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Case Report

Right hepatectomy for advanced hepatocellular carcinoma (cT4N0M0) with inferior vena cava invasion: challenges and curative surgical strategies

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ABSTRACT

Advanced hepatocellular carcinoma (HCC) with major vascular involvement remains a surgical challenge, particularly in cases classified as cT4N0M0. Inferior vena cava (IVC) invasion significantly increases operative complexity and perioperative risk. However, in selected patients with preserved liver function and adequate future liver remnant (FLR), curative-intent hepatectomy may still be considered. A 46-year-old male presenting with persistent right upper quadrant pain. Imaging studies including contrast-enhanced CT scan and three-phase whole abdominal CT demonstrated a right lobe liver mass consistent with malignant tumor, staged as cT4N0M0. Multidisciplinary evaluation was performed. FLR was 80%, and portal vein embolization was not indicated. The patient underwent open right hepatectomy with Pringle maneuver, right Glissonean pedicle ligation, and cholecystectomy. Intraoperatively, tumor involvement led to two ruptures of the IVC, which were managed with primary repair. Advanced HCC (cT4N0M0) with macrovascular invasion, including portal vein or IVC involvement, has traditionally been associated with poor prognosis; however, recent meta-analyses and nationwide cohort studies demonstrate that curative-intent liver resection can achieve meaningful survival benefits, with 1 and 3 year overall survival rates exceeding those of non-surgical therapy in carefully selected patients. Right hepatectomy with IVC repair can be performed safely in selected patients with advanced HCC (cT4N0M0) and sufficient FLR. Careful preoperative planning, multidisciplinary evaluation, and meticulous vascular control are critical to achieving curative resection in complex cases involving major vascular structures.

Keywords: Hepatocellular carcinoma, Right hepatectomy, Inferior vena cava invasion, Curative-intent surgery

INTRODUCTION

Hepatocellular carcinoma (HCC) is the most common primary liver malignancy and remains a leading cause of cancer-related mortality worldwide.[1] Despite advances in surveillance and imaging, many patients are still diagnosed at an advanced stage, frequently with macrovascular invasion, which significantly worsens prognosis.[2,3] Involvement of major vascular structures such as the IVC reflects aggressive tumor biology and is associated with high risks of intraoperative bleeding, tumor embolization, and postoperative liver failure.[3,4]

The Barcelona Clinic Liver Cancer staging system (BCLC) categorizes HCC with major vascular invasion as advanced-stage disease and recommends systemic therapy as standard treatment.[2] However, accumulating evidence over the past five years suggests that surgical resection may offer superior survival in carefully selected patients with preserved liver function, limited extrahepatic spread, and technically resectable disease.[3,6] Improvements in anesthetic management, vascular exclusion techniques, intraoperative ultrasonography, and perioperative critical care have contributed to expanding surgical indications in specialized hepatobiliary centers.

Right hepatectomy for advanced HCC (cT4N0M0) with IVC invasion remains technically demanding. Achieving R0 resection may require complex vascular control strategies, including total hepatic vascular exclusion, IVC clamping, or thrombectomy, while maintaining hemodynamic stability.[4,5] Accurate preoperative assessment of future liver remnant (FLR), portal hypertension, and liver functional reserve is essential to minimize postoperative liver failure.[6] In selected patients, aggressive surgical management has demonstrated meaningful long-term survival compared with non-surgical therapies.[3,6]

This case report describes a patient with advanced HCC (cT4N0M0) involving the IVC who underwent right hepatectomy with curative intent. We emphasize the preoperative evaluation, intraoperative vascular strategies, and multidisciplinary considerations that enabled safe resection and potential oncologic benefit in a condition traditionally considered unsuitable for surgery.

CASE REPORT

A 46-year-old male was referred with persistent right upper quadrant abdominal pain unresponsive to symptomatic treatment. Physical examination revealed a palpable 5 × 5 cm firm mass in the right upper quadrant. Laboratory evaluation showed HbsAg reactive status, elevated SGOT level of 196 U/L, and alpha-fetoprotein (AFP) >400.00 ng/mL. Liver function assessment revealed a Child-Pugh score of 5, consistent with Class A (least severe liver disease), with no encephalopathy, no ascites, total bilirubin <2 mg/dL, prothrombin time prolongation <4 seconds, and INR <1.7. Abdominal ultrasonography demonstrated hepatomegaly and a 0.5 cm gallstone within the gallbladder.

Figure 1 (A-C): Abdominal physical examination.

Initial contrast-enhanced CT scan performed at the referring hospital revealed hepatomegaly with heterogeneous liver density, sharp angles, and regular margins, without dilatation of the intrahepatic or extrahepatic bile ducts. A large heterodense nodule with necrotic areas measuring approximately 0.2×10.7×12.8 cm was identified in the right hepatic lobe involving segments VI and VII, demonstrating a typical wash-in and wash-out contrast enhancement pattern. Subsequent three-phase whole abdominal CT confirmed a right hepatic lobe mass consistent with advanced HCC. The patient was then diagnosed with hepatomegaly due to right lobe liver tumor suspicious for malignancy, staged as cT4N0M0. Following multidisciplinary evaluation, the patient underwent open right hepatectomy with cholecystectomy, repair IVC, and take specimen for pathology anatomy.

