Supplementary Table 1. IVIM-DWI parameters of hepatic right lobe segments V–VIII in three groups [M (P25, P75)]

Parameter	Unit	Healthy Control (n = 42)	EHF (S1-S2, n = 46)	AHF (S3-S4, n=51)	Kruskal-Wallis H	*P* value
SV ADC	$\times10^{-3}$ mm²/s	1.45 (1.38–1.52)	1.32 (1.25–1.39)	1.15 (1.08–1.22)	68.25	< 0.001
SVII ADC	$\times10^{-3}$ mm²/s	1.48 (1.40–1.55)	1.30 (1.23–1.37)	1.12 (1.05–1.19)	72.18	< 0.001
SVIII Dslow	$\times10^{-3}$ mm²/s	1.25 (1.18–1.32)	1.08 (1.01–1.15)	0.92 (0.85–0.99)	75.36	< 0.001
SVI Dfast	$\times10^{-3}$ mm²/s	15.68 (14.25–17.12)	12.35 (11.02–13.68)	9.86 (8.95–10.78)	65.89	< 0.001
Mean f value	%	28.5 (25.2–31.8)	25.1 (22.3–27.9)	21.6 (19.2–24.0)	58.72	< 0.001

ADC, apparent diffusion coefficient; Dslow, slow diffusion component; Dfast, fast diffusion component; f, perfusion fraction; EHF, early hepatic fibrosis; AHF, advanced hepatic fibrosis; IVIM-DWI, intravoxel incoherent motion diffusion-weighted imaging.

Supplementary Table 2. Logistic regression coefficients and multicollinearity of IVIM-DWI/GPR fusion model (healthy control vs. EHF)

Predictor	β	SE	Wald χ^2	*P* value	OR (95%CI)	VIF	Parallel line test *P*
SV ADC	-0.158	0.089	3.125	0.077	0.854 (0.723–1.010)	3.21	0.286
SVII ADC	-0.213	0.105	4.12	0.042	0.808 (0.661–0.989)	2.89	0.315
SVIII Dslow	-0.326	0.128	6.512	0.012	0.722 (0.561–0.935)	3.57	0.268
SVI Dfast	-0.189	0.096	3.875	0.049	0.828 (0.691–0.992)	2.65	0.352
GPR	0.289	0.106	7.458	0.008	1.335 (1.082–1.649)	2.18	0.401
Constant	1.258	0.569	4.926	0.027	-	-	-

ADC, apparent diffusion coefficient; β, regression coefficient; SE, standard error; OR, odds ratio; VIF, variance inflation factor; EHF, early hepatic fibrosis; CI, confidence interval; IVIM-DWI, intravoxel incoherent motion diffusion-weighted imaging; GPR, gamma-glutamyl transpeptidase-to-platelet ratio; Dslow, slow diffusion component; Dfast, fast diffusion component.

Supplementary Table 3. Logistic regression coefficients and multicollinearity of IVIM-DWI/GPR fusion model (EHF vs. AHF)

Predictor	β	SE	Wald χ^2	*P* value	OR (95%CI)	VIF	Parallel line test *P*
SVII ADC	-0.196	0.102	3.708	0.054	0.822 (0.673–1.001)	2.45	0.328
SVI Dfast	-0.178	0.095	3.512	0.061	0.837 (0.690–1.012)	2.19	0.365
GPR	0.215	0.099	4.652	0.031	1.240 (1.018–1.511)	1.87	0.415
Constant	0.896	0.485	3.432	0.064	-	-	-

β, regression coefficient; SE, standard error; OR, odds ratio; VIF, variance inflation factor; EHF, early hepatic fibrosis; AHF, advanced hepatic fibrosis; IVIM-DWI, intravoxel incoherent motion diffusion-weighted imaging; ADC, apparent diffusion coefficient; GPR, gamma-glutamyl transpeptidase-to-platelet ratio; CI, confidence interval; Dfast, fast diffusion component.

