

**Table S1** Univariate and multivariable analysis for RFS in HCC patients with HVTT before PSM (n=307)

Clinical variables	Univariate analysis			Multivariate analysis		
	$\beta$	HR (95% CI)	P	$\beta$	HR (95% CI)	P
Age, year	0.000	1.000 (0.990–1.011)	0.915			
Sex, female vs. male	-0.180	0.835 (0.597–1.167)	0.292			
HBsAg, yes vs. no	0.064	1.066 (0.827–1.374)	0.617			
Anti-viral treatment, yes vs. no	-0.094	0.910 (0.558–1.480)	0.706			
Satellite nodules, yes vs. no	0.353	1.424 (0.976–2.077)	0.066			
Tumor capsulation						
Incomplete vs. no	0.266	1.305 (0.866–1.966)	0.203			
Complete vs. no	0.040	1.041 (0.720–1.506)	0.828			
Lymph node invasion, yes vs. no	0.156	1.169 (0.819–1.667)	0.387			
Ascites, yes vs. no	0.449	1.566 (1.110–2.210)	0.010			
Multiple tumor, yes vs. no	-0.050	0.940 (0.727–1.229)	0.675			
AFP, ng/mL						
400–1,000 vs. <400	0.104	1.109 (0.711–1.732)	0.648			
$\geq$ 1,000 vs. <400	0.222	1.248 (0.976–1.596)	0.077			
Child-Pugh grade, A vs. B	0.401	1.493 (0.834–2.673)	0.176			
Tumor diameter, cm	0.030	1.030 (0.998–1.063)	0.019	0.038	1.039 (1.005–1.073)	0.021
PT, s	0.019	1.019 (0.949–1.095)	0.590			
ALT, U/L	0.000	0.998 (0.996–0.999)	0.022			
TP, g/L	0.000	0.990 (0.977–1.010)	0.692			
ALB, g/L	0.000	0.993 (0.968–1.019)	0.641			
AST, U/L	0.000	0.996 (0.994–0.990)	0.007	-0.003	0.997 (0.994–0.999)	0.026
GGT, U/L	0.000	0.999 (0.998–1.000)	0.261			
ALP, U/L	0.000	0.900 (0.998–1.001)	0.578			
PLT, $10^9$ /L	0.000	1.000 (0.999–1.002)	0.278			
TBIL, $\mu$ mol/L	0.000	0.996 (0.991–1.001)	0.131			
DBIL, $\mu$ mol/L	-0.010	0.980 (0.962–1.001)	0.070			
Extent of HVTT						
mHCTT vs. pHVTT	0.325	1.385 (1.037–1.849)	0.027	0.287	1.332 (0.980–1.810)	0.066
IVCTT vs. pHVTT	1.014	2.757 (2.037–3.733)	<0.001	1.127	3.080 (2.252–4.200)	<0.001
Extent of PVTT						
Type I vs. no	0.305	1.357 (1.023–1.79)	0.033	0.487	1.627 (1.209–2.189)	0.001
Type II vs. no	0.278	1.321 (0.961–1.814)	0.085	0.307	1.359 (0.976–1.894)	0.069
Treatment, LR vs. IMRT	-0.400	0.665 (0.526–0.841)	<0.001	-0.727	0.483 (0.370–0.623)	<0.001

RFS, recurrence-free survival; HCC, hepatocellular carcinoma; HVTT, hepatic vein tumor thrombus; PSM, propensity score matching; IMRT, intensity-modulated radiation therapy; LR, liver resection; HBsAg, hepatitis B surface antigen; AFP,  $\alpha$ -fetoprotein; PT, prothrombin time; ALT, alanine aminotransferase; TP, total protein; ALB, albumin; AST, aspartate aminotransferase; GGT,  $\gamma$ -glutamyltransferase; ALP, alkaline phosphatase; PLT, platelet; TBIL, total bilirubin; DBIL, direct bilirubin; pHVTT, peripheral type of HVTT; mHVTT, major type of HVTT; IVCTT, inferior vena cava tumor thrombus; PVTT, portal vein tumor thrombus.