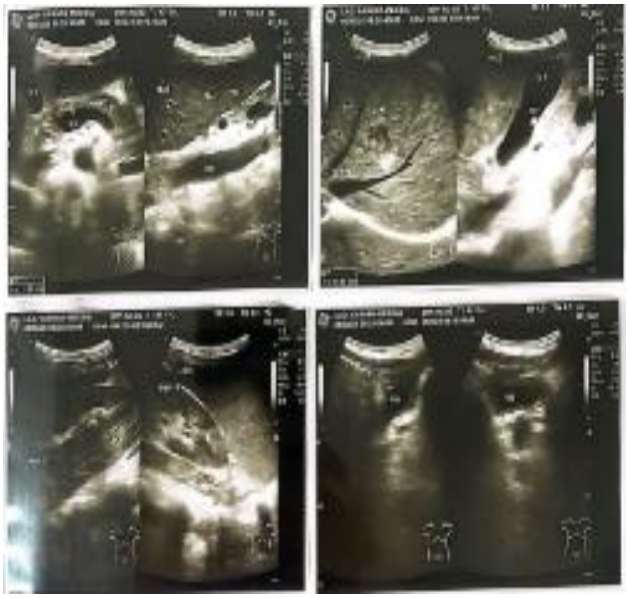

Figure 2: Abdominal ultrasonography demonstrated hepatomegaly and a 0.5 cm gallstone.

Figure 3: CT scan contrast demonstrated hepatomegaly with heterogeneous liver density, sharp angles, and regular margins, heterodense nodule with necrotic areas measuring approximately 0.2 × 10.7 × 12.8 cm was identified in the right hepatic lobe. demonstrating a typical wash-in and wash-out contrast (white arrow) enhancement pattern.

The surgery start with a J-shaped incision and dissection was carried out layer by layer until the peritoneum was identified and sharply opened. Intraoperative findings revealed a tumor mass in the right hepatic lobe with underlying liver cirrhosis. A cholecystectomy was performed, followed by the application of the Pringle maneuver to achieve vascular inflow control. The right glissonean pedicle was ligated, resulting in a visible color change to pallor in the right hepatic parenchyma, confirming adequate inflow control. Right hepatectomy

was then performed. During tumor resection, rupture of the IVC occurred at two sites; both were immediately managed with primary suturing, and bleeding was successfully controlled. The right hepatic vein was ligated, and the right Glissonean pedicle was secured using a stapling device. Final hemostasis was ensured before completion of the procedure.

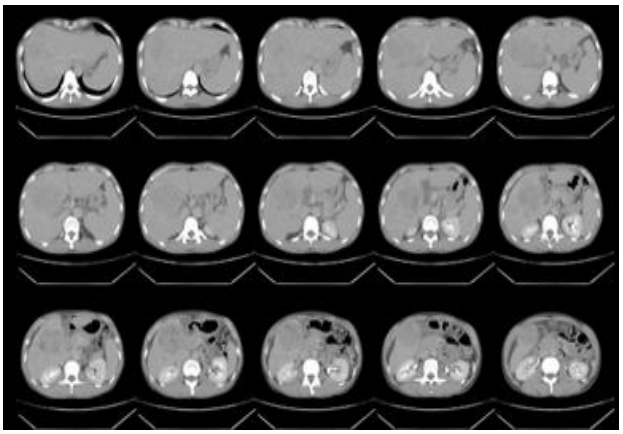

Figure 4: Subsequent three-phase whole abdominal CT showed a right hepatic lobe mass consistent with advanced HCC. The patient was then diagnosed with hepatomegaly due to right lobe liver tumor suspicious for malignancy.

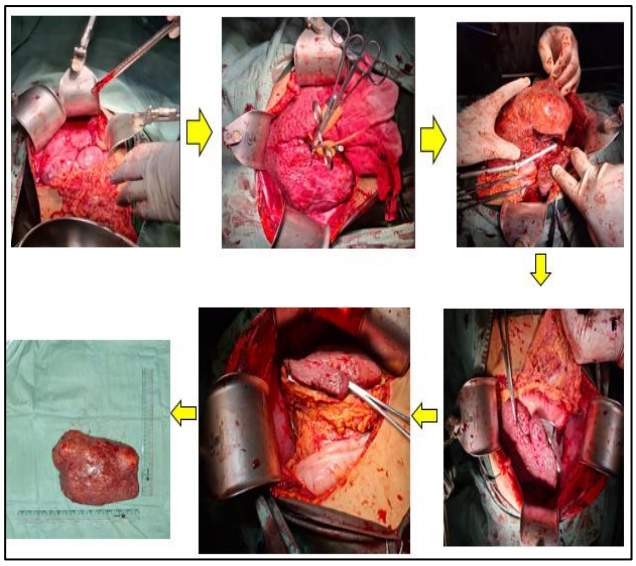

Figure 5: Surgery of open right hepatectomy with cholecystectomy and repair of IVC.

