SHUNT FLOW AND CAVAL PRESSURE GRADIENT DURING VENO-VENOUS BYPASS IN HUMAN ORTHOTOPIC LIVER TRANSPLANTATION


SUMMARY

The routine use of veno-venous bypass during the anhepatic phase of orthotopic liver transplantation is controversial. Decreased shunt flows (1.5–3.0 litre min⁻¹), as reported in the literature, may explain the lack of beneficial effects on outcome. We have studied the influence of bypass flows on caval pressure gradient (CPG) and renal perfusion pressure (RPP) in 45 patients undergoing orthotopic liver transplantation using a portofemoro-subclavian veno-venous bypass system. Mean shunt flow was 3.63 litre min⁻¹. Second-order polynomial regressions best described the relationship between shunt flow and CPG (r² = 0.674), RPP (r² = 0.727), and cardiac output (r² = 0.602). Shunt flows less than 3.0 litre min⁻¹ failed to normalize CPG and RPP, whereas flows greater than 5.0 litre min⁻¹ did not substantially improve haemodynamic state.

KEY WORDS

There is no evidence that extracorporeal veno-venous bypass during orthotopic liver transplantation is beneficial [1] as far as outcome is concerned [2]; however, improvement in such physiological variables as cardiac output and urine production has been demonstrated [2].

Shunt flows described in the literature range from 1.5 to 3.0 litre min⁻¹ in adults [2-4]. It is not known if such flows are sufficient to normalize haemodynamic pressures and thus cardiac output. Therefore, we have assessed the efficacy of shunt flow during portofemoro-subclavian bypass by measuring infra-(ICAVP) to suprahepatic (SCAVP) caval pressure gradient (CPG) and mean arterial pressure (MAP), from which renal perfusion pressure (RPP = MAP – ICAVP) was derived.

METHODS AND RESULTS

After obtaining local Ethics Committee approval and written, informed consent, we studied the efficacy of portofemoro-subclavian bypass in 45 consecutive adult patients (23 male) undergoing elective or emergency orthotopic liver transplantation. Adults with a body weight less than 50 kg were excluded. Median age was 42 yr (range 19–65 yr) and median body surface area 1.84 m² (range 1.34–2.28 m²). Thirty patients were classified Child B, and 15 Child C; nine were “high urgent” (Eurotransplant urgency code HU) because of fulminant hepatic failure.

General anaesthesia was maintained by a continuous infusion of propofol 40–60 µg kg⁻¹ min⁻¹ and fentanyl 0.1–0.3 µg kg⁻¹ min⁻¹ with 0.4–0.6% isoflurane. Fluid administration, blood transfusion and catecholamine support were adjusted to produce a normal haemodynamic state with a mean arterial pressure > 60 mm Hg, central venous pressure 5–10 mm Hg, cardiac index > 2.5 litre min⁻¹ m⁻², haemoglobin concentration 10 g litre⁻¹ and PCV 30%. All patients received low-dose dopamine 3–5 µg kg⁻¹ min⁻¹. In six urgent cases, adrenaline 0.1–0.3 µg kg⁻¹ was given to maintain cardiac output. ICAVP was measured via the right femoral vein.

Before operation, the left femoral and subclavian veins were cannulated with 7-mm single lumen catheters (LAUB percutaneous cannulation set, Cook Europe, Mönchengladbach, Germany) for portofemoro-subclavian bypass. Shunt flows were initially rendered optimum by adjusting the pump speed to the greatest possible flow rate before collapse of the tubing.

When shunt flow reached a steady state during the anhepatic phase, haemodynamic measurements were performed. Cardiac index (CI), oxygen transport (Do₂) and oxygen consumption (Vo₂) were derived using the usual equations. Statistical analysis was performed by linear and second order polynomial regression analysis. The significance of sample correlation coefficient (r) was calculated using a two-tailed t test. P < 0.05 was considered significant.

Mean shunt flow was 3.63 (SEM 0.20) litre min⁻¹ (range 0–6.6 litre min⁻¹). In one patient it was not possible to establish a shunt flow because of air entrainment into the portal cannula. Mean haemo-
subclavian bypass ensures large shunt flows (mean 3.6 litre min\(^{-1}\)). The data indicate that CPG and hence RPP were dependent on shunt flow and that this relationship was almost linear for a shunt flow less than 3 litre min\(^{-1}\). The correlation between shunt flow and CO \((r = 0.602, P < 0.0005)\) in our patients was good, as were the correlations between shunt flow and RPP \((r = 0.675, P < 0.0005)\) or CPG \((r = 0.571, P < 0.0005)\), respectively. ICAVP and hence CPG and RPP were dependent mainly on shunt flow and thus mirrored the efficacy of blood drainage from the portocaval to the superior caval venous system.

If orthotopic liver transformation is performed without veno-venous bypass RPP is usually small, leading to intraoperative oliguria [1]. Estrin and colleagues [5] found a mean RPP between 40 and 49 mm Hg in 26 adult patients without veno-venous bypass and the CPG was 36-37 mm Hg. In that group of patients, mean arterial pressure during the anhepatic phase was surprisingly increased and even greater (82-98 mm Hg) than in the pre-anhepatic phase (81-91 mm Hg), probably because of fluid and catecholamine administration.

Adverse haemodynamic changes associated with cross clamping of the caval vein can be overcome by volume loading [5] without major complications [1] such as fluid overload. Even with veno-venous bypass, this remains a major problem and has led to the institution of intraoperative continuous arterio-venous haemofiltration in some centres [6].

Our study shows that shunt flows less than 3.0 litre min\(^{-1}\) failed to normalize CPG and RPP. Our data show that the relationship between shunt flow index and CI, CPG and RPP behaved in a curvilinear fashion that in an increase in shunt flows led to an increase in RPP and a decrease of CPG linearly when shunt flows were decreased (< 3.5 litre min\(^{-1}\)) but optimized CPG (< 5 mm Hg) and RPP (> 60 mm Hg) to only a small extent when shunt flows were great (> 5 litre min\(^{-1}\)).

REFERENCES