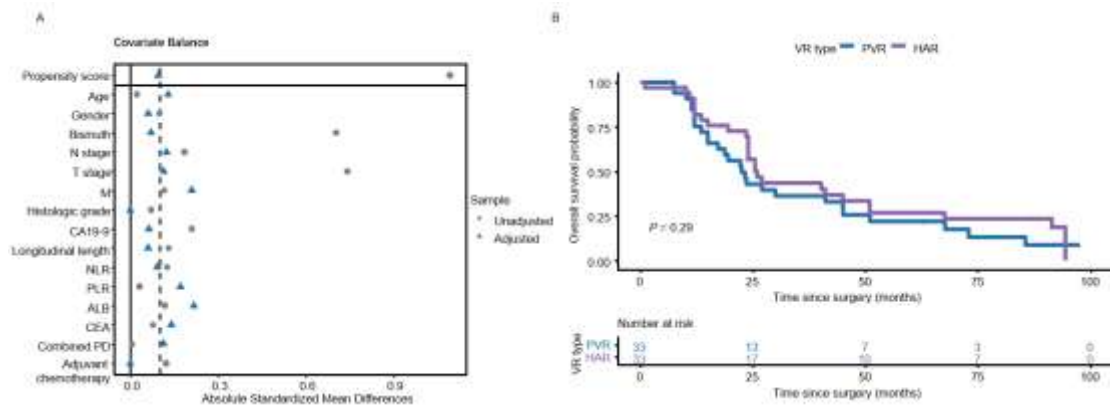
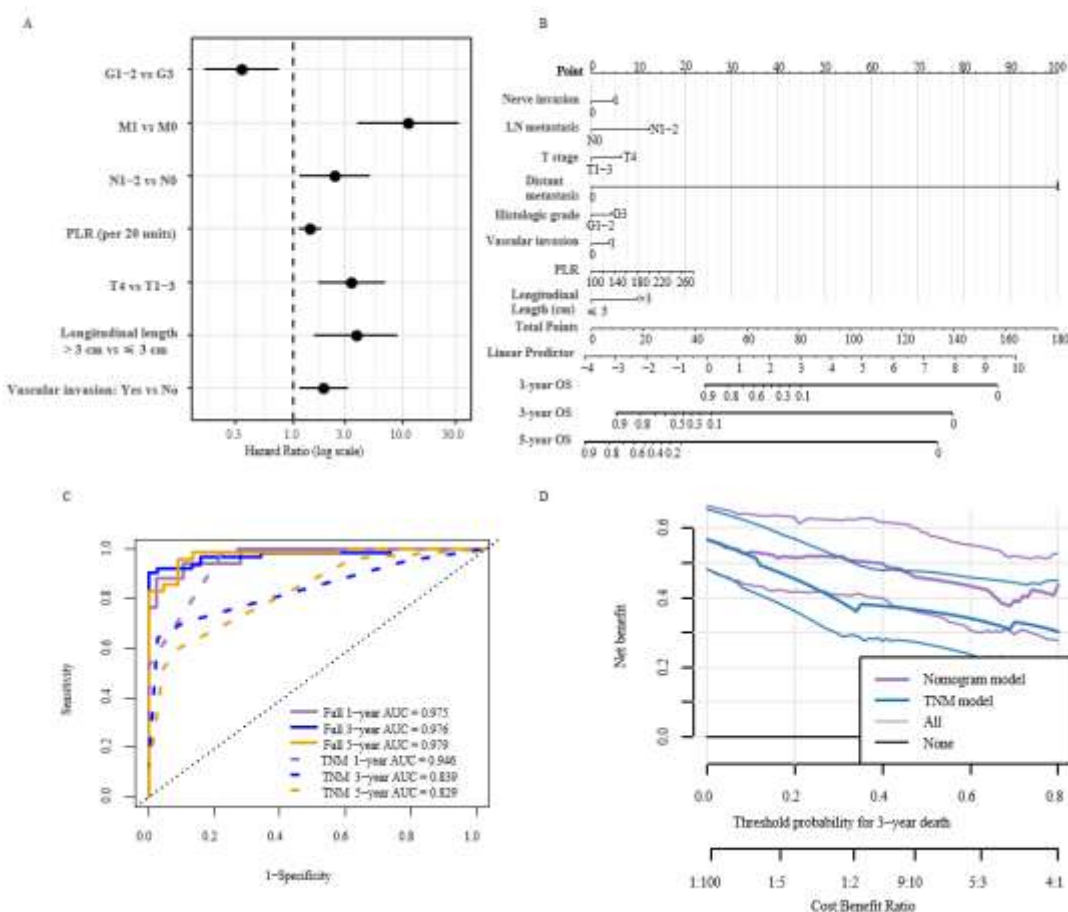


