



Case Report

In vivo Right Hepatectomy and its Autotransplantation with Inferior Vena Cava Replacement for Conventionally Unresectable Intrahepatic Cholangiocarcinoma: A Case Report

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Citation: Kim SH, Moon DB (2022) *In vivo* Right Hepatectomy and its Autotransplantation with Inferior Vena Cava Replacement for Conventionally Unresectable Intrahepatic Cholangiocarcinoma: A Case Report. J Surg 7: 1545. DOI: 10.29011/2575-9760.001545

Received Date: 04 August, 2022; **Accepted Date:** 10 August, 2022; **Published Date:** 12 August, 2022

Abstract

Background: The large and centrally located intrahepatic cholangiocarcinoma (iCCA) that invades the Inferior Vena Cava (IVC), Hepatic Vein (HV) confluence, or hepatic hilum, is considered unresectable. We report a novel surgical technique for complete removal of conventionally unresectable iCCA.

Case Presentation: A 54-year-old woman patient presented to the hospital with generalized weakness and jaundice. Computed tomography and magnetic resonance cholangiography showed significantly dilated posterior intrahepatic ducts and a solitary at the caudate lobe extending to the hepatic hilum measuring 4.4 cm in diameter, with involvement of the second-order branches of bile ducts and portal veins, the middle and left hepatic arteries, and the confluence of left HV and IVC, consistent with iCCA. We performed an *in vivo* tumor-free extended right liver resection, and en bloc total hepatectomy of remnant liver including the tumor in caudate lobe and IVC. After IVC replacement with a Hemashield graft, the extended right liver graft was autotransplanted using the piggyback technique. The patient was discharged on postoperative day 23 without complications. Four months after surgery, computed tomography detected graft congestion and stenosis of the right posterior Portal Vein (PV) and right HV, which were treated with PV and right HV stent insertion.

Conclusions: For conventionally unresectable iCCA involving the confluence of the left HV and IVC, *in vivo* right sided hepatectomy and autotransplantation, with retrohepatic IVC replacement using a synthetic graft can provide complete surgical removal and low perioperative mortality.

Keywords: Autotransplantation; Intrahepatic cholangiocarcinoma; *In-vivo* resection; IVC replacement

Abbreviations: CT: Computed Tomography; HA: Hepatic Artery; HV: Hepatic Vein; iCCA: intrahepatic Cholangiocarcinoma; IVC: Inferior Vena Cava; PV: Portal Vein; TVE: Total Vascular Exclusion

Introduction

The incidence and mortality of intrahepatic Cholangiocarcinoma (iCCA) are increasing worldwide [1]. Patients with iCCA often have a long asymptomatic period, which makes early diagnosis difficult. Therefore, most patients with advanced iCCA at diagnosis are unable to undergo curative-intent surgery [2,3]. If an unresectable iCCA is left untreated, the median overall survival of patients is < 5 months [4]. The large and centrally located iCCA that invades the Inferior Vena Cava (IVC), Hepatic Vein (HV) confluence, or hepatic hilum, is considered unresectable. However, *in vivo* hepatectomy and autotransplantation with retrohepatic IVC replacement can provide complete surgical removal and a wide surgical field that allows complex

vascular reconstruction to be performed easily. Herein, we report the case of a patient of conventionally unresectable iCCA in the caudate lobe with good perioperative outcomes after *in vivo* liver resection and en bloc total hepatectomy, under Total Vascular Exclusion (TVE) and venovenous bypass, followed by IVC replacement using a Hemasheild graft and autotransplantation.

Case Presentation

This study was approved by the Institutional Review Board of Asan Medical Center, which waived the requirement for informed consent due to the retrospective nature of this study (IRB No. 2022-0623), and was conducted in accordance with the ethical guidelines of the World Medical Association Declaration of Helsinki 2013. A 54-year-old woman patient with a history of hepatitis B presented our department with generalized weakness and jaundice. Computed Tomography (CT) and magnetic resonance cholangiography showed significantly dilated posterior intrahepatic ducts and a solitary at the caudate lobe extending to the hepatic hilum measuring 4.4 cm in diameter (Figure 1A).

