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# Evaluation of orthotopic liver transplantation with no veno-venous bypass*

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**Abstract：** Objective：To assess the feasibility and outcome of orthotopic liver transplantation(OLT) with no veno-venous bypass(v-v bypass) in adult patients. Methods：Between 1999 and 2001，43 adult patients underwent OLT with v-v bypass，33 with no v-v bypass. The operation time，anhepatic time，amount of blood loss，amount of blood transfusion，ICU stay days of the two groups were compared；renal function and gastrointestinal function in the two groups were examined. Results：There was no significant difference in mean serum creatinine on day 3 and gas discharge time in patients with v-v bypass or not. With no v-v bypass，the average operation time was 5.7±1.3 hours，anhepatic time was 64±13 minutes，median amount of blood loss in operation was 4000±820 mL，median amount of blood transfused intraoperatively was 4650±910 mL，median ICU stay was 5.7 days；all those were lower or shorter than those with v-v bypass；and these differences between the two groups had statistical significances. Conclusion：OLT with no v-v bypass is safe and can be performed in the majority of adult patients. The practice of liver transplantation with no v-v bypass is associated with shorter total operation time，shorter anhepatic time，lower blood product usage，and shorter ICU stay compared with standard technique of OLT with routine use of v-v bypass.

**Key words：** Liver transplantation，Orthotopic，Veno-venous bypass
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## INTRODUCTION

The current decade has witnessed a dramatic increase in both the number of liver transplants and the number of centers engaged in orthotopic liver transplantation (OLT). OLT is unique in that the recipients undergo a substantial hemodynamic challenge during surgery，which is reflected in the complications and postoperative course. In the early stage of OLT，the use of veno-venous bypass (v-v bypass) offset the immature surgical techniques，and it was advocated as aimed of facilitating hemodynamic stability during the anhepatic phase (Rossi et al.，1998). In 1987，31 of 35 liver transplant centers in North America used some variation of v-v bypass in adult OLT (Wall et al.，1987). However，v-v bypass，a two-edged knife，it can also lead to larger amount of blood loss in operation and longer operation time. V-v bypass was adopted in many Chinese liver transplantation centers. Since 1999，we have successfully performed 76 orthotopic liver transplantations (OLT)；the early 43 cases with v-v bypass (group with v-v bypass) and the latter 33 cases without v-v bypass (group without v-v bypass). Here we report the experience of OLT with no v-v bypass and discuss its feasibility.

## CLINICAL DATA

Between January 1999 and December 2001，76 consecutive adult patients with end stage liver

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diseases underwent OLT in our transplant program. The ages of the recipients ranged from 26 to 56 years, with mean of 42 years. The early 43 patients underwent OLT by the classical technique with v-v bypass; while the recent 33 patients underwent OLT without v-v bypass. The primary diseases and United Network for Organ Sharing (UNOS) grade are shown in Table 1.

**Table 1 The primary diseases and UNOS grade in two groups of patients**

| | Group with v-v bypass(43cases) | Group without v-v bypass(33cases) |
|---|---|---|
| Sex | | |
| Male | 37 | 28 |
| Female | 6 | 5 |
| Mean age | 42.3 | 40.9 |
| Primary diseases | | |
| Benign end stage liver diseases | 21 | 18 |
| Liver neoplasms | 22 | 15 |
| UNOS grade | | |
| Grade I | 4 | 3 |
| Grade II | 37 | 30 |
| Grade III | 2 | 0 |
| Grade IV | 0 | 0 |

In the classical OLT group, bypass catheters were placed by cutdown in the femoral vein and axillary vein. A portal vein catheter was placed directly in the portal vein after it was divided for explanting the native liver. Vascular clamps were placed on the supra- and infrahepatic vena cava and v-v bypass was started as the recipient liver, together with the retrohepatic cava, was removed. A pump was used to pump portal and caval blood into the axillary vein through tubing. Donor graft harvest, graft trim, liver explant and graft implant were referred to our previous reports (Zheng et al., 2001). In the operation without v-v bypass, suprahepatic vena cava, infra hepatic vena cava and portal vein were directed occluded with vascular clamps. The femoral vein, axillary vein and portal vein catheters were cancelled. The other procedure was identical with those of classical OLT. The details of liver transplantation were recorded in detail, including operation time, anhepetic time, amount of blood loss, amount of blood transfusion, hemodynamic data (CVP, PAWP), urine output, etc. After the operation, patients were transferred to ICU, where they received standard management and were carefully followed to collect data on renal function parameters, gastrointestinal function parameters and ICU stay days.

Triple immunotherapy was given with cyclosporin (CsA) or tacrolimus (FK506), azathioprin (Aza) or mycophenolate mofetil (MMF); steroids were given posttransplantation and some patients might change the immunosuppressants or use dual immunotherapy.

Measures were taken to prevent infection of bacteria, fungi and viruses. Organ functions including heart, lung, kidney and gastrointestinal tract were supervised.