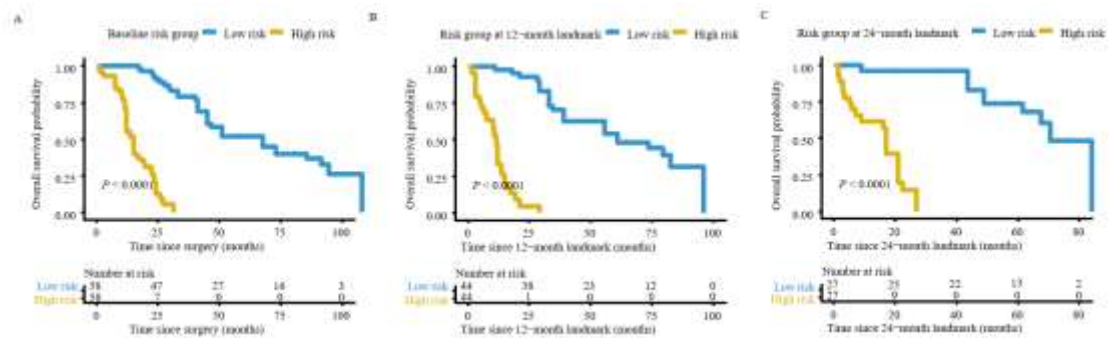


Supplementary Figure 1 Propensity score-adjusted comparison between HAR and PVR. A: Covariate balance before and after matching, shown by absolute standardized mean differences; B: Kaplan-Meier OS curves comparing HAR and PVR after matching, with numbers at risk. OS: Overall survival; HAR: Hepatic artery resection; PVR: Portal vein resection

