

Liver & Biliary Tumor Resection Protocol

Surgical Oncology Clinical Protocol

1. Scope & Purpose

This protocol provides a standardized approach for hepatic resection and biliary tumor surgery, encompassing hepatocellular carcinoma (HCC), intrahepatic cholangiocarcinoma (iCCA), perihilar cholangiocarcinoma (Klatskin tumor), distal cholangiocarcinoma, gallbladder carcinoma, and colorectal liver metastases (CRLM). It covers preoperative assessment, volumetric planning, operative technique, and postoperative management.

2. Preoperative Evaluation

2.1 Imaging

- Multiphasic CT (arterial, portal venous, delayed phases) or MRI with hepatobiliary-specific contrast (gadoxetate/Eovist)
- MRCP for biliary tumors — delineate biliary anatomy and extent of ductal involvement
- CT volumetry: calculate future liver remnant (FLR) as percentage of total liver volume (TLV) or total estimated liver volume (TELV)
- PET-CT for iCCA, gallbladder carcinoma, or suspected extrahepatic disease
- Chest CT for pulmonary staging

2.2 Laboratory Assessment

- CBC, CMP, INR/PT, albumin, total bilirubin, direct bilirubin
- Tumor markers: AFP (HCC), CA 19-9 (cholangiocarcinoma), CEA (CRLM)
- ICG clearance test (ICG-R15) when available — assess hepatic functional reserve
- MELD score calculation for cirrhotic patients
- Hepatitis B/C serology; liver fibrosis assessment (FibroScan, biopsy if indicated)

2.3 Functional Assessment & FLR Planning

Patient Population	Minimum FLR Threshold	Augmentation Strategy
Normal liver	≥ 20% standardized FLR	None — proceed to resection
Post-chemotherapy (steatosis/steatohepatitis)	≥ 30% sFLR	Portal vein embolization (PVE); reassess at 4–6 weeks
Cirrhosis (Child-Pugh A)	≥ 40% sFLR	PVE or ALPPS (selected cases); HCC within Milan — consider transplant

Patient Population	Minimum FLR Threshold	Augmentation Strategy
Cirrhosis (Child-Pugh B/C)	Generally not surgical candidates	Evaluate for transplant, locoregional therapy, or systemic therapy

- **Portal vein embolization (PVE):** Indicated when FLR is below threshold; reassess volumetry at 4–6 weeks; target $\geq 5\%$ hypertrophy or achievement of threshold
- **ALPPS (Associating Liver Partition and Portal Vein Ligation for Staged Hepatectomy):** For patients failing PVE or requiring rapid hypertrophy; high morbidity — restrict to experienced centers
- **Two-stage hepatectomy:** For bilobar CRLM — clear FLR of disease in stage 1, PVE, then completion hepatectomy

3. Tumor-Specific Surgical Considerations

3.1 Hepatocellular Carcinoma (HCC)

- Resection preferred for single tumor in non-cirrhotic liver or Child-Pugh A with adequate FLR
- Anatomic resection (segmentectomy or greater) provides better oncologic margins when feasible
- Transplant evaluation for Milan criteria (single ≤ 5 cm, or ≤ 3 tumors each ≤ 3 cm); consider bridging therapy
- Ablation (RFA/MWA) for tumors ≤ 3 cm not amenable to resection or as bridge to transplant
- TACE/TARE for unresectable, non-transplant candidates
- Margin target: ≥ 1 cm anatomic margin

3.2 Intrahepatic Cholangiocarcinoma (iCCA)

- Anatomic hepatectomy with portal lymphadenectomy (station 8, 12, 13)
- Margin target: ≥ 1 cm when possible; R0 is critical for survival
- Assess for satellite lesions (multifocal disease portends worse prognosis)
- Neoadjuvant therapy: gemcitabine/cisplatin for locally advanced; reassess resectability
- Adjuvant: capecitabine $\times 8$ cycles per BILCAP trial

3.3 Perihilar Cholangiocarcinoma (Klatskin Tumor)

Classify per Bismuth-Corlette system:

- Type I: below confluence — bile duct resection + lymphadenectomy
- Type II: involves confluence — extended bile duct resection + hepaticojejunostomy
- Type IIIa/IIIb: extends into right or left hepatic duct — hemihepatectomy + caudate lobectomy + bile duct resection + hepaticojejunostomy
- Type IV: bilateral extension — evaluate for transplant protocol (selected centers) vs. palliative management
- Caudate lobe resection (segment 1): include in all perihilar resections due to direct biliary drainage
- Preoperative biliary drainage of FLR side mandatory if obstructed

- PVE of resection side when FLR inadequate
- Portal lymphadenectomy: stations 8, 12, 13; minimum 6 nodes

