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Open Minor Hepatectomy with Takasaki's Glissonean Pedicle Control for Hepatocellular Carcinoma: A Vietnamese Cohort Study

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Simple Summary

Liver cancer is common in Vietnam, where many patients have chronic hepatitis B and need treatment that removes the tumor while preserving as much healthy liver as possible. This study reviewed 74 patients with hepatocellular carcinoma who underwent open minor liver resection using Takasaki's Glissonean pedicle control, a technique that selectively controls the blood inflow to the tumor-bearing part of the liver. All patients had well-preserved liver function before surgery. The operation was associated with limited blood loss and a low rate of major complications. After follow-up, survival and freedom from recurrence were acceptable for this selected patient group. These findings support the use of this anatomy-based, liver-sparing open approach in experienced centers, while confirming the need for larger studies to identify which patients benefit most.

Abstract

Surgical resection remains a curative-intent treatment for hepatocellular carcinoma, but procedure-specific evidence for open minor hepatectomy using Takasaki's Glissonean pedicle control remains limited. We retrospectively reviewed 74 consecutive patients with histologically confirmed hepatocellular carcinoma who underwent elective open minor hepatectomy, defined as resection of fewer than three Couinaud segments, using Takasaki-style Glissonean pedicle control at a Vietnamese hepatopancreatobiliary center between January 2021 and March 2024. Survival was estimated using the Kaplan–Meier method, and prognostic factors were explored using Cox regression. All patients had Child–Pugh class A liver function; 81.1% were hepatitis B surface antigen-positive and 87.8% had Barcelona Clinic Liver Cancer stage A disease. Median tumor diameter, operative time, and blood loss were 42 mm, 150 min, and 200 mL, respectively. R0 resection was achieved in 94.6%. Post-hepatectomy liver failure, major complications, and 90-day mortality occurred in 1.4%, 4.1%, and 1.4%, respectively. At a median follow-up of 39.6 months, 3-year overall and disease-free survival were 74.7% and 59.9%. This approach appears feasible and safe in selected Child–Pugh class A patients, with acceptable mid-term oncological outcomes.

Keywords: hepatocellular carcinoma; hepatectomy; Glissonean pedicle; Takasaki method; treatment outcome; survival analysis

1. Introduction

Hepatocellular carcinoma (HCC) caused an estimated 759,000 deaths globally in 2022, with the highest burden in East and Southeast Asia [1–3]. In Vietnam, liver cancer is the leading cause of cancer-related death in men, driven primarily by endemic chronic HBV infection [1,4]. Surgical

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resection remains the principal curative-intent treatment for patients with preserved liver function and resectable disease [2,5–7].

The oncological rationale for anatomical resection of HCC rests on the propensity of the tumor to disseminate through the portal venous system [8,9]. Takasaki's Glissonean pedicle transection method translates this rationale into a reproducible operative strategy by selectively controlling the tumor-bearing secondary or tertiary Glissonean pedicle, thereby producing ischemic demarcation of the target portal territory while preserving perfusion of the future liver remnant [10,11]. Large institutional series have reported favorable perioperative and oncological outcomes after anatomical hepatectomy using Glissonean pedicle approaches and standardized hepatic resection in expert centers [12,13]. Although the Glissonean approach has been adopted in Vietnamese tertiary centers [14,15], evidence specific to open minor hepatectomy using Takasaki-style Glissonean pedicle control remains limited, particularly regarding recurrence and survival. We therefore evaluated perioperative outcomes, recurrence patterns, overall survival (OS), and disease-free survival (DFS) after this procedure in patients with HCC at a Vietnamese hepatopancreatobiliary center.

2. Materials and Methods

2.1. Study Design, Setting, and Patients

This was a retrospective, single-center cohort study of consecutive patients underwent open minor hepatectomy with Takasaki's Glissonean pedicle control at the Hepato-Biliary and Pancreatic Surgery Department, 108 Military Central Hospital, Hanoi, Vietnam. The Institutional Review Board approved the study (protocol code: 3253/GCN-BV; approval date: 23 May 2025) and waived the requirement for written informed consent because of the retrospective design. The study was conducted in accordance with the Declaration of Helsinki [16] and reported with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. Clinical, operative, laboratory, pathological, postoperative, and follow-up data were retrospectively extracted from institutional medical records, operative reports, pathology reports, laboratory records, and follow-up documentation.

All consecutive patients who underwent elective open liver resection with Takasaki's Glissonean pedicle control between January 2021 and March 2024 were screened. Patients were eligible if they met the following criteria: (1) final histopathological diagnosis of HCC; (2) Child-Pugh class A liver function before surgery; (3) no radiological evidence of extrahepatic HCC spread before surgery; and (4) minor hepatectomy, defined as resection of fewer than 3 Couinaud liver segments. Patients with non-HCC final pathology or incomplete operative records were excluded. No emergency liver resections were included. Patient selection is summarized in Figure 1. Seventy-four patients constituted the analytic cohort.

2.2. Surgical Technique

Operations were performed by experienced hepatobiliary surgeons using a Takasaki-style Glissonean approach based on secondary or tertiary pedicle control [10,11,17]. After laparotomy, the target Glissonean pedicle was approached extrahepatically at the hepatic hilum when feasible, or intrahepatically during parenchymal transection for selected segmental or tertiary branches. Temporary clamping of the target pedicle was used to confirm the ischemic territory, and the demarcation line was marked with electrocautery. Parenchymal transection was performed using an ultrasonic surgical aspirator (CUSA Excel®, Integra LifeSciences, Princeton, NJ, USA) when appropriate. Depending on pedicle accessibility, the target pedicle was divided either before or, more commonly, after parenchymal transection. Selective Glissonean pedicle control was used as the primary inflow-control strategy.