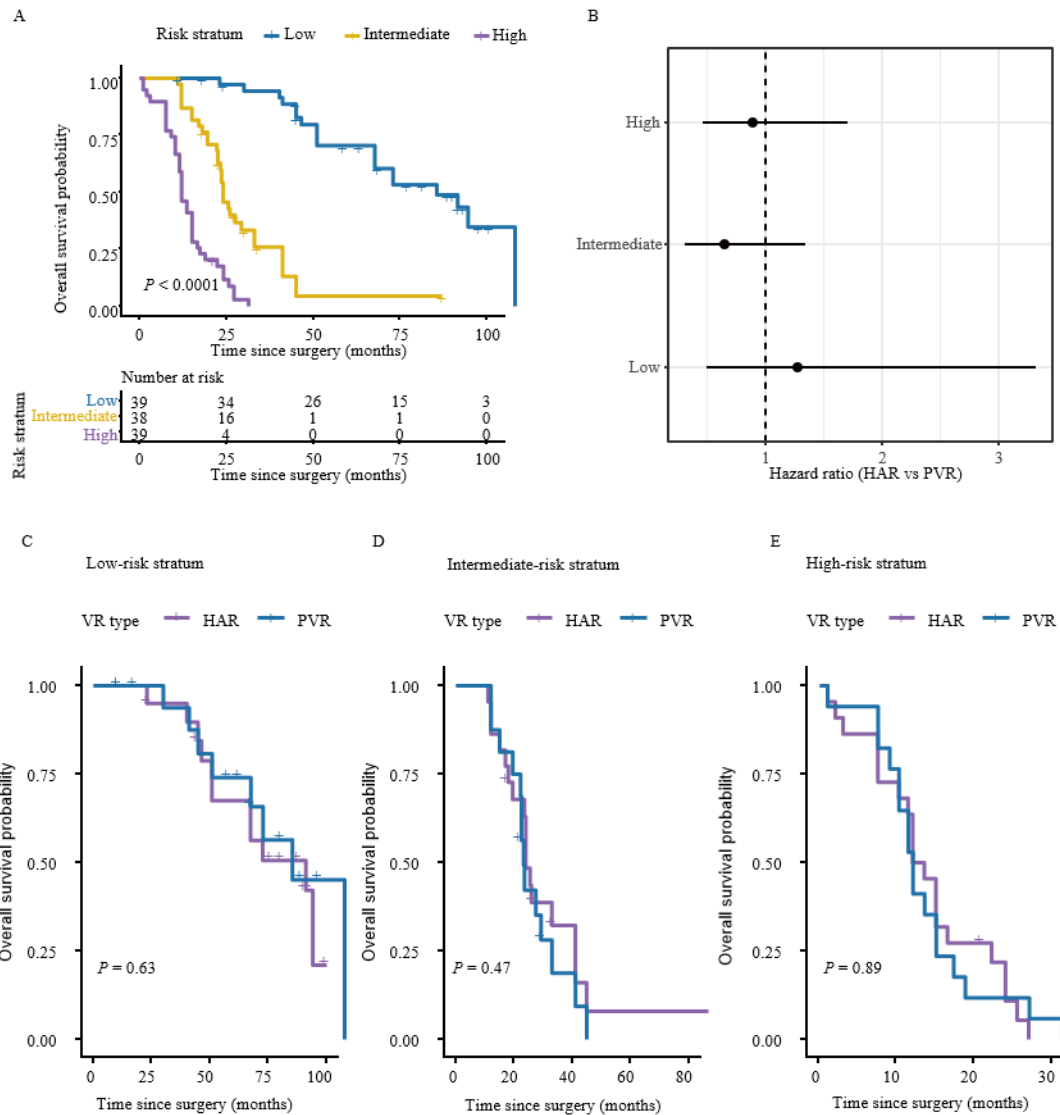


Supplementary Figure 2 Prognostic model and clinical utility in the VR cohort. A: Forest plot of the multivariable Cox model. HRs with 95% CIs are

shown on a log scale; the vertical reference line indicates HR = 1; B: Nomogram for predicting 1-, 3-, and 5-year overall survival (OS); C: Time-dependent ROC curves comparing the nomogram and TNM models; D: Decision curve analysis for 3-year death. VR: Vascular resection; HR: Hazard ratio; CI: Confidence interval; ROC: Receiver operating characteristic; TNM: Tumor-node-metastasis. AUC: Area under the curve.

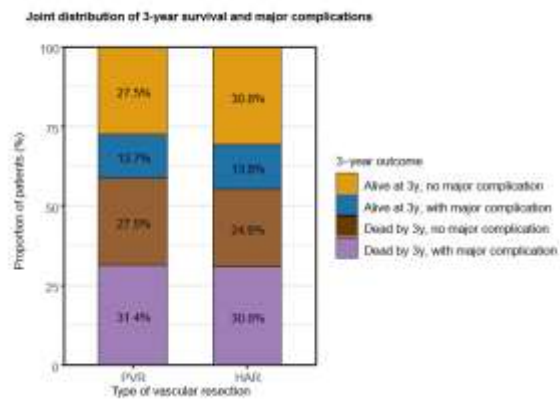


Supplementary Figure 3 Risk stratification and landmark analyses in the vascular resection (VR) cohort. A: Overall survival (OS) according to risk group; B: 12-month landmark analysis; C: 24-month landmark analysis.