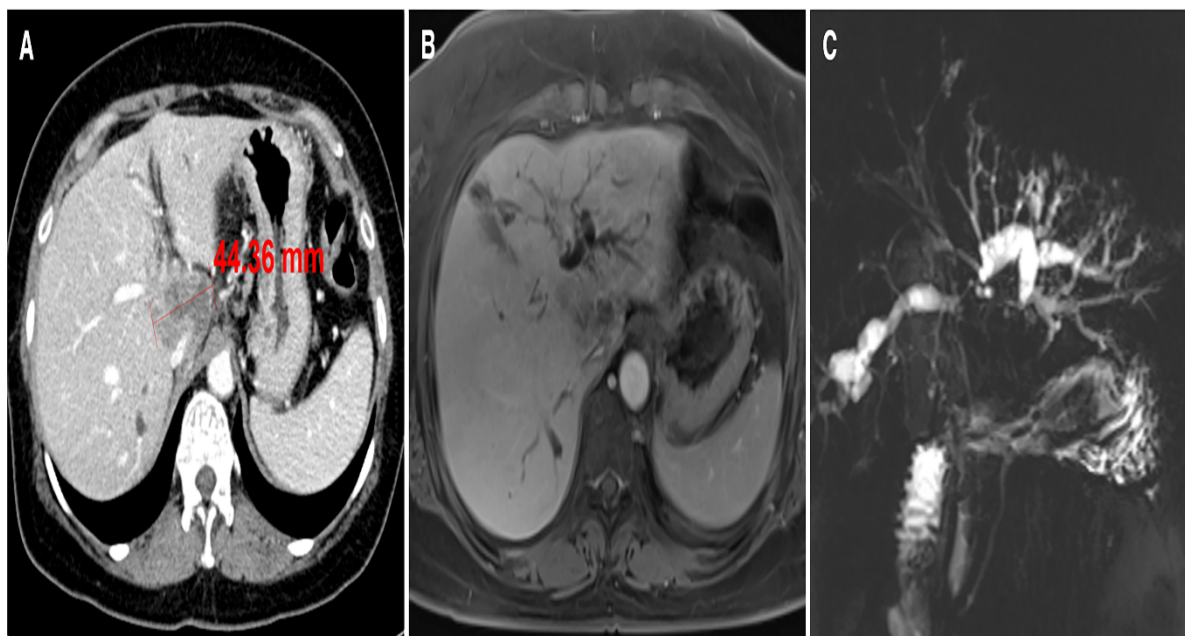


Figure 1: Preoperative images. Computed tomography showing a 4.4 cm solitary tumor in the caudate lobe extending to the hepatic hilum (a). Magnetic resonance cholangiography revealing severe dilatation of bilateral intrahepatic ducts (b) and cancer invasion to the second order branches of both bile ducts (c).

There was invasion of tumor including the second-order branches of Portal Veins (PVs) and bile ducts, the confluence of the left HV and IVC, and the middle and left Hepatic Arteries (HAs) (Figure 1B and 1C). The features of the tumor were consistent with those of iCCA. Surgical resection was planned with *in vivo* right sided liver resection followed by autotransplantation with retrohepatic IVC replacement using a Hemashield graft in consideration of patient's age and good general health.

During laparotomy, dissection of HA was proceeded from the left to the right along with the full course of the gastroduodenal artery. The retrohepatic IVC was mobilized, and the infrahepatic and suprahepatic IVC were isolated. The common bile duct was divided at the suprapancreatic level, and the suprarenal and retropancreatic lymph nodes were removed en bloc. Under the intermittent Pringle maneuver, an extended right hepatectomy was carried out using the clamp-crushing technique. The intrahepatic bile ducts in the right lobe were divided separately to obtain a tumor-free resection margin. Afterward the right HA was divided, and

the right anterior and posterior PVs were divided separately. Then the extended right lobe autograft was harvested *in vivo* and transferred to the bench surgery (Figure 2A), and en bloc hepatectomy of the remnant liver including caudate tumor and IVC (Figure 2B). The IVC replacement was carried out using a Hemashield graft. Two portal vein openings were combined into a single opening by anastomosis with a fresh cadaveric iliac vein Y-graft, and venoplasty for creating a large single orifice of the right and middle HVs using a fresh cadaveric iliac vein was performed in bench surgery (Figure 2C). In the graft implantation procedures, the extended right liver graft was autotransplanted using the piggyback technique, and the reconstructed a single orifice of the right and middle HVs was anastomosed to the artificial IVC graft. PV anastomosis was performed and the autograft was reperfed. The HA flow was restored by anastomosis between RHA of autograft and the gastroduodenal artery under a microscope. Intraoperative Doppler sonography showed that all vascular structures were patent. Roux-en-Y loop hepaticojejunostomy was performed for the 3 separated bile ducts anastomoses.