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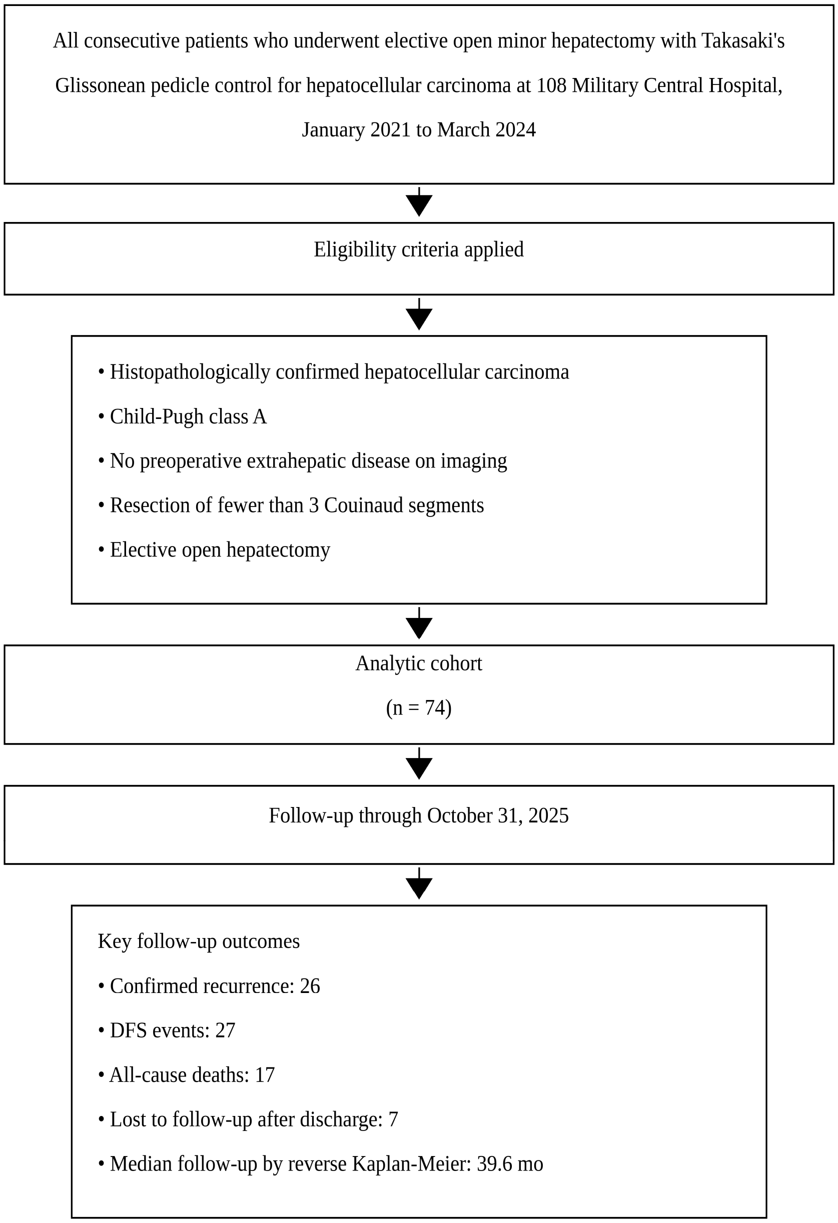

Figure 1. Study flow diagram. Consecutive patients who underwent elective open minor hepatectomy with Takasaki's Glissonean pedicle control for hepatocellular carcinoma at 108 Military Central Hospital between January 2021 and March 2024 were screened. Seventy-four patients met the eligibility criteria and constituted the analytic cohort. DFS, disease-free survival.

2.3. Definitions and Outcomes

Preoperative liver function was assessed using the Child-Pugh classification and the Albumin-Bilirubin (ALBI) score [18,19]. Tumors were staged according to the Barcelona Clinic Liver Cancer (BCLC) 2022 system [7]. Resection extent was categorized according to the number of Couinaud liver segments removed. Minor hepatectomy was operationally defined as resection of fewer than 3 Couinaud liver segments. Procedure categories were defined by the anatomical territory resected and included segmentectomy, contiguous bisegmentectomy, right posterior sectionectomy (segments 6/7), right anterior sectionectomy (segments 5/8), and left lateral sectionectomy (segments 2/3). Post-hepatectomy liver failure (PHLF) was defined according to the International Study Group of Liver Surgery (ISGLS) concept of impaired coagulation and hyperbilirubinemia on or after postoperative

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day (POD) 5 [20]. Bile leak was defined by ISGLS criteria [21]; complications were graded using the Clavien-Dindo system [22], with major complications defined as grade III or higher. Margin-negative (R0) denoted the absence of tumor at the microscopic resection margin; microscopically positive (R1) margin denoted microscopic tumor involvement of the resection margin. Tumor differentiation was reported according to the Edmondson-Steiner system [23].

OS was measured from surgery to death from any cause. DFS was measured from surgery to first documented recurrence or death from any cause, whichever occurred first. Postoperative follow-up followed Vietnamese Ministry of Health guidance and institutional practice, with reassessment at 1 month, 3 mo, and every 3 mo thereafter using clinical examination, α-FP measurement, and imaging as indicated including ultrasonography, contrast-enhanced computed tomography, or magnetic resonance imaging when clinically indicated. Follow-up was censored on October 31, 2025. Median follow-up was estimated using the reverse Kaplan-Meier method [24].

2.4. Statistical Analysis

Continuous variables were summarized as mean ± SD or median (interquartile range [IQR]), and categorical variables as n (%). Group comparisons, when performed, used the Mann-Whitney U test or Fisher's exact test. OS and DFS were estimated by the Kaplan-Meier method and compared using log-rank tests. Univariable Cox proportional hazards regression was used for exploratory prognostic analyses. An exploratory multivariable Cox model for DFS included R1 margin, BCLC stage B, and α-FP >400 ng/mL, corresponding to 9 events per variable. A multivariable model for OS was not constructed because of the limited number of deaths (n = 17). Two-sided $P < 0.05$ was considered statistically significant. All analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Kaplan–Meier curves and postoperative laboratory trend plots were generated using jamovi version 2.7.30 for graphical presentation, based on the same analytic dataset.

