GDT management, median intra-operative haemorrhage decreased by almost a litre, with no increase in post-operative complications.

**Conclusions:** Changes in CVP reflect changes in hepatic venous pressure in the supine position, but not during patient tilt. Tilting is not effective in reducing hepatic venous pressures. Nitroglycerine reduces the hepatic and portal venous pressures, but adverse central hemodynamic effects may limit its application. Vasopressin reduces portal and hepatic blood flow with only minor effect on pressures. Introducing goal-directed therapy with a low CVP protocol led to a large reduction in intra-operative blood loss compared to previous anaesthetic management techniques.

**Keywords:** Liver resection, blood loss, central venous pressure, hepatic venous pressure, portal venous pressure, patient position, PEEP, nitroglycerine, vasopressin, hepato-splanchnic blood flow, portal venous blood flow, goal directed therapy, low central venous pressure (LCVP)

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