**Table S2** Univariate and multivariable analysis for OS in HCC patients with HVTT after PSM (n=164)

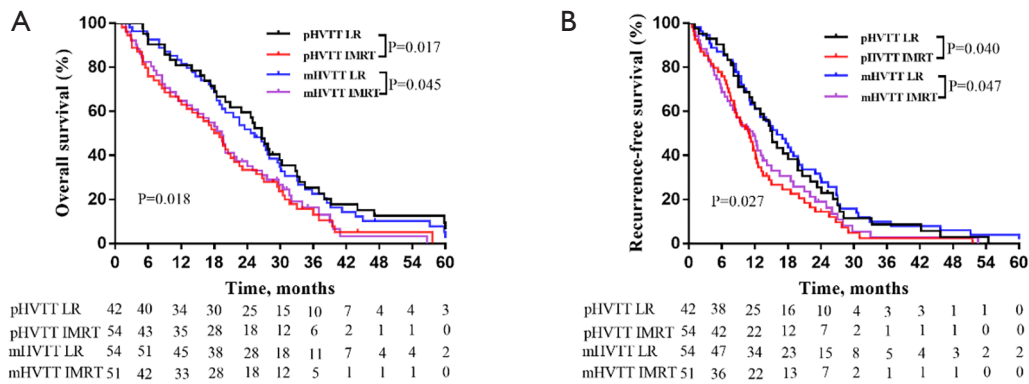
Variables	Univariate analysis			Multivariate analysis		
	$\beta$	HR (95% CI)	P	$\beta$	HR (95% CI)	P
Age, year	-0.006	0.994 (0.980–1.008)	0.441			
Sex, female vs. male	-0.052	0.949 (0.580–1.552)	0.836			
HBsAg, yes vs. no	-0.210	0.810 (0.577–1.136)	0.223			
Anti-viral treatment, yes vs. no	0.211	1.234 (0.859–1.773)	0.254			
Satellite nodules, yes vs. no	-0.015	0.980 (0.570–1.700)	0.958			
Tumor capsulation						
Incomplete vs. no	-0.052	0.948 (0.517–1.741)	0.866			
Complete vs. no	-0.180	0.835 (0.489–1.424)	0.509			
Lymph node invasion, yes vs. no	-0.005	0.994 (0.615–1.608)	0.983			
Ascites, yes vs. no	0.461	1.586 (1.050–2.395)	0.028			
Multiple tumor, yes vs. no	-0.106	0.899 (0.620–1.302)	0.574			
AFP, ng/mL						
400–1,000 vs. <400	0.009	1.009 (0.553–1.842)	0.976			
$\geq$ 1,000 vs. <400	-0.009	0.991 (0.712–1.380)	0.959			
Child-Pugh grade, A vs. B	1.162	3.000 (0.995–10.25)	0.051			
Tumor diameter, cm	0.005	1.000 (0.961–1.050)	0.819			
PT, s	-0.003	0.997 (0.875–1.136)	0.966			
ALT, U/L	0.000	0.999 (0.996–1.002)	0.766			
TP, g/L	-0.003	0.996 (0.970–1.020)	0.810			
ALB, g/L	0.006	1.005 (0.968–1.043)	0.772			
AST, U/L	-0.003	0.996 (0.992–1.000)	0.126			
GGT, U/L	-0.001	0.999 (0.998–1.000)	0.273			
ALP, U/L	0.000	0.999 (0.997–1.001)	0.629			
PLT, $10^9$ /L	0.000	1.000 (0.998–1.002)	0.929			
TBIL, $\mu$ mol/L	0.003	1.002 (0.997–1.008)	0.319			
DBIL, $\mu$ mol/L	0.008	1.007 (0.975–1.040)	0.637			
Extent of HVTT						
mHCTT vs. pHVTT	0.033	1.033 (0.693–1.542)	0.870	0.098	1.103 (0.735–1.653)	0.635
IVCTT vs. pHVTT	1.073	2.922 (1.959–4.358)	<0.001	1.407	4.080 (2.650–6.294)	<0.001
Extent of PVTT						
Type I vs. no	0.050	1.051 (0.728–1.517)	0.789			
Type II vs. no	0.392	1.480 (0.954–2.295)	0.080			
Treatment, LR vs. IMRT	-0.918	0.399 (0.288–0.551)	<0.001	-1.139	0.320 (0.227–0.450)	<0.001