3. Results

3.1. Baseline Characteristics

Baseline characteristics are summarized in Table 1. The cohort was predominantly male (65/74, 87.8%), with a median age of 59 years (IQR, 50–64). HBsAg was positive in 60 patients (81.1%). All patients had Child-Pugh class A liver function, and 58 (78.4%) were ALBI grade 1. The median preoperative α-FP level was 8.3 ng/mL (IQR, 2.8–55.6), with α-FP >400 ng/mL in 10 patients (13.5%). The median tumor diameter was 42 mm (IQR, 32–58); 24 patients (32.4%) had a solitary tumor >5 cm, and 9 (12.2%) had multifocal disease. Most patients were BCLC stage A (65/74, 87.8%).

Table 1. Baseline clinicopathological characteristics (n = 74).

Characteristic	Value
Age (yr)	
Mean ± SD	55.9 ± 11.5
Median (IQR)	59 (50–64)
Range	18–75
≥60 yr	34 (45.9)
Sex	
Male	65 (87.8)
Female	9 (12.2)
ECOG performance status 0	74 (100.0)
Incidental diagnosis	37 (50.0)
Etiology and risk factors	
HBsAg-positive	60 (81.1)
Anti-HCV positive	2 (2.7)
Liver function	
Child-Pugh class A	74 (100.0)

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ALBI grade 1	58 (78.4)
ALBI grade 2	16 (21.6)
Preoperative α-FP (ng/mL)	
Median (IQR)	8.3 (2.8–55.6)
≤20	45 (60.8)
>20–400	19 (25.7)
>400	10 (13.5)
Tumor characteristics	
Median diameter (IQR), mm	42 (32–58)
Range, mm	21–133
Solitary <30 mm	12 (16.2)
Solitary 30–50 mm	29 (39.2)
Solitary >50 mm	24 (32.4)
Multifocal	9 (12.2)

Values are presented as number (%) unless otherwise indicated. SD, standard deviation; IQR, interquartile range; ECOG, Eastern Cooperative Oncology Group; HBsAg, hepatitis B surface antigen; anti-HCV, antibody to hepatitis C virus; ALBI, albumin–bilirubin; α-FP, alpha-fetoprotein; BCLC, Barcelona Clinic Liver Cancer.

3.2. Operative Findings and Immediate Outcomes

Operative characteristics and perioperative outcomes are summarized in Table 2. Right posterior sectionectomy was the most common procedure (31/74, 41.9%). Intraoperative cirrhotic morphology was observed in 44 patients (59.5%). Median operative time, parenchymal transection time, and blood loss were 150 minutes, 35 minutes, and 200 mL, respectively, and only 1 patient (1.4%) required intraoperative blood transfusion. Intraoperative complications occurred in 3 patients (4.1%): bile duct injury, hepatic vein injury, and diaphragmatic perforation. All were recognized and managed during the index operation, without apparent postoperative sequelae attributable to these events.

Table 2. Operative characteristics and perioperative outcomes (n = 74).

Characteristic / Outcome	Value
Operative findings	
J-shaped subcostal incision	72 (97.3)
Supraumbilical midline incision	2 (2.7)
Intraoperative cirrhotic liver morphology	44 (59.5)
Hepatectomy type	
Right posterior sectionectomy (segments 6/7)	31 (41.9)
Right anterior sectionectomy (segments 5/8)	4 (5.4)
Left lateral sectionectomy (segments 2/3)	3 (4.1)
Segmentectomy	25 (33.8)
Contiguous bisegmentectomy	11 (14.9)
Surgical technique	
Pedicle divided after parenchymal transection	70 (94.6)
Pedicle divided before parenchymal transection	4 (5.4)
CUSA Excel as primary transection device	61 (82.4)
Other or combined transection device	13 (17.6)
Operative times	
Operative time, min, median (IQR)	150 (125–175)
Operative time, range, min	90–255
Parenchymal transection time, min, median (IQR)	35 (30–50)
Blood loss	
Intraoperative blood loss, mL, median (IQR)	200 (100–300)
Intraoperative blood loss, range, mL	50–1000
Intraoperative blood transfusion	1 (1.4)

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Any intraoperative complication	3 (4.1)
Postoperative outcomes	
PHLF	1 (1.4)
Any 30-day complication	18 (24.3)
Major complication (Clavien–Dindo ≥III)	3 (4.1)
Bile leak	1 (1.4)
Length of hospital stay, days, median (IQR)	8 (7–9)
Length of hospital stay, range, days	4–19
In-hospital mortality, n (%)	0 (0.0)
90-day mortality, n (%)	1 (1.4)

Values are presented as number (%) unless otherwise indicated. CUSA Excel®, Integra LifeSciences, Princeton, NJ, USA. Other or combined transection devices included an ultrasonic dissector other than CUSA (n = 6), LigaSure (n = 1), and combined devices (n = 6). Segmentectomy denotes resection of one Couinaud segment; contiguous bisegmentectomy denotes resection of two adjacent Couinaud segments recorded separately from standard sectionectomies. PHLF was defined according to the ISGLS concept; bile leak was defined according to ISGLS criteria. USA, Cavitron Ultrasonic Surgical Aspirator; IQR, interquartile range; PHLF, post-hepatectomy liver failure; ISGLS, International Study Group of Liver Surgery.