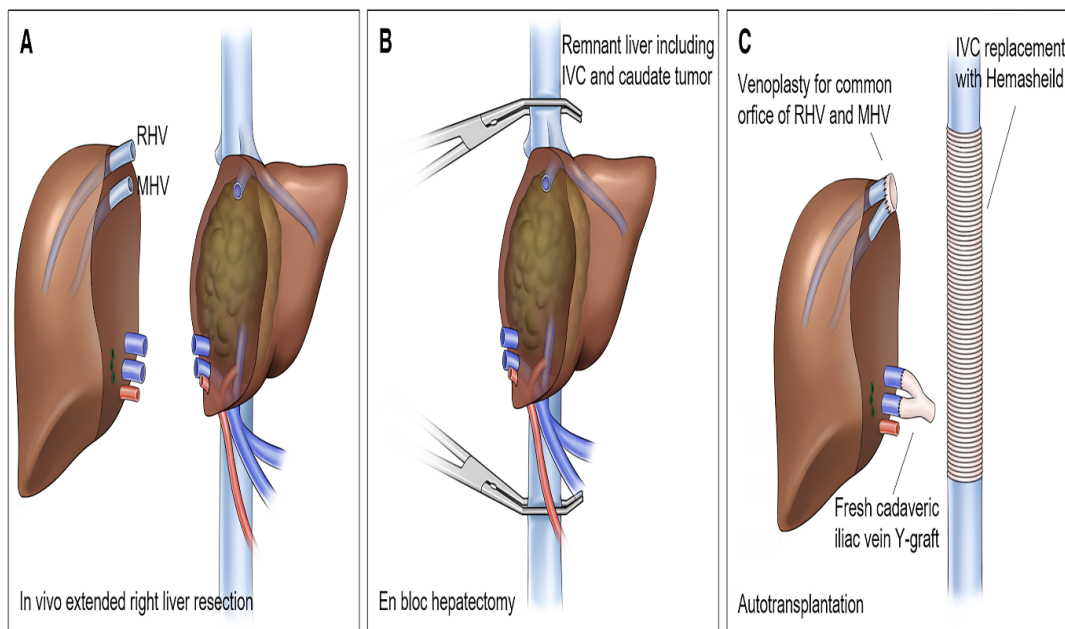


Figure 2: Schematic illustration of the surgical procedure. An extended right lobe autograft was harvested *in vivo* and transferred to the back table (a). En bloc hepatectomy of the remnant liver including caudate tumor and inferior vena cava (b). Autotransplantation and inferior vena cava replacement with the Hemashield graft (c). Two portal vein openings were combined into a single opening by anastomosis with a cadaveric iliac vein Y-graft, and venoplasty for creating a single orifice of the right and middle hepatic veins using a cadaveric iliac vein was performed in bench surgery.

The cold ischemic time was 119 min. The total operation time was 900 min, and six units of red blood cells transfusion were required during operation. Pathology revealed that mass-forming iCCA invaded both the hepatic hilum and retrohepatic IVC, with LHV and metastatic lymph nodes; however, R0 resection was achieved. The patient was discharged without complications on postoperative day 23 (Figure 3A). However, 4 months after surgery, CT detected graft congestion and stenosis of the right posterior PV and right HV (Figure 3B). These were treated with PV and right HV stent insertion and the patency of vascular structures was maintained (Figure 3C). At the 20 months follow-up visit, peritoneal carcinomatosis and a liver abscess were identified in the CT scan, and the patient died 24 months after the surgery.