Supplementary Table 4. Diagnostic performance comparison of all evaluated methods for hepatic fibrosis staging

Model	HC vs. EHF AUC (95% CI)	EHF vs. AHF AUC (95% CI)
FIB-4	0.911 (0.844–0.969)	0.637 (0.520–0.747)
APRI	0.843 (0.755–0.923)	0.573 (0.454–0.690)
IVIM+GPR Fusion	0.745 (0.643–0.847)	0.698 (0.592–0.804)
GPR	0.730 (0.622–0.834)	0.698 (0.592–0.804)
IVIM alone	0.652 (0.535–0.769)	0.595 (0.480–0.710)

AUC, area under the curve; CI, confidence interval; HC, healthy controls; EHF, early hepatic fibrosis (Scheuer S1-S2); AHF, advanced hepatic fibrosis (Scheuer S3-S4); FIB-4, Fibrosis-4 index; APRI, aminotransferase-to-platelet ratio index; GPR, γ-glutamyl transpeptidase-to-platelet ratio; IVIM, intravoxel incoherent motion. DeLong test: HC vs. EHF—Fusion vs. APRI, $P = 0.023$; Fusion vs. FIB-4, $P < 0.001$; EHF vs. AHF—no significant differences (all $P > 0.05$).

Supplementary Table 5. Bootstrap feature selection stability (1,000 iterations)

Variable	Selection frequency (HC vs. EHF) Selection frequency (EHF vs. AHF)	Selection frequency (HC vs. EHF) Selection frequency (EHF vs. AHF)
SV ADC	76.4%	—
SVII ADC	85.7%	73.2%
SVIII Dslow	92.1%	—
SVI Dfast	79.3%	71.5%
GPR	89.6%	87.8%

Selection frequency = percentage of bootstrap iterations (n = 1,000) in which the variable was retained in the final LASSO model. Variables with frequency. ADC, apparent diffusion coefficient; Dslow, slow diffusion component; Dfast, fast diffusion component; GPR, gamma-glutamyl transpeptidase-to-platelet ratio; EHF, early hepatic fibrosis; AHF, advanced hepatic fibrosis; HC, healthy control;.

Supplementary Table 6. Intra- and inter-reader reliability of segmental IVIM-DWI parameters across healthy controls and patients with chronic hepatitis B–related hepatic fibrosis