3.3. Postoperative Outcomes

Postoperative laboratory trends are shown in Figure 2. Aminotransferases peaked on postoperative day (POD) 1 and declined substantially by POD 5; total bilirubin peaked on POD 3, and prothrombin activity reached its nadir on POD 1 before improving by POD 5. PHLF occurred in 1 patient (1.4%) and was classified as grade C. This patient had undergone concomitant right nephroureterectomy, was discharged at family request on POD 10, and died after discharge on POD 12. Overall postoperative complications within 30 days occurred in 18 patients (24.3%), and major complications occurred in 3 patients (4.1%). Major complications included grade C PHLF, postoperative intra-abdominal hemorrhage requiring reoperation, and bile leak requiring percutaneous drainage. Pleural effusion managed conservatively was the most frequent individual complication (14/74, 18.9%). Other complications included ascites (3/74, 4.1%), surgical-site infection (2/74, 2.7%), and intra-abdominal abscess (3/74, 4.1%) (Table S1). There was no in-hospital mortality, and 90-day mortality was 1.4% (1/74). The median hospital stay was 8 days (IQR, 7–9; range, 4–19).

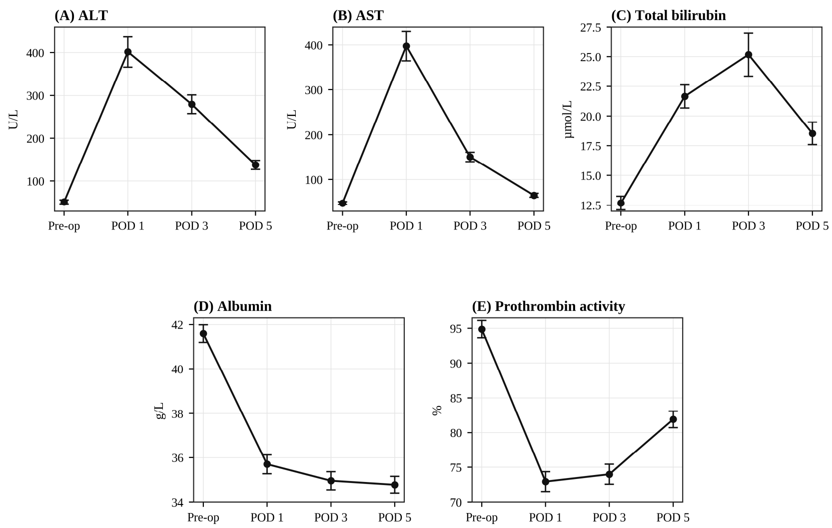

Figure 2. Perioperative dynamics of liver function parameters after open minor hepatectomy. (a) Alanine aminotransferase. (b) Aspartate aminotransferase. (c) Total bilirubin. (d) Albumin. (e) Prothrombin activity. Data are presented as mean ± standard error. POD, postoperative day.

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3.4. Pathology and Recurrence

Pathological findings, recurrence patterns, and follow-up are summarized in Table 3. R0 resection was achieved in 70 patients (94.6%), whereas 4 patients (5.4%) had microscopic R1 margins. Tumor differentiation was moderate in 62 patients (83.8%) and poor in 12 patients (16.2%). During follow-up, 26 patients (35.1%) developed documented recurrence. Recurrence was intrahepatic only in 19 patients (73.1% of recurrent cases), extrahepatic only in 6 patients (23.1%), and both intrahepatic and extrahepatic in 1 patient (3.8%). There were 27 DFS events, comprising 26 documented recurrences and 1 death from PHLF before recurrence could be assessed. Thirteen DFS events occurred within 12 months after surgery (48.1%). Patients with early DFS events had numerically higher preoperative α-FP than those with later events, but the difference was not statistically significant (110.8 ng/mL vs. 17.1 ng/mL; $P = 0.198$). Seventeen patients (23.0%) died from any cause, and 7 patients (9.5%) were lost to follow-up after discharge. Median follow-up estimated by the reverse Kaplan–Meier method was 39.6 months; median observation time among survivors was 38.3 months (range, 0.2–57.8).

Table 3. Pathological findings, recurrence, and follow-up (n = 74).

Variable	Value
Pathology	
R0 resection	70 (94.6)
R1 resection (microscopic)	4 (5.4)
Histological differentiation	
Well	0 (0.0)
Moderate	62 (83.8)
Poor	12 (16.2)
Recurrence and follow-up	
Confirmed recurrence during follow-up	26 (35.1)
Intrahepatic only, n/recurrences (%)	19/26 (73.1)
Extrahepatic only, n/recurrences (%)	6/26 (23.1)
Combined intra- and extrahepatic, n/recurrences (%)	1/26 (3.8)
Total DFS events	27 (36.5)
Early DFS event (≤12 mo), n/DFS events (%)	13/27 (48.1)
Late DFS event (>12 mo), n/DFS events (%)	14/27 (51.9)
Preoperative α-FP in early DFS events, ng/mL, median (IQR)	110.8 (8.9–243.7)
Preoperative α-FP in late DFS events, ng/mL, median (IQR)	17.1 (5.8–35.0)
All-cause deaths	17 (23.0)
Lost to follow-up after discharge	7 (9.5)
Median follow-up (reverse Kaplan–Meier), mo	39.6
Median observation time among survivors, mo (range)	38.3 (0.2–57.8)