## RESULTS

The 33 consecutive cases without v-v bypass were safe and stable. During the period of vascular occlusion, heartbeat, blood pressure, CVP, PAWP were stable after rapid liquid infusion and administration of epinephrine. In the anhepatic phase, 30 patients had no urine output but the other 3 had. The urine amount of the 3 patients was 40 ml, 60 ml and 40 ml respectively. In 0－20 minutes (mean 12 minutes) after liver reperfusion, all the 33 patients had urine output

. In the anhepatic phase, congestion, edema, distension and petechia was observed in the bowel, and gradually disappeared after liver reperfusion. The oozing of blood during operation on patients without v-v bypass significantly decreased compared with patients with v-v bypass. The patients without v-v bypass had no operation-related complication. Renal function and GI function recovered in 3 – 4 d after operation. The in operation and after operation clinical data of two groups are summarized in Table 2. The hospital mortality rate was 16.3% in group with v-v bypass, and 3.0% in group without v-v bypass.

**Table 2 Comparison between groups with and without v-v bypass**

| | Group with v-v bypass(43cases) | Group without v-v bypass(33 cases) | *P* value |
|---|---|---|---|
| Operation time(h) | 8.6±2.1 | 5.7±1.5 | <0.05 |
| Anhepatic time(min) | 82±15 | 64±13 | <0.05 |
| Blood loss in operation(mL) | 6800±1010 | 4000±820 | <0.05 |
| Blood transfusion in operation(mL) | 7200±1200 | 4650±910 | <0.05 |
| Creatinine value on POD 3(umol/L) | 98±16 | 87±11 | >0.05 |
| Gas discharge time(d) | 3.3±0.2 | 3.2±0.2 | >0.05 |
| ICU stay(d) | 15.7±1.3 | 5.7±0.6 | <0.05 |

## DISCUSSION

The necessity of v-v bypass in OLT is controversial. OLT produces major intraoperative hemodynamic and physiologic alterations due to occlusion of the portal vein and vena cava during the anhepatic period. v-v bypass was developed to avoid these undesirable effects. However, iatrogenic complications have been described with the use of v-v bypass. Lymphocele and hematoma were the most common complications; patients having major vascular injury, air embolism, or dying were reported (Chari et al., 1998). Moreover heparin was needed in v-v bypass, which resulted in coagulation disorders and more blood loss during operation. Therefore, attempts have been made to develop other surgical techniques. Original techniques of hepatectomy with IVC preservation had been developed, such as piggyback technique, which reduced the need for v-v bypass (Reddy et al., 2000). Some reports suggested that safe OLT can be accomplished without v-v bypass even in classical OLT (Kuo et al., 1995). In 1987, Wall et al. (1987) reported 50 cases of OLT without use of v-v bypass, in which systolic blood pressure decreased by 21%, cardiac output decreased by 52%, and there was a doubling of the systemic vascular resistance. The hemodynamic alternations promptly returned to proclamping level after hepatic revascularization. Nevertheless, In China a safe method of v-v bypass remained an appealing and attractive concept.

On the basis of our experience on OLT with v-v bypass and with better surgical skills in liver and vascular surgery in the past years, we did not adopt v-v bypass in 33 consecutive liver transplant patients. The results suggested that liver transplantation with no v-v bypass is associated with shorter total operation time, lower blood product usage, and shorter ICU stay compared with standard technique of OLT with routine use of v-v bypass. The patients without v-v bypass had benefits of shorter hospital stay and less cost. The patients without v-v bypass had no more incidence of renal dysfunction than the patients with v-v bypass. OLT with no v-v bypass is safe and can be performed in the majority of adult patients. Some patients acquired renal dysfunction in operation or just after operation, which resulted from kidney congestion due to occlusion of IVC. Generally, renal function returned to normal on POD 3 (postoperation day). v-v bypass support is not associated with any

clear benefit in renal function (Grande et al., 1996). The occlusion time was limited to within 90 minutes in our patients; and the longest occlusion time still remains to be further studied.

However, we do not advocate that all OLT be performed without v-v bypass. Patients without lung, cardiac and renal dysfunction can well tolerate the vascular occlusion, and can choose OLT without v-v bypass . V-v bypass was recommended in patients with lung, cardiac and renal dysfunction to maintain hemodynamic stability during the anhepatic phase and to guarantee safe operation. OLT without v-v bypass can be performed in portal hypertension patients because the enlarged portosystemic collaterals maintained hemodynamic stability when the portal vein was occluded. In addition, cirrhotic patients commonly have higher cardiac output and lower systemic vascular resistance than patients without liver diseases. This cardiovascular function anomaly may make the cirrhotic patients tolerate better reduction of cardiac output. In our group, three severe portal hypertension patients had urine output and manifested lower degree of intestinal congestion. Several studies suggested selective use of v-v bypass depending on clamping test during operation (Johnson et al., 1996). Decrease of blood pressure and cardiac output during clamping of the suprahepatic vena cava and infrahepatic vena cava indicate necessity for the use of v-v bypass. The criterion for using the bypass was the inability to maintain a systolic blood pressure greater than 100 mm Hg during infrahepatic vena cava and portal venous clamping (Kuo et al., 1995). In our group, 33 consecutive OLT operation without v-v bypass were all successful. It is safe and practicable for adults to undergo OLT without v-v bypass. The factor determining the choice of v-v bypass was preoperative evaluation of lung and cardiac function. The clamping test during operation is not necessary in all patients. In the beginning stage of performing OLT, v-v bypass should be routinely used due to lack of experience in anesthetic and surgical techniques.

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