Segment		Intra-reader		Inter-reader	
Segment	**Parameter**	**ICC (2,1) (95% CI)**	**CV (%)**	**ICC (2,1) (95% CI)**	**CV (%)**
Seg V	ADC	0.96 (0.91–0.98)	1.6 [0.7–2.9]	0.26 (-0.10–0.58)	6.2 [3.9–11.4]
Seg VI		0.96 (0.91–0.98)	1.6 [0.8–3.5]	0.60 (0.26–0.80)	5.3 [2.7–11.0]
Seg VII		0.95 (0.89–0.98)	2.0 [0.7–3.8]	0.68 (0.39–0.85)	3.9 [1.5–9.2]
Seg VIII		0.93 (0.84–0.97)	2.1 [1.2–4.1]	0.61 (0.29–0.81)	4.1 [1.6–10.5]
V–VIII (mean)		0.97 (0.93–0.99)	1.3 [0.6–2.1]	0.78 (0.41–0.91)	4.4 [2.9–5.3]
Seg V	Dslow	0.98 (0.95–0.99)	2.4 [1.7–4.7]	0.17 (-0.26–0.54)	11.5 [7.2–19.5]
Seg VI		0.99 (0.97–0.99)	1.2 [0.8–2.4]	0.46 (0.06–0.73)	9.9 [5.4–18.0]
Seg VII		0.99 (0.99–1.00)	1.9 [1.2–3.2]	0.59 (0.23–0.80)	7.4 [2.3–13.9]
Seg VIII		0.98 (0.95–0.99)	3.1 [1.3–4.3]	0.60 (0.25–0.81)	6.3 [3.0–12.3]
V–VIII (mean)		0.99 (0.98–1.00)	1.1 [0.5–2.1]	0.65 (0.33–0.84)	6.7 [2.9–11.4]
Seg V	Dfast	0.97 (0.93–0.99)	8.0 [3.7–17.7]	0.68 (0.38–0.85)	29.5 [12.1–70.9]
Seg VI		0.98 (0.95–0.99)	8.6 [3.1–14.9]	0.82 (0.63–0.92)	22.9 [12.2–50.4]
Seg VII		0.98 (0.95–0.99)	6.6 [2.0–10.7]	0.21 (-0.23–0.57)	16.2 [11.6–58.8]
Seg VIII		0.98 (0.96–0.99)	7.9 [3.2–13.2]	0.69 (0.40–0.85)	27.3 [7.1–44.4]
V–VIII (mean)		0.99 (0.98–1.00)	3.3 [2.5–6.2]	0.85 (0.68–0.93)	13.5 [4.9–29.7]
Seg V	f	0.99 (0.98–1.00)	3.1 [1.8–4.9]	0.34 (-0.07–0.65)	19.9 [8.2–31.6]
Seg VI		0.96 (0.91–0.98)	5.6 [1.4–6.7]	0.61 (0.26–0.81)	16.7 [7.2–23.5]
Seg VII		0.93 (0.85–0.97)	4.2 [2.8–7.7]	0.54 (0.17–0.77)	10.5 [5.2–30.2]
Seg VIII		0.93 (0.84–0.97)	4.4 [2.0–8.9]	0.65 (0.33–0.84)	11.9 [8.4–16.8]
V–VIII (mean)		0.97 (0.94–0.99)	2.4 [1.0–3.5]	0.77 (0.52–0.89)	8.7 [5.5–14.6]
Seg V	ADC	0.97 (0.92–0.99)	1.7 [1.2–3.6]	0.59 (0.26–0.80)	6.0 [3.8–10.6]
Seg VI		0.94 (0.87–0.98)	2.3 [1.7–3.6]	-0.07 (-0.48–0.35)	5.1 [2.4–10.2]
Seg VII		0.96 (0.90–0.98)	2.3 [0.9–3.9]	0.65 (0.34–0.84)	6.1 [3.6–12.5]
Seg VIII		0.97 (0.93–0.99)	1.6 [0.9–2.7]	0.77 (0.54–0.90)	4.8 [3.6–9.7]
V–VIII (mean)		0.98 (0.95–0.99)	0.9 [0.3–1.6]	0.49 (0.10–0.75)	3.9 [1.4–7.9]
Seg V	Dslow	0.96 (0.91–0.98)	1.9 [0.8–4.2]	0.30 (-0.08–0.62)	7.4 [4.1–12.7]
Seg VI		0.97 (0.94–0.99)	1.5 [0.7–2.9]	0.28 (-0.12–0.61)	9.1 [6.7–15.3]
Seg VII		0.97 (0.93–0.99)	1.6 [0.6–3.9]	0.44 (0.03–0.72)	4.3 [2.7–16.5]
Seg VIII		0.97 (0.93–0.99)	1.9 [0.8–4.3]	0.68 (0.38–0.85)	9.1 [1.2–22.2]
V–VIII (mean)		0.98 (0.96–0.99)	1.1 [0.7–2.3]	0.60 (0.26–0.81)	6.3 [2.4–9.6]
Seg V	Dfast	0.95 (0.89–0.98)	8.9 [5.4–13.2]	0.20 (-0.21–0.56)	31.7 [14.1–48.9]
Seg VI		0.96 (0.91–0.98)	9.4 [7.0–14.2]	0.33 (-0.11–0.65)	25.6 [17.0–54.3]
Seg VII		0.95 (0.90–0.98)	10.1 [4.6–16.6]	0.08 (-0.33–0.47)	28.6 [13.9–49.2]
Seg VIII		0.93 (0.84–0.97)	8.3 [3.8–17.6]	0.52 (0.13–0.76)	27.7 [14.2–48.0]
V–VIII (mean)		0.98 (0.95–0.99)	3.0 [1.4–6.4]	0.29 (-0.13–0.62)	17.4 [14.1–26.2]
Seg V	f	0.93 (0.85–0.97)	4.9 [2.7–7.9]	0.52 (0.16–0.76)	14.7 [7.1–23.5]
Seg VI		0.94 (0.87–0.98)	5.3 [1.9–7.7]	0.68 (0.38–0.85)	15.7 [5.2–21.2]
Seg VII		0.92 (0.82–0.97)	5.4 [1.7–10.1]	0.65 (0.33–0.84)	8.9 [2.4–25.2]
Seg VIII		0.96 (0.89–0.98)	3.6 [1.8–6.7]	0.80 (0.59–0.91)	9.1 [3.9–15.0]
V–VIII (mean)		0.98 (0.94–0.99)	2.0 [1.1–5.1]	0.81 (0.60–0.91)	5.2 [3.0–12.5]
Seg V	ADC	0.97 (0.94–0.99)	1.7 [0.7–4.6]	0.82 (0.65–0.91)	4.8 [1.6–8.8]
Seg VI		0.96 (0.92–0.98)	2.7 [1.5–3.5]	0.64 (0.37–0.82)	7.8 [3.2–15.2]
Seg VII		0.98 (0.96–0.99)	1.7 [0.8–3.0]	0.72 (0.48–0.86)	5.2 [1.4–10.1]
Seg VIII		0.95 (0.89–0.98)	2.7 [1.6–4.8]	0.71 (0.47–0.85)	3.6 [1.2–5.9]
V–VIII (mean)		0.98 (0.97–0.99)	1.5 [0.7–2.3]	0.84 (0.68–0.92)	3.2 [1.0–6.2]
Seg V	Dslow	0.95 (0.90–0.98)	3.9 [1.8–6.7]	0.50 (0.18–0.72)	8.2 [4.3–15.2]
Seg VI		0.99 (0.98–0.99)	2.1 [0.7–2.8]	0.65 (0.38–0.82)	4.7 [2.9–17.1]
Seg VII		0.58 (0.28–0.78)	2.5 [1.3–4.7]	0.12 (-0.23–0.46)	12.1 [5.3–21.2]
Seg VIII		0.94 (0.88–0.97)	2.8 [0.4–5.2]	0.61 (0.32–0.80)	7.8 [3.9–16.5]
V–VIII (mean)		0.86 (0.72–0.93)	1.0 [0.4–2.2]	0.43 (0.09–0.68)	4.7 [3.0–11.0]
Seg V	Dfast	0.94 (0.87–0.97)	7.5 [3.4–15.1]	0.30 (-0.07–0.60)	26.9 [14.9–38.5]
Seg VI		0.94 (0.87–0.97)	10.7 [7.0–14.4]	0.52 (0.21–0.74)	21.4 [13.6–34.6]
Seg VII		0.93 (0.85–0.96)	11.2 [5.2–17.5]	0.00 (-0.35–0.36)	26.9 [11.9–65.3]
Seg VIII		0.90 (0.80–0.95)	9.0 [3.6–15.9]	0.24 (-0.14–0.56)	28.2 [18.0–47.7]
V–VIII (mean)		0.92 (0.84–0.96)	4.6 [2.5–7.4]	-0.05 (-0.40–0.31)	13.5 [6.1–29.2]
Seg V	f	0.95 (0.89–0.98)	5.8 [2.7–9.2]	0.76 (0.54–0.88)	14.0 [3.5–22.1]
Seg VI		0.98 (0.96–0.99)	3.3 [1.2–6.1]	0.77 (0.56–0.88)	9.8 [4.0–18.5]
Seg VII		0.97 (0.94–0.99)	5.3 [3.0–9.0]	0.75 (0.53–0.87)	14.4 [6.3–22.0]
Seg VIII		0.96 (0.92–0.98)	5.1 [3.0–9.9]	0.71 (0.48–0.85)	12.4 [5.9–16.9]
V–VIII (mean)		0.99 (0.98–1.00)	1.4 [0.8–4.7]	0.88 (0.76–0.94)	5.9 [2.9–12.3]