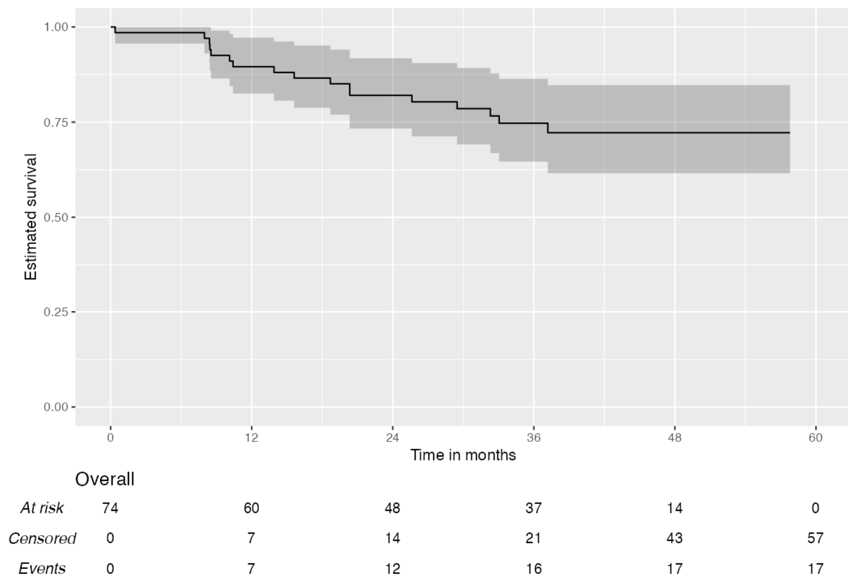
Values are presented as number (%) unless otherwise indicated. DFS events included 26 documented recurrences and 1 patient who died from post-hepatectomy liver failure before recurrence could be assessed. Comparison of preoperative α-FP between early and late DFS events used the Mann–Whitney U test ($P = 0.198$). Resection margin width, microvascular invasion, and satellite nodules were not consistently recorded during the study period and were unavailable for analysis. R0, microscopically negative margin; R1, microscopically positive margin; DFS, disease-free survival; α-FP, alpha-fetoprotein; IQR, interquartile range.

3.5. Survival and Prognostic Analyses

Median follow-up estimated by the reverse Kaplan–Meier method was 39.6 months; median observation time among survivors was 38.3 months (range, 0.2–57.8). Seventeen patients (23.0%) died from any cause, including 1 postoperative death after grade C PHLF. The estimated 1-, 2-, and 3-year OS rates were 89.6%, 82.0%, and 74.7%, respectively (Figure 3a); corresponding DFS rates were 80.6%, 63.7%, and 59.9% (Figure 3b). Median OS and DFS were not reached. Exploratory margin-stratified

Kaplan–Meier curves showed lower OS and DFS in patients with R1 margins than in those with R0 margins (Figure 4; log-rank P = 0.003 and P = 0.019, respectively). In the small BCLC stage B subgroup (n = 9), the 3-year OS rate was lower than that in BCLC stage A patients (46.9% vs. 78.6%; log-rank P = 0.005), whereas DFS did not differ significantly between BCLC stage B and A patients (3-year DFS, 50.0% vs. 61.4%; log-rank P = 0.168) (Figure 5). Exploratory Cox regression results are presented in Table 4, with Kaplan–Meier estimates for selected subgroups provided in Table S2.

(a)



(b)

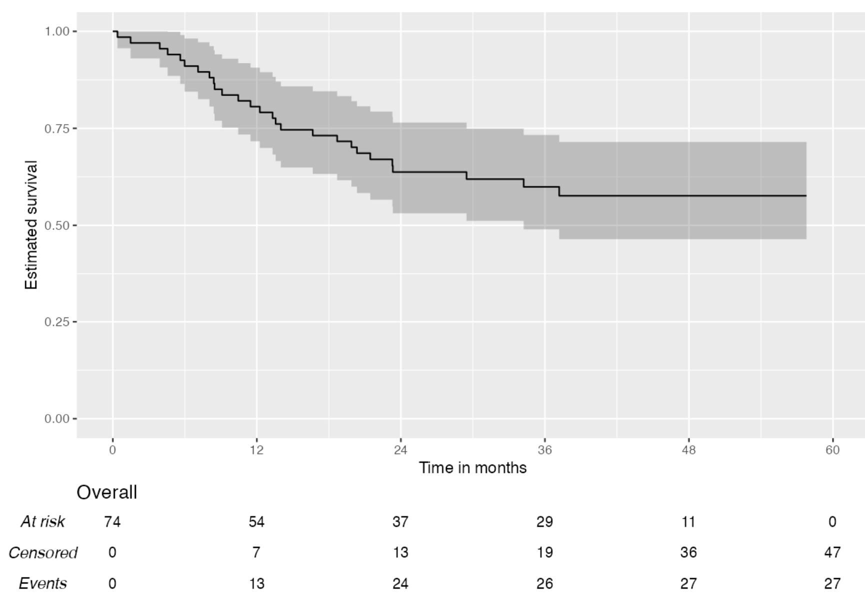


Figure 3. Kaplan–Meier survival curves for the overall cohort. (a) Overall survival (OS). (b) Disease-free survival (DFS). Shaded areas indicate 95% confidence intervals. Numbers at risk, cumulative censored observations, and cumulative events are shown below each plot.

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(a)

(b)