3.4 Gallbladder Carcinoma

- **T1a:** Cholecystectomy is curative; ensure cystic duct margin negative
- **T1b:** Radical cholecystectomy (hepatic bed resection + portal lymphadenectomy); port-site excision if prior laparoscopic cholecystectomy
- **T2:** Radical cholecystectomy (segments IVb/V resection) + portal lymphadenectomy; common bile duct resection if cystic duct margin positive
- **T3–T4:** Extended hepatectomy + bile duct resection as needed; assess for vascular involvement; consider neoadjuvant therapy
- Port-site and extraction-site excision if incidental finding after laparoscopic cholecystectomy

3.5 Colorectal Liver Metastases (CRLM)

- Resection is the standard of care for resectable CRLM with adequate FLR
- Anatomic or non-anatomic resection acceptable — R0 margin is primary goal (≥ 1 mm)
- Parenchyma-sparing hepatectomy preferred for bilobar disease to maximize future options
- Perioperative chemotherapy: FOLFOX or FOLFIRI $\pm$ biologic for 3 months pre- and post-resection
- Ablation may supplement resection for small deep lesions (≤ 3 cm)
- Disappearing liver metastases: mark with clips or fiducials pre-chemotherapy; resect or ablate original site
- Repeat hepatectomy: feasible and indicated for recurrent CRLM if adequate FLR

4. Operative Technique — General Principles

- **Intraoperative ultrasound (IOUS):** Mandatory for all hepatectomies — identify additional lesions, delineate vascular anatomy, guide transection plane
- **Parenchymal transection:** CUSA, Cavitron, harmonic scalpel, or clamp-crush technique per surgeon preference
- **Vascular control:** Pringle maneuver (intermittent: 15 min on / 5 min off); selective hepatic vascular exclusion for tumors involving hepatic veins or IVC
- **CVP management:** Maintain low CVP (< 5 mmHg) during transection to minimize blood loss
- **Hemostasis:** Argon beam, topical hemostats, suture ligation of major vessels
- **Biliary reconstruction:** Roux-en-Y hepaticojejunostomy for bile duct resections; mucosa-to-mucosa technique; stent per surgeon preference
- **Drain placement:** Closed-suction drain near transection surface; remove when output serous and < 200 mL/day

5. Postoperative Management

5.1 Post-Hepatectomy Liver Failure (PHLF) Monitoring

- Monitor: INR, bilirubin, lactate, glucose daily; ISGLS criteria for grading
- Grade A: no change in management
- Grade B: non-invasive management — fresh frozen plasma, albumin, diuretics, glucose infusion
- Grade C: invasive management — ICU, vasopressors, CRRT, consider rescue therapies

5.2 Complication Management

- **Bile leak:** Assess drain bilirubin ($> 3 \times$ serum = biliary fistula); manage with percutaneous drainage $\pm$ ERCP stenting; reoperation rarely needed
- **Hemorrhage:** Early (< 24 h) — consider re-exploration; Late — CT angiography $\pm$ embolization
- **Perihepatic abscess:** CT-guided percutaneous drainage; culture-directed antibiotics
- **Ascites:** Common after major hepatectomy in cirrhotic patients; manage with diuretics, albumin, paracentesis
- **Portal vein thrombosis:** Surveillance with Doppler US; anticoagulation if confirmed

5.3 Recovery Milestones

- Advance diet as tolerated; supplemental nutrition if needed
- Monitor liver function trend: bilirubin and INR should improve by POD 5
- DVT prophylaxis: mechanical + pharmacologic (timing per hemorrhage risk)
- Discharge target: POD 5–7 for minor hepatectomy; POD 7–14 for major hepatectomy

6. Adjuvant Therapy

Diagnosis	Adjuvant Recommendation
HCC	Surveillance per AASLD; adjuvant atezolizumab/bevacizumab (IMbrave050) for high-risk resected HCC
iCCA	Capecitabine $\times$ 8 cycles (BILCAP); gemcitabine/cisplatin if not given neoadjuvant
Perihilar CCA	Consider capecitabine or gemcitabine-based therapy; radiation for R1 margin
Gallbladder carcinoma	Gemcitabine/cisplatin or capecitabine; chemoradiation for R1 or node-positive
CRLM	Perioperative FOLFOX or FOLFIRI $\pm$ biologic to complete 6 months total

7. Surveillance

- **HCC:** AFP + multiphasic CT or MRI every 3–6 months for 2 years, then every 6 months
- **CCA / Gallbladder:** CA 19-9 + CT every 6 months for 2 years, then annually to year 5
- **CRLM:** CEA + CT chest/abdomen/pelvis every 3–6 months for 2 years, then every 6–12 months to year 5

- Colonoscopy at 1 year (CRLM patients), then per colorectal surveillance protocol

This protocol is intended as a clinical reference and should be adapted based on institutional guidelines, individual patient factors, and evolving evidence. All treatment decisions should be made in the context of multidisciplinary review.

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