OS, overall survival; HCC, hepatocellular carcinoma; HVTT, hepatic vein tumor thrombus; PSM, propensity score matching; IMRT, intensity-modulated radiation therapy; LR, liver resection; HBsAg, hepatitis B surface antigen; AFP,  $\alpha$ -fetoprotein; PT, prothrombin time; ALT, alanine aminotransferase; TP, total protein; ALB, albumin; AST, aspartate aminotransferase; GGT,  $\gamma$ -glutamyltransferase; ALP, alkaline phosphatase; PLT, platelet; TBIL, total bilirubin; DBIL, direct bilirubin; pHVTT, peripheral type of HVTT; mHVTT, major type of HVTT; IVCTT, inferior vena cava tumor thrombus; PVTT, portal vein tumor thrombus.

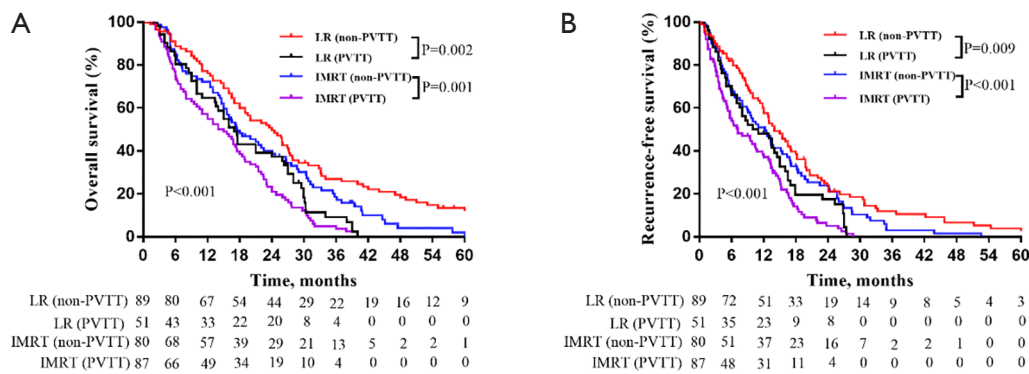
**Table S3** Univariate and multivariable analysis for RFS in HCC patients with HVTT after PSM (n=164)

Clinical variables	Univariate analysis			Multivariate analysis		
	$\beta$	HR (95% CI)	P	$\beta$	HR (95% CI)	P
Age, year	0.000	0.993 (0.980–1.007)	0.380			
Sex, female vs. male	-0.100	0.901 (0.549–1.477)	0.680			
HBsAg, yes vs. no	-0.190	0.823 (0.586–1.156)	0.261			
Anti-viral treatment, yes vs. no	0.175	1.190 (0.731–1.937)	0.482			
Satellite nodules, yes vs. no	0.035	1.035 (0.598–1.791)	0.900			
Tumor capsulation						
Incomplete vs. no	0.009	1.009 (0.544–1.871)	0.975			
Complete vs. no	-0.090	0.900 (0.529–1.547)	0.715			
Lymph node invasion, yes vs. no	0.080	1.091 (0.673–1.768)	0.721			
Ascites, yes vs. no	0.587	1.800 (1.180–2.744)	0.000	0.478	1.613 (1.049–2.480)	0.029
Multiple tumor, yes vs. no	-0.060	0.939 (0.648–1.359)	0.739			
AFP, ng/mL						
400–1,000 vs. <400	0.055	1.057 (0.598–1.866)	0.850			
$\geq$ 1,000 vs. <400	-0.092	1.096 (0.784–1.532)	0.591			
Child-Pugh grade, A vs. B	0.810	2.255 (0.709–7.172)	0.168			
Tumor diameter, cm	0.000	1.009 (0.966–1.054)	0.669			
PT, s	0.000	0.974 (0.850–1.112)	0.703			
ALT, U/L	0.000	0.998 (0.990–1.001)	0.431			
TP, g/L	0.000	0.993 (0.967–1.019)	0.627			
ALB, g/L	0.011	1.011 (0.976–1.047)	0.530			
AST, U/L	0.000	0.996 (0.991–1.000)	0.074			
GGT, U/L	0.000	0.999 (0.998–1.00)	0.101			
ALP, U/L	0.000	0.999 (0.997–1.001)	0.656			
PLT, $10^9/L$	0.000	1.000 (0.998–1.002)	0.800			
TBIL, $\mu\text{mol/L}$	0.000	1.000 (0.990–1.010)	0.929			
DBIL, $\mu\text{mol/L}$	0.000	1.000 (0.966–1.035)	0.981			
Extent of HVTT						
mHCTT vs. pHVTT	0.270	1.310 (0.883–1.944)	0.178	0.371	1.449 (0.969–2.160)	0.070
IVCTT vs. pHVTT	1.083	2.950 (1.940–4.501)	<0.001	1.269	3.558 (2.283–5.545)	<0.001
Extent of PVTT						
Type I vs. no	-0.010	0.988 (0.689–1.418)	0.951			
Type II vs. no	0.135	1.145 (0.735–1.784)	0.548			
Treatment, LR vs. IMRT	-0.930	0.391 (0.282–0.541)	<0.001	-1.119	0.326 (0.230–0.458)	<0.001