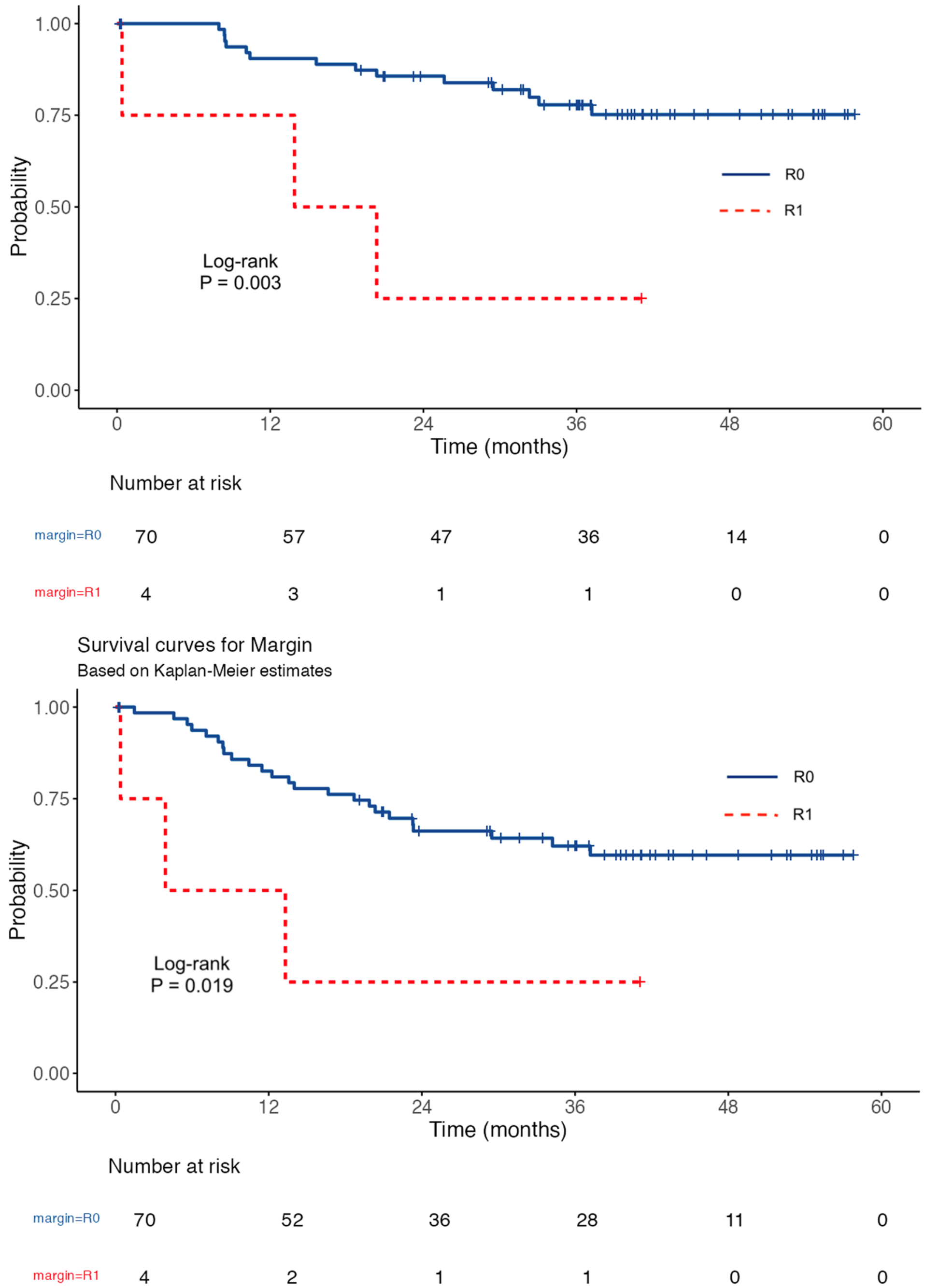

Figure 4. Exploratory Kaplan–Meier survival curves stratified by resection margin status. (a) Overall survival. (b) Disease-free survival. Survival curves were compared between the R0 and R1 resection groups using the log-rank test.

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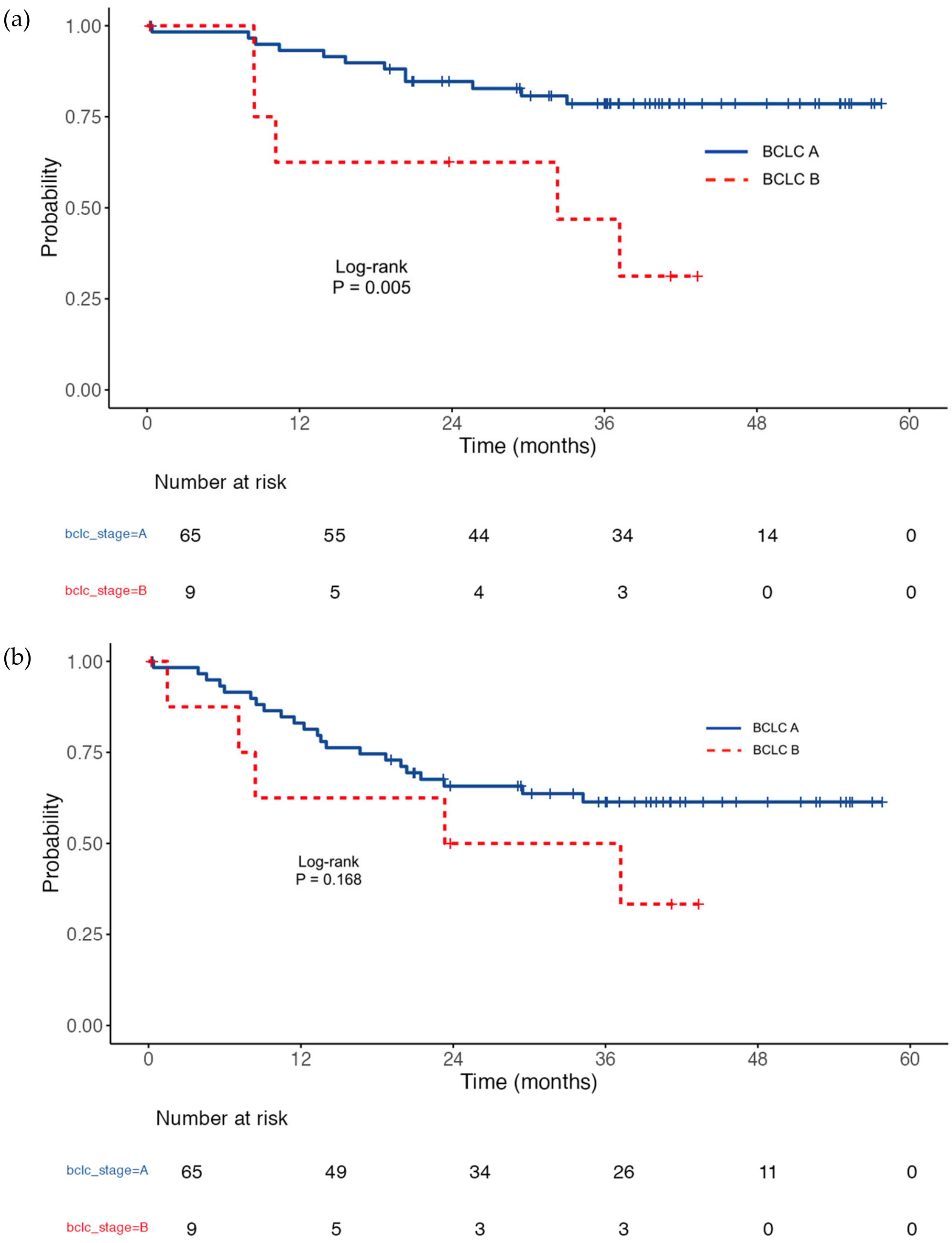

