

Original Article: Liver Cancer Surgery Technique



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ABSTRACT

The surgical management of liver cancer encompasses a diverse array of techniques aimed at achieving optimal tumor resection while preserving functional liver tissue. This abstract provides an overview of the various surgical approaches employed in liver cancer surgery. Open surgery, the traditional approach, involves meticulous dissection and resection of liver tumors, offering comprehensive tumor clearance and vascular control. Minimally invasive techniques, including laparoscopic and robotic-assisted surgery, provide enhanced precision and reduced postoperative morbidity. Endoscopic surgery offers a minimally invasive option for early-stage liver cancers, minimizing invasiveness and promoting rapid recovery. Specialized techniques such as cytoreductive surgery and hyperthermic intraperitoneal chemotherapy (HIPEC) play a crucial role in the management of advanced or recurrent liver cancers. Advances in surgical techniques, perioperative care, and patient selection continue to improve outcomes and expand the surgical armamentarium for liver cancer treatment. This abstract highlight the evolving landscape of liver cancer surgery and underscores the importance of a multidisciplinary approach in achieving optimal outcomes for patients with liver malignancies.

Introduction

Liver cancer surgery, encompassing various surgical techniques, stands at the forefront of treatment for hepatocellular carcinoma (HCC) and other liver malignancies. As a primary or metastatic cancer site, the liver presents unique challenges due to its complex anatomy and vital functions. Surgical intervention plays a pivotal role in the management of liver cancer, offering curative options for eligible patients and

palliative measures to improve quality of life[1]. Over the years, advancements in surgical techniques, perioperative care, and multidisciplinary approaches have significantly enhanced outcomes and expanded the treatment landscape for liver cancer[2]. Traditionally, liver cancer surgery has primarily involved two main approaches: resection and transplantation. Hepatic resection, or partial liver removal, aims to excise the tumor while preserving sufficient functional liver tissue. This approach is suitable for patients with localized

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disease and adequate liver function, offering the potential for cure. On the other hand, liver transplantation provides a curative option for select patients with unresectable tumors or underlying liver cirrhosis. It involves the removal of the diseased liver and replacement with a healthy donor liver, addressing both the tumor and the underlying liver disease[3].

In recent years, there has been a paradigm shift towards minimally invasive techniques in liver cancer surgery. Laparoscopic and robotic-assisted liver resections have gained popularity due to their advantages of reduced blood loss, shorter hospital stays, and quicker recovery times compared to traditional open surgery. These techniques offer precision and improved visualization, allowing surgeons to perform complex liver surgeries with smaller incisions and minimal disruption to surrounding tissues[4].

Moreover, advancements in surgical navigation, intraoperative imaging, and perioperative care have further refined liver cancer surgery techniques. Image-guided procedures, such as radiofrequency ablation (RFA) and microwave ablation (MWA), provide effective options for patients with small tumors or those deemed unsuitable for resection. Additionally, innovations in liver transplantation, including living donor transplantation and machine perfusion technologies, have expanded the donor pool and improved transplant outcomes[5-8].

As liver cancer surgery continues to evolve, ongoing research efforts focus on optimizing patient selection, refining surgical approaches, and integrating adjunctive therapies to improve long-term outcomes. The introduction of targeted therapies, immunotherapies, and locoregional treatments complements surgical interventions, offering personalized treatment strategies tailored to individual patient needs[9]. Through multidisciplinary collaboration and a patient-centered approach,

liver cancer surgery remains a cornerstone in the comprehensive management of liver malignancies, providing hope for improved survival and quality of life for patients worldwide[10].

Open surgery; Traditionally approach

Open liver surgery, with its enduring significance in the management of liver cancer, underscores the complex nature of hepatobiliary malignancies and the necessity for meticulous surgical approaches. The intricacies of liver anatomy, coupled with the potential for vascular and biliary involvement, necessitate the expertise and precision offered by open surgical techniques[11]. Despite the rise of minimally invasive methods, open liver surgery remains indispensable for cases requiring extensive tumor resection, vascular reconstruction, or liver transplantation[12].

The indications for open liver surgery encompass a broad spectrum of scenarios, ranging from large tumors that necessitate meticulous dissection to complex lesions situated in challenging anatomical locations. Intrahepatic cholangiocarcinoma (ICC), known for its propensity for vascular and biliary invasion, often demands open surgery for extensive resections to achieve complete tumor clearance[13]. Additionally, liver transplantation, as a curative option for patients with unresectable tumors or underlying liver cirrhosis, underscores the essential role of open surgery in achieving total hepatectomy and graft implantation[14].

