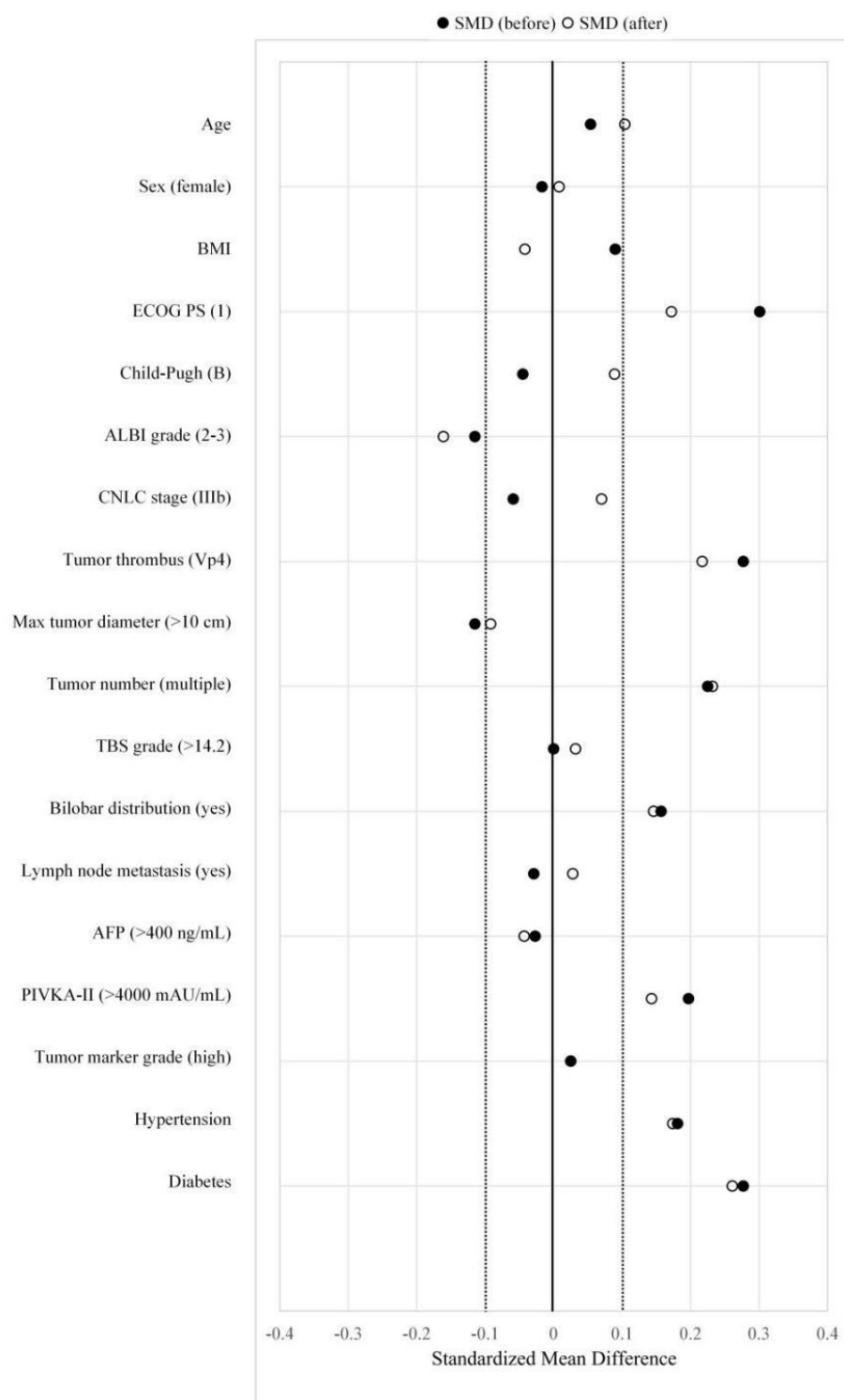




Supplementary Figure 1 Love plot for covariate balance before and after propensity score matching. Solid circles represent pre-match (n=92), open circles represent post-match (n=79); dashed lines indicate $SMD=\pm 0.1$ (threshold for adequate balance).