RFS, recurrence-free survival; HCC, hepatocellular carcinoma; HVTT, hepatic vein tumor thrombus; PSM, propensity score matching; IMRT, intensity-modulated radiation therapy; LR, liver resection; HBsAg, hepatitis B surface antigen; AFP,  $\alpha$ -fetoprotein; PT, prothrombin time; ALT, alanine aminotransferase; TP, total protein; ALB, albumin; AST, aspartate aminotransferase; GGT,  $\gamma$ -glutamyltransferase; ALP, alkaline phosphatase; PLT, platelet; TBIL, total bilirubin; DBIL, direct bilirubin; pHVTT, peripheral type of HVTT; mHVTT, major type of HVTT; IVCTT, inferior vena cava tumor thrombus; PVTT, portal vein tumor thrombus.



**Figure S1** Kaplan-Meier analysis of OS and RFS of HCC patients with pHVTT and mHVTT of HVTT on subgroup analysis. (A) The OS for HCC patients after LR or IMRT (42 vs. 54 patients in pHVTT; 54 vs. 51 patients in mHVTT) after LR ( $P=0.018$ ); (B) the RFS for HCC patients after LR or IMRT (42 vs. 54 patients in pHVTT; 54 vs. 51 patients in mHVTT) after LR ( $P=0.027$ ). OS, overall survival; RFS, recurrence-free survival; HCC, hepatocellular carcinoma; HVTT, hepatic vein tumor thrombus; pHVTT, peripheral type of HVTT; mHVTT, major type of HVTT; IMRT, intensity-modulated radiation therapy; LR, liver resection.



**Figure S2** Kaplan-Meier analysis of OS and RFS in HCC patients with or without PVTT on subgroup analysis. (A) The OS for HCC patients with or without PVTT (87 vs. 80 patients after IMRT; 51 vs. 89 patients after LR) after LR ( $P<0.001$ ); (B) the RFS for HCC patients with or without PVTT (87 vs. 80 patients after IMRT; 51 vs. 89 patients after LR) after LR ( $P<0.001$ ). OS, overall survival; RFS, recurrence-free survival; HCC, hepatocellular carcinoma; PVTT, portal vein tumor thrombus; IMRT, intensity-modulated radiation therapy; LR, liver resection.

**Table S4** Adverse events of patients with HCC and HVTT who underwent IMRT

Adverse event	No. of patients with CTCAE grade (n)		
	3	4	5
Fatigue	3	–	–
Anorexia	2	2	–
Nausea	2	2	–
ALT increase	1	–	–
Bilirubin increase	1	1	–
Gastroduodenitis	1	–	–
Gastric ulcer	2	–	–
Duodenal ulcer	3	1	–

Adverse event was evaluated according to Common Terminology Criteria for Adverse Events (CTCAE) Version 4.0. HCC, hepatocellular carcinoma; HVTT, hepatic vein tumor thrombus; IMRT, intensity-modulated radiation therapy; ALT, alanine aminotransferase.

**Table S5** Operative procedures and outcomes

Operative details	No. (%)
Major hepatectomy	89 (63.6)
Extent of resection	
R0	115 (82.1)
R1	25 (17.9)
Anatomical resection	86 (61.4)
Median hospital stay (days)	19 [14–24]
Clavien-dindo grade (total)	45 (32.1)
I	22 (15.7)
II	18 (12.9)
III	3 (2.1)
IV	2 (1.4)
V	0

Data are the median [IQR] or number (percentage) unless otherwise indicated.