Surgical techniques in open liver surgery are tailored to individual patient and tumor characteristics, with the overarching goal of achieving complete tumor resection while preserving functional liver tissue[15]. The diversity of procedures, from anatomical resections to vascular reconstructions, highlights the versatility and adaptability of open surgery in addressing a wide range of

clinical scenarios. Anatomical resections, in particular, ensure the meticulous removal of tumors along with corresponding liver segments and associated vascular and biliary structures, thus optimizing oncological outcomes[16].

Despite its efficacy, open liver surgery is not without risks, and complications may occur. Hemorrhage, liver failure, biliary complications, infection, and vascular and biliary injury are among the potential complications associated with this surgical approach[17]. However, advancements in surgical techniques, perioperative care, and patient selection have contributed to improved outcomes and reduced morbidity rates. Enhanced imaging modalities, intraoperative navigation techniques, and strategies to promote liver regeneration exemplify the ongoing efforts to optimize patient outcomes in open liver surgery[18].

In conclusion, open liver surgery remains a vital component in the multidisciplinary management of liver cancer, providing curative options for localized disease and palliative measures for advanced tumors. Its enduring significance underscores the complexity of hepatobiliary malignancies and the necessity for meticulous surgical approaches. With ongoing advancements in surgical techniques and perioperative care, open liver surgery continues to evolve, offering optimal oncological outcomes and improved quality of life for patients with liver malignancies[19].

Liver transplantation technique

Liver transplantation stands as a transformative treatment modality for patients with end-stage liver disease (ESLD) and select cases of hepatocellular carcinoma (HCC) and other liver malignancies. This intricate surgical procedure involves the removal of the recipient's diseased liver (total hepatectomy) and the transplantation of a healthy donor liver graft. Liver transplantation offers a curative option for patients with liver failure and unresectable

tumors, providing a chance for extended survival and improved quality of life[20].

Indications for liver transplantation in the context of liver cancer include HCC within established criteria, such as the Milan or UCSF criteria, which typically include single tumors ≤ 5 cm or up to three tumors ≤ 3 cm each, without macrovascular invasion or extrahepatic spread. Additionally, liver transplantation may be considered for intrahepatic cholangiocarcinoma (ICC) in highly selected cases with limited tumor burden and no evidence of vascular invasion or extrahepatic spread[21]. However, transplantation for cholangiocarcinoma remains controversial due to the risk of tumor recurrence and the scarcity of suitable donor organs. Liver transplantation may also be considered for other primary liver malignancies, such as fibrolamellar carcinoma or hepatoblastoma, in select cases where resection is not feasible or has failed[22].

The surgical technique of liver transplantation involves several key steps, beginning with donor organ procurement, recipient hepatectomy, vascular and biliary reconstruction, and graft implantation. Donor organ procurement entails retrieving a suitable donor liver from a deceased donor or, less commonly, from a living donor. The donor liver is then preserved and transported to the recipient center for implantation[23]. Recipient hepatectomy involves the meticulous removal of the recipient's diseased liver, ensuring preservation of critical vascular and biliary structures for subsequent graft implantation[24]. Vascular and biliary reconstruction is essential for ensuring adequate blood supply and biliary drainage of the graft, with techniques such as venous jump grafts or arterial conduits employed to overcome anatomical challenges or donor-recipient size disparities. Graft implantation completes the surgical procedure, with the healthy donor liver graft being connected to the recipient's vasculature and biliary system.

Careful hemostasis and closure of surgical incisions follow to ensure optimal postoperative recovery and graft function[25].

Liver transplantation offers favorable outcomes for appropriately selected patients with liver cancer, with high rates of long-term survival and disease-free survival reported in compliant patients meeting established criteria. However, liver transplantation is not without risks, and complications may occur, including graft rejection, infection, biliary complications, vascular complications, recurrence of cancer, and immunosuppression-related complications[26]. Despite these risks, advancements in surgical techniques and perioperative care have focused on improving patient outcomes, minimizing complications, and expanding transplantation criteria. These include living donor liver transplantation (LDLT), machine perfusion techniques, pretransplant bridging therapies, and personalized medicine approaches[27].

In conclusion, liver transplantation represents a transformative treatment modality for patients with liver cancer, offering a curative option for select cases of HCC, cholangiocarcinoma, and other liver malignancies. With ongoing advancements in surgical techniques, perioperative care, and donor organ utilization, liver transplantation continues to evolve, providing extended survival and improved quality of life for patients with end-stage liver disease and unresectable tumors[28].

