

Surgical outcomes of hepatocellular carcinoma invading hepatocaval confluence

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BACKGROUND: Combined liver and inferior vena cava (IVC) resection followed by IVC and/or hepatic vein reconstruction (HVR) is a curative operation for selected patients with hepatocellular carcinoma (HCC) invading the hepatocaval confluence. The present study aimed to elucidate the prognostic factors for patients with HCC invading the hepatocaval confluence.

METHODS: Forty-two consecutive patients underwent hepatectomy, combined with IVC replacement and/or HVR for HCC between January 2009 and December 2014 were included in this study. The cases were divided into three groups based on the surgical approaches of HVR: group 1 ($n=13$), tumor invaded the hepatocaval confluence but with one or two hepatic veins intact in the residual liver, thus only the replacement of IVC, not HVR; group 2 ($n=23$), the hepatic vein of the residual liver was also partially invaded, and the hepatic vein defect was repaired with patches locally; group 3 ($n=6$), three hepatic veins at the hepatocaval confluence were infiltrated, and the hepatic vein remnant was re-implanted onto the side of the tube graft. The patient characteristics, intra- and postoperative results, and long-term overall survival were compared among the three groups. The survival-related factors were analyzed by univariate and multivariate analysis.

RESULTS: The group 1 had higher preoperative alpha-fetoprotein level ($P<0.001$), shorter operation time, hepatic ischemic time and hospital stay compared with groups 2 and 3 ($P<0.05$). The 1-, 3-, and 4-year overall survival rates of group 1 were 84.6%, 23.1% and 23.1%, respectively; group 2 were 78.3%, 8.7% and 8.7% respectively and group 3 were 83.3%, 0 and 0,

respectively. The multivariate analysis showed that the independent poor prognostic factors of overall survival were preoperative higher HBV DNA level ($\geq 10^3$ copies/mL; $P=0.001$), tumor size (≥ 9 cm; $P<0.0001$), age (≥ 60 years; $P=0.010$) and underwent HVR ($P<0.0001$).

CONCLUSIONS: Patients with reconstructing hepatic vein with patches locally (group 2) or to the artificial graft (group 3) had worse long-term survival than those without HVR (group 1). HVR was one of the unfavorable prognostic factors of overall survival.

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KEY WORDS: hepatocellular carcinoma; inferior vena cava; hepatic vein; reconstruction

Introduction

When liver malignancy such as hepatocellular carcinoma (HCC) involves the major vessels including inferior vena cava (IVC) and hepatic veins adjacent to its caval confluence, combined liver and IVC resection followed by IVC and/or hepatic outflow reconstruction is a primary modality of care. A variety of surgical techniques are employed in the process of hepatectomy, vascular exclusion and vascular reconstruction. Total vascular exclusion (TVE) is the basic blood control technique which makes the procedure performed on IVC possible. If TVE is applied longer than 60 minutes, hypothermic hepatic perfusion may be necessary to acquire an extended period of time and protect the remnant liver.^[1] Venovenous bypass (VVB) is needed in some TVE patients, especially when *in situ* perfusion technique is used.^[2, 3] Although it is technically challenging, we believe that combined liver and IVC resection followed by IVC and/or hepatic outflow reconstruction with synthetic or autogenous grafts is the only radical treatment that may achieve complete tumor extirpation, which offers new chances for R0 resection in otherwise unresectable cases.^[4-6]

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Undoubtedly, the patency of hepatic outflow was significant for the remnant liver function after hepatectomy and IVC replacement. If the hepatic vein of the residual liver was involved by the tumor, hepatic vein reconstruction (HVR) is necessary and meaningful. Different materials including allograft patches, autogenous vein patches, Dacron patches, ePTFE (expanded polytetrafluoroethylene) patches can be applied to reconstruct the hepatic vein. The present study evaluated the outcomes of different surgical approaches. We also investigated the factors associated with overall survival of patients underwent IVC replacement and/or HVR.