Histopathological examination of the surgical specimen, consisting of liver and gallbladder tissue, revealed a liver specimen measuring 18×14×8 cm with a firm and friable consistency. The accompanying gallbladder measured 8×3×2.5 cm. Microscopic evaluation of the liver demonstrated an epithelial, epithelioid tumor with predominantly solid-trabecular growth pattern and invasive features. The tumor cells resembled hepatocytes, appearing polygonal with eosinophilic cytoplasm, enlarged atypical nuclei, and coarse chromatin. These findings were consistent with hepatocellular carcinoma. Examination of the gallbladder showed features of chronic inflammation, including hyperplasia of the gallbladder wall, glandular hyperplasia, vascular dilatation, and infiltration of chronic inflammatory cells, without evidence of specific infection. The final pathological diagnosis was hepatocellular carcinoma of the liver and chronic glandular cholecystitis of the gallbladder.

Conclusion of this case presentation, the patient initially presented with prior imaging studies from an external facility, including abdominal ultrasound and CT scan. Based on these findings, liver function was assessed using the Child-Pugh score and staging was determined according to the Barcelona Clinic Liver Cancer (BCLC) classification. From the initial evaluation, the patient was planned for surgical resection and was referred to the radiology department for consideration of embolization. However, during a multidisciplinary conference, the radiology team determined that the external CT scan was not adequate to serve as a basis for clinical decision-making. Therefore, a repeat examination using a triple phase abdominal CT scan was performed for a more comprehensive evaluation, particularly to assess lesion characteristics, vascularization, possible vascular invasion, and more accurate staging. The results of this reassessment demonstrated a change in the patient's BCLC classification, which subsequently impacted the management plan. Based on these findings, the radiology team concluded that embolization was not indicated, based on clinical and radiological considerations.

DISCUSSION

Advanced HCC (cT4N0M0) with macrovascular invasion, including portal vein or IVC involvement, has traditionally been associated with poor outcomes, but recent evidence suggests that surgical resection can improve survival in selected patients; a large meta-analysis including over 8,000 patients reported that those undergoing liver resection with curative intent demonstrated a 1-year overall survival of approximately 54.5% and a 3-year overall survival of about 23.2 %, outcomes that compare favorably with non-surgical systemic therapies in appropriately selected cases, indicating that aggressive surgery may be justified in advanced disease when liver function and resectability criteria are met.[7] Advanced HCC with invasion into the IVC represents a biologically aggressive form of disease that carries a poor untreated prognosis, but evidence from a large multicenter surgical cohort shows that hepatectomy with tumor thrombus removal can achieve measurable survival outcomes in selected patients (median survival ~2.47 years for lower-level thrombi) by directly removing both the primary tumor and vascular extension, which systemic therapies alone cannot reliably accomplish.[8]

Recent evidence within the last five years further supports an aggressive surgical approach in selected patients with HCC and macrovascular invasion. Surgical resection offers the only potentially curative option in this context because it can eliminate the mechanical obstruction and hemodynamic risks associated with IVC tumor thrombi such as pulmonary embolism and right sided heart failure hereby reducing life-threatening complications.[9] A large contemporary meta analysis including more than 8,000 patients demonstrated that liver resection for HCC with macrovascular invasion was associated with meaningful median overall survival of approximately 14.4 months and significant 1 and 3 year survival benefits compared with non-surgical management, supporting surgery in carefully selected candidates.[10] Similarly, a nationwide cohort study evaluating surgical resection in HCC patients with portal vein invasion confirmed significant overall survival improvement in resected patients with preserved liver function, reinforcing the role of surgery beyond traditional BCLC-C contraindications.[11] Furthermore, recent multicenter data indicate that systemic therapy followed by conversion hepatectomy may further improve prognosis in HCC with macrovascular invasion, suggesting that multimodal strategies can expand surgical eligibility and enhance long-term survival outcomes.[12]

A 2022 prognostic analysis also reported that selected patients undergoing resection after tumor downstaging achieved encouraging survival results, highlighting the importance of individualized multidisciplinary planning.[13] In technically advanced cases, staged surgical techniques such as ALPPS have been explored for patients with insufficient future liver remnant and macrovascular invasion, demonstrating feasibility and acceptable perioperative outcomes in specialized centers.[14] Additionally, recent retrospective analyses emphasize that pathological factors such as microvascular invasion significantly influence post hepatectomy prognosis in patients with portal vein tumor thrombus, underscoring the need for careful risk stratification even after curative-intent surgery.[15]

Collectively, these contemporary studies reinforce that macrovascular invasion including portal vein or IVC involvement should not be considered an absolute contraindication to surgery. Instead, in patients with preserved liver function and technically resectable disease, hepatic resection either upfront or following conversion therapy may provide the most favorable opportunity for long-term oncologic control compared with systemic therapy alone.

CONCLUSION

Right hepatectomy with IVC repair is feasible in selected patients with advanced HCC (cT4N0M0) and adequate future liver remnant. Careful preoperative assessment, multidisciplinary planning, and meticulous intraoperative vascular control are essential to minimize complications. Curative-intent resection may still provide meaningful oncologic benefit despite major vascular involvement.

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