Supplementary Table 1 Distribution of Targeted Therapy and Immunotherapy Agent Types in the Two Groups After PSM

Variable	Systemic therapy alone group (n=31)	Combination therapy group (n=48)	P value
Targeted therapy agents, n (%)			
Lenvatinib	9 (29.03%)	21 (43.75%)	0.188
Donafenib	8 (25.81%)	11 (22.92%)	0.769
Bevacizumab	3 (9.68%)	4 (8.33%)	1.000*
Sorafenib	0 (0.00%)	4 (8.33%)	0.150*
Ivonescimab (AK112)	11 (35.48%)	0 (0.00%)	<0.001*
Apatinib	0 (0.00%)	7 (14.58%)	0.038*
Anlotinib	0 (0.00%)	1 (2.08%)	1.000*
Immunotherapy agents, n (%)			
Sintilimab	6 (19.35%)	19 (39.58%)	0.059
Tislelizumab	10 (32.26%)	17 (35.42%)	0.773
Ivonescimab (AK112)	11 (35.48%)	0 (0.00%)	<0.001*
Camrelizumab	0 (0.00%)	8 (16.67%)	0.020*
Atezolizumab	0 (0.00%)	3 (6.25%)	0.276*
Cadonilimab (AK104)	2 (6.45%)	0 (0.00%)	0.151*
Finotonlimab (SCTH10A)	2 (6.45%)	0 (0.00%)	0.151*
Toripalimab	0 (0.00%)	1 (2.08%)	1.000*

Note: Data are presented as n (%). Between-group comparisons were performed using the chi-square test or Fisher's exact test (denoted by *). Ivonescimab (AK112) is a bispecific antibody against programmed cell death-1 and vascular endothelial growth factor, exerting both targeted and immunotherapeutic effects; it is therefore listed under both categories of agents.

Supplementary Table 2 Univariate and Multivariate Cox Regression Analyses of PFS in the Entire Cohort

Variable	Univariate analysis		Multivariate analysis	
	HR (95%CI)	P value	HR (95%CI)	P value
Age (years) (continuous variable)	0.985 (0.961-1.010)	0.236		
Sex (female vs. male)	0.743 (0.268-2.061)	0.568		
ECOG PS score (1 vs. 0)	0.940 (0.558-1.584)	0.818		
Child-Pugh class (B vs. A)	0.798 (0.468-1.362)	0.408		
ALBI grade (2-3 vs. 1)	1.090 (0.606-1.961)	0.773		
CNLC stage (IIIb vs. IIIa)	1.600 (0.986-2.598)	0.057	1.573 (0.968-2.557)	0.068
Tumor thrombus type (Vp4 vs. Vp3)	0.960 (0.590-1.561)	0.869		
Maximum tumor diameter (>10 cm vs. ≤10 cm)	0.932 (0.525-1.655)	0.811		
Tumor number (multiple vs. solitary)	1.416 (0.863-2.323)	0.169		

Variable	Univariate analysis		Multivariate analysis	
	HR (95%CI)	P value	HR (95%CI)	P value
TBS grade (>14.2 vs. ≤14.2)	1.230 (0.767-1.972)	0.390		
Bilobar distribution (yes vs. no)	1.276 (0.794-2.052)	0.314		
Lymph node metastasis (yes vs. no)	1.131 (0.710-1.800)	0.604		
AFP (ng/mL) (>400 vs. ≤400)	1.153 (0.680-1.953)	0.598		
PIVKA-II (mAU/mL) (>4000 vs. ≤4000)	0.868 (0.502-1.500)	0.611		
Tumor marker grade (high risk vs. low risk)	1.150 (0.547-2.418)	0.712		
Treatment regimen (combination therapy vs. systemic therapy alone)	0.737 (0.458-1.187)	0.210	0.758 (0.471-1.222)	0.256

Note: Variables with $P < 0.10$ in univariable analysis (CNLC stage) together with treatment group were entered into the multivariable Cox proportional hazards model. The PFS multivariable model included 79 patients, with 73 events and 6 censored observations. The primary model satisfied the proportional hazards assumption (Schoenfeld residual test, all variables $P > 0.05$).