Figure 5. Kaplan–Meier curves stratified by Barcelona Clinic Liver Cancer stage. (a) Overall survival according to BCLC stage A versus B. (b) Disease-free survival according to BCLC stage A versus B. Survival curves were compared using the log-rank test. BCLC, Barcelona Clinic Liver Cancer; OS, overall survival; DFS, disease-free survival.

Table 4. Key exploratory Cox proportional hazards analyses of disease-free and overall survival.

Variable	DFS HR (95% CI)	P	OS HR (95% CI)	P
Univariable Cox models				
R1 vs. R0 margin	3.84 (1.15–12.82)	0.029	5.38 (1.53–18.88)	0.009
BCLC stage B vs. A	1.96 (0.74–5.18)	0.176	3.96 (1.39–11.28)	0.010
α-FP >400 vs. ≤400 ng/mL	1.61 (0.61–4.27)	0.336	1.34 (0.38–4.69)	0.644
Multifocal disease	1.27 (0.44–3.68)	0.657	2.52 (0.82–7.73)	0.107
ALBI grade 2 vs. 1	1.09 (0.44–2.71)	0.849	0.79 (0.23–2.77)	0.717

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Major postoperative complication	2.71 (0.64–11.51)	0.178	2.32 (0.30–17.76)	0.418
Exploratory multivariable Cox model for DFS				
R1 vs. R0 margin	4.23 (1.08–16.60)	0.039	—	—
BCLC stage B vs. A	2.17 (0.80–5.91)	0.129	—	—
α-FP >400 vs. ≤400 ng/mL	1.05 (0.35–3.12)	0.936	—	—

Values are hazard ratios with 95% confidence intervals unless otherwise indicated. In the univariable Cox models, each variable was entered separately. The exploratory multivariable DFS model included R1 resection margin, BCLC stage B, and α-FP >400 ng/mL (27 DFS events; events per variable = 9); estimates in this section are adjusted hazard ratios. A multivariable Cox model for OS was not constructed because of the limited number of deaths (n = 17). Dashes indicate not applicable. HR, hazard ratio; CI, confidence interval; DFS, disease-free survival; OS, overall survival; R0/R1, microscopically margin-negative/margin-positive resection; BCLC, Barcelona Clinic Liver Cancer; α-FP, alpha-fetoprotein; ALBI, albumin–bilirubin.

4. Discussion

In this selected Vietnamese cohort with predominantly HBV-related HCC, open minor hepatectomy using Takasaki's Glissonean pedicle control was feasible and associated with low major morbidity, no in-hospital mortality, and acceptable mid-term survival. These findings should not be interpreted as evidence of superiority over non-anatomical, laparoscopic, or robotic approaches, because the study was retrospective and had no comparator group. Rather, the study provides procedure-specific evidence that an anatomy-based, parenchymal-sparing open approach can be delivered safely in carefully selected Child-Pugh class A patients. This is clinically relevant in a HBV-endemic setting, where many patients have underlying chronic liver disease and where preservation of functional liver parenchyma remains central to safe hepatectomy.

The study adds to, rather than replaces, the existing Vietnamese literature on Glissonean-based hepatectomy. Previous Vietnamese reports have described combined extrahepatic Takasaki and intrahepatic Ton That Tung pedicle approaches, right anatomical hepatectomy using an extrahepatic Glissonean approach with liver hanging, and Glissonean pedicle approaches combined with different parenchymal transection techniques [14,15,25]. The narrower contribution of the present series is its focus on open minor hepatectomy using Takasaki-style extrafascial Glissonean pedicle control as the primary inflow-control strategy, with integrated reporting of perioperative outcomes, recurrence pattern, and Kaplan-Meier OS and DFS. This focus is important because minor anatomical resection is frequently required in patients with limited hepatic reserve, where oncological clearance and parenchymal preservation must be balanced within the same operation.

The technical value of Takasaki's method lies in linking oncological anatomy to operative control. HCC may spread microscopically along portal venous branches, which provides the biological rationale for anatomical removal of the tumor-bearing portal territory [8,9,26]. Takasaki's Glissonean approach translates this principle into a reproducible operative step: selective clamping of the corresponding secondary or tertiary Glissonean pedicle produces an ischemic demarcation that guides the intended transection plane [10,11]. In the present cohort, early postoperative biochemical changes were consistent with recovery after minor hepatectomy, and the low bile leak rate supports the technical safety of selective pedicle control when performed by experienced hepatobiliary surgeons.

A practical feature of this cohort was that right posterior sectionectomy was the most common procedure. Resection of segments 6/7 is technically demanding because of the deep location, limited exposure, and proximity to the right hepatic vein. The Morioka consensus recognized posterosuperior segments as among the most difficult locations for minimally invasive liver resection [27]. In this context, hilum-based Glissonean control may be useful because it defines the posterior sector by its inflow territory before or during parenchymal transection, rather than relying solely on surface anatomy. Our data do not argue against minimally invasive surgery; instead, they support the continuing role of a technically sound open anatomical approach for selected posterosuperior tumors, particularly in centers where minimally invasive posterior sectionectomy is not yet routine.