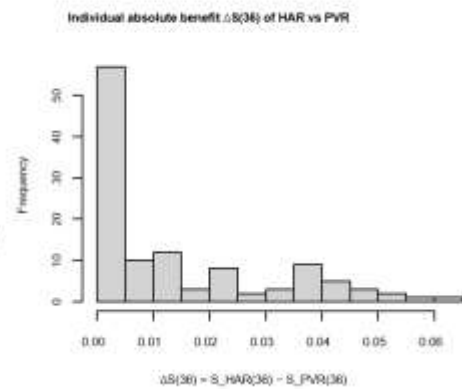


Supplementary Figure 4 Risk-stratified comparison between HAR and PVR in the VR cohort. A: OS according to low-, intermediate-, and high-risk strata; B: Forest plot of HAR *vs* PVR across risk strata; the dashed line indicates HR = 1; C–E: OS comparisons between HAR and PVR within the low-, intermediate-, and high-risk strata.

A



B



Supplementary Figure 5 Exploratory survival-morbidity classification and individualized survival estimates. A: Distribution of the four-level survival-morbidity classification according to VR type; B: Model-estimated individual difference in 3-year OS between hypothetical HAR and PVR.

Supplementary Table 1 Vascular reconstruction techniques and postoperative complications in the vascular resection cohort

Reconstruction category		Reconstruction technique	<i>n</i>	HA-associated complications	PV thrombosis	Major morbidity	90-day mortality
Portal vein reconstruction	vein	Wedge resection	16	1/16 (6.3%)	2/16 (12.5%)	NA	0/16 (0.0%)
		Segmental resection	52	2/52 (3.8%)	2/52 (3.8%)	NA	1/52 (1.9%)
Hepatic artery reconstruction		End-to-end anastomosis	40	8/40 (20.0%)	0/40 (0.0%)	NA	0/40 (0.0%)
		Arterial transposition	10	2/10 (20.0%)	0/10 (0.0%)	NA	1/10 (10.0%)
Hepatic artery reconstruction		Graft interposition	10	2/10 (20.0%)	2/10 (20.0%)	NA	1/10 (10.0%)
		Two reconstruction	2	0/2 (0.0%)	1/2 (50.0%)	NA	1/2 (50.0%)
Hepatic artery reconstruction		No reconstruction	3	1/3 (33.3%)	0/3 (0.0%)	NA	0/3 (0.0%)

reconstructio							
n							
Vascular	PVR overall	51	3/51 (5.9%)	4/51	23/51	1/51	
resection				(7.8%)	(45.1%)	(2.0%)	
group							
Vascular	HAR overall	65	13/65	3/65	29/65	3/65	
resection			(20.0%)	(4.6%)	(44.6%)	(4.6%)	
group							
Vascular	Overall	VR	11	16/116	7/116	52/116	4/116
resection	cohort		6	(13.8%)	(6.0%)	(44.8%)	(3.4%)
group							

Note: Data are presented as n/N (%). Reconstruction categories were not mutually exclusive in patients with combined arterial and portal venous reconstruction. HA-associated complications included thrombosis, bleeding/pseudoaneurysm, liver abscess, and liver infarction. Major morbidity was defined as Clavien–Dindo grade ≥ III. HA: Hepatic artery; PV: Portal vein; PVR: Portal vein resection; HAR: Hepatic artery resection; VR: Vascular resection. NA: Not applicable.

Supplementary Table 2 Association between clinically relevant postoperative pancreatic fistula and vascular-specific complications in the vascular resection cohort

Variable	Overall (n = 116)	Without POPF (n= 94)	With POPF (n= 22)	P value
Hepatic artery-associated complication	16 (14%)	10 (11%)	6 (27%)	0.078
Portal vein thrombosis	7 (6.0%)	6 (6.4%)	1 (4.5%)	1.000
Any vascular-specific complication	19 (16%)	13 (14%)	6 (27%)	0.200

Type of vascular resection			1.000
PVR	51 (44%)	41 (44%)	10 (45%)
HAR	65 (56%)	53 (56%)	12 (55%)

Note: Data are presented as n (%). POPF: Postoperative pancreatic fistula; PVR: Portal vein resection; HAR: Hepatic artery resection.