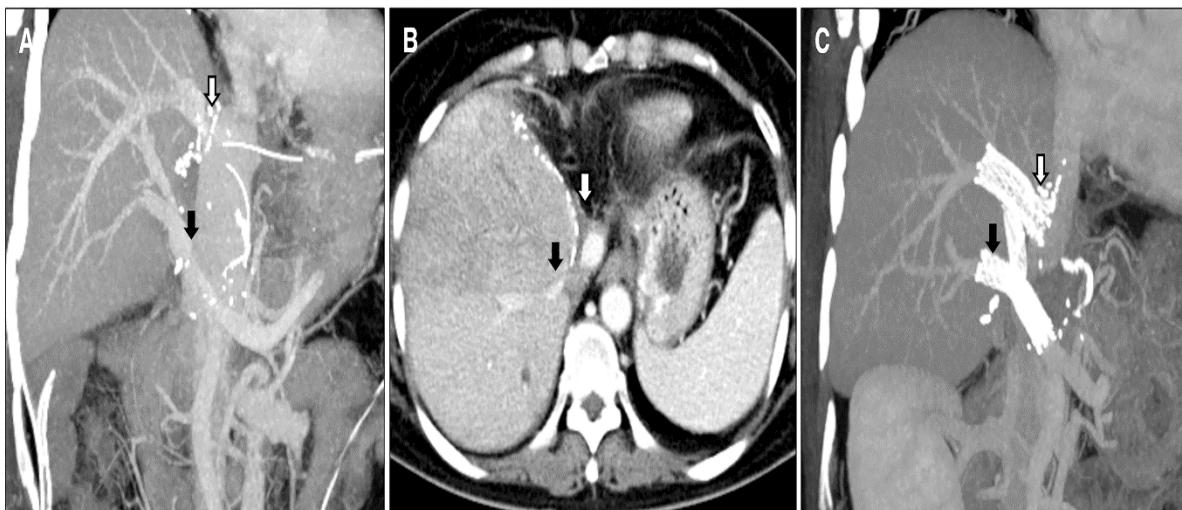


Figure 3: Postoperative computed tomography images. Seven days after surgery, patent portal veins reconstructed using a cadaveric iliac vein Y-graft (black arrow) and the outflow of the reconstructed hepatic veins to the inferior vena cava (white arrow) were showed (a). At 4 months follow-up, graft congestion and stenosis of the right posterior portal vein (black arrow) and right hepatic vein (white arrow) were identified (b). After stent insertion of both portal veins (black arrow) and right hepatic vein (white arrow), the patency of vascular structures was shown (c).

Discussion

During the recent years, with advances in perioperative management and surgical techniques, liver function and perioperative mortality have significantly improved. With the development and modification of various hepatic resection techniques, most hepatic tumors involving the IVC or the confluence of HVs can be removed using partial or total TVE, which involves continuous clamping of the portal triad and the infra- and suprahepatic IVC [5]. In addition, in situ liver resection under hypothermic perfusion allows the complete resection of tumors that invade the major vascular structures of the hilum, confluence of HVs, and retrohepatic IVC; and complex venous reconstruction under TVE, with preserved liver function after hepatectomy [6]. Hepatic outflow reconstruction with venoplasty technique [7], which was introduced for living donor liver transplantation, can be used to create enlarged orifices.

This report describes a case of successful R0 resection of a conventionally unresectable iCCA occupying the caudate lobe by en bloc hepatectomy and autotransplantation after *in vivo* procurement of autograft. The tumor involved major vascular and biliary structures, including the retrohepatic IVC, trunk of the middle and left HV, bifurcation of the PV, left HA and proximal right HA, and the hilar bile duct. Among all the major vascular structures, only the right HV was intact. A significantly complicated operation was expected if *ex vivo* liver resection after total hepatectomy was performed, requiring very long cold ischemic and anhepatic times. To overcome these problems, we decided to perform an *in vivo* extended right hepatectomy and en bloc total hepatectomy with IVC replacement, which has been reported as a novel surgical strategy for living donor liver transplantation to achieve long-term survival in HCCs located at the HV confluence and paracaval portion [8]. There

are several advantages of *in vivo* liver resection over *ex vivo* liver resection in this case. First, cold ischemic time of liver graft can be reduced because additional *ex vivo* resection is not required. Subsequently anhepatic time in the patient can be minimized even though long back-table operation time is necessary. Second, accurate anatomical resection is possible by obtaining precise demarcation line of resection. As a result, risk and amount of cut-surface bleeding from the implanted autograft can be reduced after reperfusion.

In our case, postoperative complications of the right posterior PV and right HV stenosis occurred, which were treated with stent insertion. Although various venous and prosthetic grafts are available for hepatic vascular reconstruction, unlike transplant patients taking immunosuppressants, patients who undergo hepatectomy may have early atrophy or occlusion of homologous venous grafts due to rejection [9]. If the stenosis of the portal vein, reconstructed using cadaveric fresh iliac vein Y-graft, cannot be resolved by stent insertion and is occluded, there may be a risk of complications such as pericholedochal varix formation, that can cause fatal bleeding [10]. Therefore, careful follow-up imaging tests over several months after the surgery are necessary for patients with homologous venous grafts for hepatic vascular reconstruction, to ensure that patency is maintained. If abnormal findings are found, active intervention is required.

In vivo extended right liver resection and autotransplantation with IVC replacement for iCCA in the caudate lobe, invading the retrohepatic IVC; confluence of the HV, PV, HA; and hilar bile duct can achieve complete tumor resection with low perioperative mortality. This surgical approach, with careful consideration of the prevention of postoperative vascular complications, is a realistic treatment option for conventionally unresectable iCCA.

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