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The perioperative outcomes were acceptable when interpreted in the context of a highly selected cohort. Large Glissonean series have reported favorable outcomes, but they include different mixtures of major and minor hepatectomies, tumor burden, and liver function [12,13]. In the present study, all patients were Child-Pugh class A and all resections were minor, which likely contributed to the low rates of PHLF and major complications. The only PHLF event occurred in a patient who underwent concomitant right nephroureterectomy and died after discharge on POD 12. This should be viewed as an important clinical detail rather than as evidence that combined surgery is generally unsafe; nevertheless, it highlights the additional physiological burden of synchronous extrahepatic surgery in patients undergoing hepatectomy.

The mid-term oncological outcomes were within an acceptable range for a cohort with predominantly HBV-related HCC. The 3-year OS and DFS rates were 74.7% and 59.9%, respectively. Recurrence remained predominantly intrahepatic, emphasizing that anatomical hepatectomy alone cannot eliminate the long-term risk created by tumor biology and the diseased liver remnant. In an HBV-endemic setting, this finding also reinforces that surgical clearance should be integrated with structured surveillance and antiviral management when indicated [2,5,28]. HBV DNA levels, antiviral adherence, and post-recurrence treatment were not recorded in a standardized manner and could not be analyzed in this study. The association between R1 margin and inferior survival is clinically important but should be interpreted cautiously. Only 4 patients had R1 margins, and exact margin width, microvascular invasion, and satellite nodules were not consistently available. Prior studies support the prognostic relevance of margin status and margin width after HCC resection [29–31], but in cirrhotic liver, a wider margin cannot be pursued indiscriminately. The practical implication is not simply to pursue wider resection in every patient, but to improve preoperative planning, use intraoperative ultrasonography when available, define the Glissonean territory and transection plane carefully, and standardize pathological reporting of margin width and microvascular invasion.

Two additional findings may guide postoperative management. First, nearly half of DFS events occurred within 12 months, and preoperative α-FP was numerically higher among patients with early events. Although this difference was not statistically significant, it is consistent with the concept that early recurrence is often driven by tumor factors present at the time of surgery, whereas late recurrence may reflect de novo carcinogenesis in the remnant liver [32].

The BCLC stage B finding should be interpreted in a regional and surgical context. In this cohort, BCLC stage B was associated with worse OS but not DFS, suggesting that intermediate-stage tumor burden may still influence survival after resection. BCLC-based algorithms have traditionally allocated intermediate-stage HCC primarily to transarterial therapy, whereas several Asian guideline systems place greater emphasis on technical resectability, liver reserve, and multidisciplinary selection [33]. The 2022 BCLC update also recognizes heterogeneity within BCLC stage B and permits treatment stage migration in selected patients [7], and recent expert recommendations emphasize individualized assessment for resectable disease with preserved liver function [6]. Vietnamese Ministry of Health guidance similarly allows hepatectomy to be considered according to resectability, liver function, and disease extent [34]. Because only 9 patients in this study were BCLC stage B, our findings should be viewed as descriptive: they support careful selection and structured postoperative surveillance, not broad expansion of surgical indications or evidence of superiority over transarterial therapy.

This study has limitations. Its retrospective single-center design introduces selection and information bias, and the inclusion of only Child-Pugh class A patients limits generalizability to patients with more advanced liver dysfunction. The sample size and number of survival events were small; therefore, the Cox analyses were exploratory. Exact margin width, microvascular invasion, and satellite nodules were not consistently recorded, limiting interpretation of the R1 association. Seven patients were lost to follow-up after discharge, and informative censoring cannot be excluded. Finally, because this study focused on open minor hepatectomy, the findings are best interpreted as procedure-specific outcomes for this selected setting rather than as comparative evidence against

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major hepatectomy, non-anatomical resection, minimally invasive approaches, or other inflow-control strategies.

5. Conclusions

In conclusion, open minor hepatectomy with Takasaki's Glissonean pedicle control appeared feasible and was associated with low major morbidity and acceptable mid-term oncological outcomes in this selected Vietnamese Child-Pugh class A cohort. The main value of this study is to provide procedure-specific evidence for an open, anatomy-based minor hepatectomy approach in a HBV-endemic setting, including technically demanding right posterior sectionectomy. The observed association between R1 margin and survival is hypothesis-generating and supports prospective standardization of margin planning and pathological reporting. Future multicenter studies should determine which patients benefit most from Takasaki-style minor hepatectomy.

Supplementary Materials: The following supporting information can be downloaded at: Preprints.org, Table S1: Detailed intraoperative and postoperative complications (n = 74); Table S2: Kaplan-Meier survival estimates by overall cohort and selected subgroups; Table S3: Full exploratory Cox proportional hazards analyses for DFS and OS.

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Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request and with permission from the relevant institutional authority. The data are not publicly available because they contain patient-level clinical information and are subject to privacy and ethical restrictions.

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Abbreviations

The following abbreviations are used in this manuscript:

AJCC	American Joint Committee on Cancer
ALBI	albumin–bilirubin
BCLC	Barcelona Clinic Liver Cancer
CI	confidence interval
CUSA	Cavitron Ultrasonic Surgical Aspirator

DFS	disease-free survival
HBV	hepatitis B virus
HBsAg	hepatitis B surface antigen
HCC	hepatocellular carcinoma
HR	hazard ratio
IQR	interquartile range
ISGLS	International Study Group of Liver Surgery
OS	overall survival
PHLF	post-hepatectomy liver failure
POD	postoperative day
R0	microscopically negative resection margin
R1	microscopically positive resection margin
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TNM	tumor–node–metastasis
α-FP	alpha-fetoprotein

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