Total hepatectomy technique

Total hepatectomy stands as a pivotal surgical procedure in liver transplantation and the management of liver malignancies, requiring meticulous planning, precise execution, and careful preservation of vascular and biliary structures[29]. This complex surgical technique involves the complete removal of the recipient's diseased liver and serves as a critical step in liver transplantation for end-stage liver disease

(ESLD) and select cases of hepatocellular carcinoma (HCC) and other liver malignancies. Total hepatectomy aims to remove the source of liver failure in ESLD patients and offers a curative option for patients with extensive tumor burden or unresectable tumors in the context of liver cancer[30].

Indications for total hepatectomy vary depending on the underlying pathology and patient characteristics. In the setting of liver transplantation, total hepatectomy is indicated for patients with ESLD due to cirrhosis, viral hepatitis, autoimmune liver disease, or metabolic liver disease who are candidates for liver transplantation. In cases of liver cancer, total hepatectomy may be indicated for patients with extensive tumor burden or unresectable tumors, particularly those within the Milan or UCSF criteria for transplantation[31]. Additionally, total hepatectomy may be considered in cases of acute liver failure or fulminant hepatic failure where urgent transplantation is warranted[32].

The surgical technique of total hepatectomy involves several key steps, beginning with meticulous dissection and mobilization of the liver within the abdominal cavity. The liver is carefully freed from surrounding structures, including the diaphragm, hepatic veins, portal vein, and inferior vena cava (IVC), to facilitate subsequent removal. Vascular control is essential during total hepatectomy to minimize blood loss and ensure patient safety. The hepatic artery, portal vein, and hepatic veins are individually identified, ligated, and divided to isolate the liver from the systemic circulation[33].

Once the liver is completely mobilized and vascular and biliary structures are controlled, total hepatectomy is performed using a combination of sharp dissection and electrocautery. The liver is carefully removed from the abdominal cavity, taking care to avoid injury to surrounding organs or structures[34].

Hemostasis is ensured, and the surgical field is thoroughly inspected to confirm complete removal of the liver. Biliary reconstruction is another critical aspect of total hepatectomy, particularly in cases where the entire biliary system is removed along with the liver[35].

Following total hepatectomy, the recipient's abdominal cavity is prepared for graft implantation. The native liver bed is inspected for hemostasis, and any residual tissue or debris is meticulously removed. The donor liver graft is then prepared for implantation, including flushing and preservation techniques to maintain graft viability. The graft is carefully positioned within the recipient's abdominal cavity, and vascular and biliary anastomoses are performed to restore blood flow and bile drainage[36].

Outcomes of total hepatectomy are generally favorable for appropriately selected patients, particularly in the context of liver transplantation. Studies have demonstrated high rates of graft survival and patient survival following total hepatectomy and liver transplantation, with 1-year and 5-year survival rates exceeding 80% and 70%, respectively, in compliant patients meeting transplantation criteria. However, total hepatectomy is not without risks, and complications may occur, including bleeding, infection, bile leaks, vascular injury, and postoperative liver failure[37].

Bleeding is a significant concern during total hepatectomy due to the rich vascularity of the liver. Meticulous hemostasis and vascular control are essential to minimize blood loss and prevent postoperative complications. Infection, including surgical site infections, bloodstream infections, or intra-abdominal abscesses, may occur postoperatively and require prompt intervention with antibiotics or drainage procedures. Bile leaks are another potential complication of total hepatectomy, particularly in cases where extensive biliary dissection is required. Biliary leaks may manifest as

abdominal pain, fever, or elevated liver enzymes and may necessitate endoscopic or surgical intervention to address[38].

Vascular injury, including injury to the hepatic artery, portal vein, or hepatic veins, may occur during total hepatectomy and require urgent intervention to salvage graft function or prevent catastrophic bleeding. Postoperative liver failure is a rare but serious complication of total hepatectomy, particularly in patients with compromised liver function or extensive resections. Liver failure may manifest as jaundice, coagulopathy, or hepatic encephalopathy and requires intensive care management to optimize patient outcomes[39].

Conclusion

In conclusion, total hepatectomy represents a critical surgical procedure in liver transplantation and the management of liver malignancies, offering a curative option for patients with end-stage liver disease and select cases of liver cancer. With meticulous surgical technique, careful patient selection, and multidisciplinary perioperative care, total hepatectomy can achieve favorable outcomes and improve survival and quality of life for patients with advanced liver disease. Ongoing advancements in surgical techniques, perioperative management, and postoperative care continue to enhance the safety and efficacy of total hepatectomy, further expanding its role in the treatment of liver pathology.

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