Methods

Patients

We reviewed the prospectively collected data of 42 consecutive patients with HCC between January 2009 and December 2014 from a liver neoplasm database compiled by the West China Hospital, Sichuan University. The HCC diagnosis was confirmed by histology. The cases that the IVC could be sutured primarily or repaired with patches were not included in this study. Patients with R1 resection were excluded. Patients with extrahepatic diseases or other hepatic diseases were excluded. The cases were divided into three groups based on the surgical approach of HVR: group 1 ($n=13$), tumor invaded the hepatocaval confluence but one or two hepatic veins were not involved in the residual liver and it was not necessary to reconstruct the hepatic outflow; group 2 ($n=23$), tumor invasion was extended to the hepatocaval confluence of the residual liver, and the hepatic vein defect could be repaired with ePTFE patches ($n=9$) or autogenous vein patches ($n=14$); group 3 ($n=6$), tumor was extended to the hepatocaval confluence of the residual liver, the hepatic vein has to be reconstructed with the artificial blood vessel to replace IVC (Fig. 1). The patient characteristics, surgical procedures, postoperative morbidity and mortality, and the long-term prognosis were compared among the three groups. This study was approved by the Ethical Committee of our hospital.

Preoperative management

The hepatic vascular ultrasonography, contrast-enhanced thoracic, abdominal and pelvic computed tomography (CT) and/or magnetic resonance imaging (MRI) were performed to evaluate the degree of IVC involvement and to exclude intrahepatic or extrahepatic disseminated disease. Liver function met the criteria for surgery: Child-Pugh grade A or indocyanine green retention rate at 15 minutes (ICGR15) below 10%. Preoperative portal vein embolization (PVE) was done when the

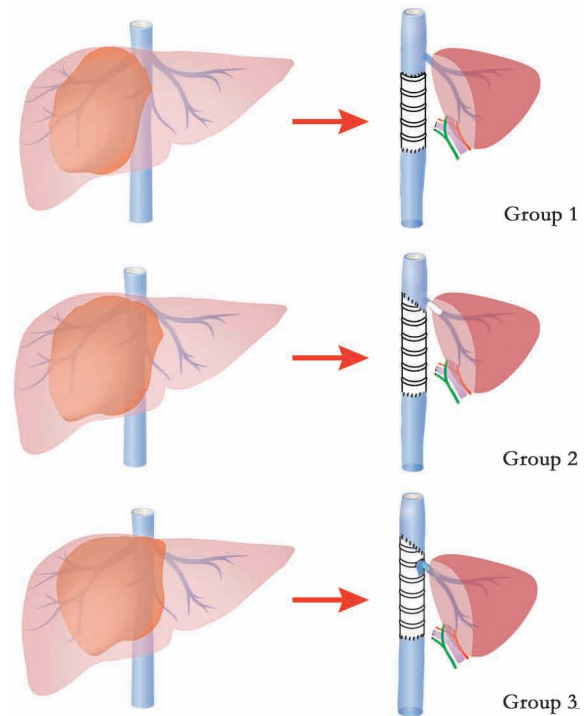


Fig. 1. Group 1, tumor invaded the hepatocaval confluence and the hepatic vein of the residual liver is intact, thus only performing IVC replacement without HVR; group 2, the hepatic vein of the residual liver was also partially invaded, and plasty of the hepatic vein was performed with patches; group 3, three hepatic veins at the hepatocaval confluence were invaded, and the hepatic vein remnant was re-implanted onto the side of the tube graft.

anticipated liver remnant after hepatectomy was less than 50% of functional liver volume. The side of the future residual liver was drained endoscopically or percutaneously in patients with severe obstructive jaundice. Cardiopulmonary and renal function were assessed carefully to exclude the patients with contraindications for surgery. Given the high risk of the surgery and some severe complications such as liver failure and graft infection may happen postoperatively, we conducted the interventions with the consent of patients and their families.

Surgical procedures

Hepatectomy

Right and left (if necessary) subcostal incision with a midline extension was the most commonly used incision. "J" shaped thoracoabdominal incision was available if the right diaphragm was infiltrated by the lesions. With the cutting line confirmed by the intraoperative ultrasonography, we divided and ligated the portal pedicles of the resected side and encircled the preserved side for latter exclusion. The infra- and supra-hepatic IVC were exposed and encircled with two tourniquets (the right adrenal vein was usually ligated). Then we detached the IVC from the liver if possible. Anterior approach is advo-

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