Supplementary Table 3 Sensitivity analysis in vascular resection patients without distant metastasis

Analysis	Cohort	PVR	HAR	Events	Estimate	P value
Kaplan-Meier/Log-rank test	M0-only VR cohort	48	59	80	NA	0.776
Univariable Cox regression	M0-only VR cohort	48	59	80	HR = 0.94, 95% CI: 0.60–1.47	0.789

Note: M0-only analysis was performed after excluding patients finally classified as M1 based on intraoperative findings or postoperative pathology. HR refers to hepatic artery resection compared with portal vein resection. PVR: Portal vein resection; HAR: Hepatic artery resection; VR: Vascular resection; HR: Hazard ratio; CI: Confidence interval. NA: Not applicable.

Supplementary Table 4 Predictive performance of the nomogram and tumor-node-metastasis staging

Metric category	Metric	Nomogram model	TNM model	Estimate (difference/effect)	95%CI
Overall discrimination	C-index	0.887	0.787	0.099	0.057-0.141
Time-dependent AUC	1-year 3-year 5-year	0.975 0.976 0.979	0.946 0.839 0.829	NA NA NA	NA NA NA

Reclassification at 3 years	IDI	NA	NA	0.327	0.188-0.496
	Continuous NRI	NA	NA	0.729	0.440-0.882

Note: TNM: Tumor-node-metastasis; C-index: Concordance index; AUC: Area under the curve; IDI: Integrated discrimination improvement; NRI: Net reclassification improvement; CI: Confidence interval. NA: Not applicable.

Supplementary Table 5 Overall survival at 1, 2, 3, and 5 years and conditional survival probabilities by risk group

Risk group	Overall Survival				Conditional Survival			
	1-Year	2-Year	3-Year	5-Year	2-Year 1-Year	3-Year 1-Year	5-Year 1-Year	5-Year 2-Year
Low-Risk	100	90.8	79	51.9	90.8	79	51.9	57.1
High-Risk	55.2	12.8	NE	NE	23.2	NE	NE	NE

Note: Data are presented as percentages. Conditional survival (*e.g.*, 2-Year | 1-Year) denotes the probability of surviving an additional 2 years given that the patient has already survived 1 year after surgery. NE: Not estimable due to an insufficient number of patients at risk beyond 2–3 years in the high-risk group.

Supplementary Table 6 Restricted mean survival time comparison for the prespecified futility subgroup ($\tau = 36$ months)

Group	Definition	<i>n</i>	RMST (0-36 months)	95%CI
High-risk futility subgroup	Lowest quintile (20th percentile) of model-	22	9.7	7.4-12.1

predicted 3-year OS; cut-off = 0.800				
Lower-risk	Remaining patients	94	28.4	26.5-30.2
Contrast	Δ RMST (months)	95%CI	<i>P</i> value	
High-risk-Lower-risk	-18.6	-21.6 to -15.7	<0.001	

Note: RMST was estimated using survRM2::rmst2 with truncation time $\tau = 36$ months. High-risk was defined using a prespecified quantile-based rule (lowest quintile of predicted 3-year OS). RMST: Restricted mean survival time; OS: Overall survival; CI: Confidence interval.

Supplementary Table 7 Effect of hepatic artery resection *vs* portal vein resection across risk strata in the vascular resection cohort

Risk stratum	HR (HAR <i>vs</i> PVR)	95%CI	<i>P</i> value
Low	1.281	0.495-3.319	0.610
Intermediate	0.650	0.315-1.342	0.244
High	0.893	0.468-1.703	0.731

Note: HR refers to hepatic artery resection compared with portal vein resection. HAR: Hepatic artery resection; PVR: Portal vein resection; HR: Hazard ratio; CI: Confidence interval.