Supplementary Table 3 Subgroup Analysis of PFS in the Entire Cohort After PSM

Subgroup variable	Stratification	Combination therapy group (Events/Total)	Systemic therapy alone group (Events/Total)	HR (95% CI)	P value (within-group)	Interaction P value
Overall		44/48	29/31			
CNLC stage						
	IIIa	24/28	16/17	0.625 (0.327-1.194)	0.155	0.357
	IIIb	20/20	13/14	0.905 (0.442-1.852)	0.785	
Tumor thrombus type						
	Vp3	31/33	17/18	0.907 (0.494-1.664)	0.752	0.203
	Vp4	13/15	12/13	0.443 (0.195-1.006)	0.052	
Child-Pugh class						
	A	32/36	20/22	0.946 (0.538-1.661)	0.846	0.102
	B	12/12	9/9	0.414 (0.156-1.098)	0.076	
TBS grade						
	≤14.2	21/24	14/15	0.494 (0.239-1.023)	0.057	0.525
	>14.2	23/24	15/16	0.866 (0.444-1.688)	0.672	

Subgroup variable	Stratification	Combination therapy group (Events/Total)	Systemic therapy alone group (Events/Total)	HR (95% CI)	P value (within-group)	Interaction P value
Tumor number						
	Solitary	16/19	8/9	1.056 (0.445-2.509)	0.902	0.395
	Multiple	28/29	21/22	0.685 (0.380-1.235)	0.208	
Age						
	≤54	27/28	16/16	0.674 (0.350-1.298)	0.238	0.887
	>54	17/20	13/15	0.741 (0.355-1.549)	0.426	
ALBI grade						
	1	8/9	6/8	1.558 (0.503-4.822)	0.442	0.044
	2-3	36/39	23/23	0.531 (0.305-0.926)	0.026	
ECOG PS score						
	0	13/16	7/8	0.681 (0.258-1.795)	0.437	0.940
	1	31/32	22/23	0.738 (0.423-1.287)	0.284	

Note: Values in the combination therapy group and systemic therapy alone group columns are expressed as events/total number of patients.

Supplementary Table 4 Sensitivity analysis of overall survival (OS) based on landmark analysis.

Landmark time	No. of patients retained, n (systemic/combination)	Median OS, months (systemic/combination)	HR (95% CI)	P value
0 (original analysis)	31/48	7.7 / 14.2	0.481 (0.295–0.782)	0.003
1 month	31/48	6.7 / 13.2	0.481 (0.295–0.782)	0.003
2 month	31/47	5.7 / 13.1	0.464 (0.284–0.756)	0.002
3 month	27/47	6.1 / 12.1	0.519 (0.312–0.865)	0.012

Note: Landmark analyses included only patients alive at each landmark time, and survival time was calculated from the landmark point. Because eligibility required ≥ 30 days of targeted therapy, no patients were excluded at the 1-month landmark; therefore, the results are identical to the original analysis.

Supplementary Table 5 Comparison of post-progression anti-tumor therapy between the two groups after PSM.

Post-progression therapy	Systemic therapy alone (n=31)	Combination therapy (n=48)	P value
Locoregional therapy			
TACE	2 (6.45%)	30 (62.50%)	<0.001
HAIC	2 (6.45%)	22 (45.83%)	<0.001
Ablation	0 (0.00%)	7 (14.58%)	0.038*
Systemic therapy			
Targeted therapy	16 (51.61%)	32 (66.67%)	0.181
Immunotherapy	12 (38.71%)	33 (68.75%)	0.008
Chemotherapy	1 (3.23%)	2 (4.17%)	1.000*
Other therapy			
Radiotherapy	2 (6.45%)	6 (12.50%)	0.470*
Radioactive seed implantation	1 (3.23%)	5 (10.42%)	0.395*
Curative resection	0 (0.00%)	1 (2.08%)	1.000*

Note: Data are presented as n (%). *Between-group comparisons by Fisher's exact test. Post-progression therapy refers to any anti-tumor treatment received after disease progression; patients may receive multiple post-progression therapies, and therefore the sum of proportions may exceed 100%.