Reliability was evaluated in 42 healthy controls (Panel A), 46 early fibrosis patients (S1–S2; Panel B), and 51 advanced fibrosis patients (S3–S4; Panel C). One radiologist performed two sessions (intra-reader); a second radiologist measured the same examinations independently and in a blinded manner (inter-reader). Each value is the reader's mean of repeated ROIs within the indicated segment. ICC, intraclass correlation coefficient (two-way random-effects, absolute agreement, single measures); 95% CIs in parentheses. CV, within-subject coefficient of variation (median [IQR], %). Seg V–VIII, Couinaud right-lobe segments; V–VIII (mean), four-segment average used by the fusion model. ADC800, ADC at b = 800 s/mm²; Dslow, true diffusion; Dfast, pseudodiffusion; f, perfusion fraction. Units: $\times10^{-3}$ mm²/s. Intra-reader ICC was good to excellent in nearly all segments (0.86–0.99), with one moderate outlier (0.58); inter-reader agreement was lowest for Dfast, particularly in segment VII (e.g., 0.08 in EHF). All segment-averaged median CVs were < 20%; per-segment Dfast inter-reader CVs exceeded 20% in some segments. VIM-DWI, intravoxel incoherent motion diffusion-weighted imaging; CI, confidence interval; CV, coefficient of variation; ADC, apparent diffusion coefficient; Dslow, true diffusion coefficient; Dfast, pseudodiffusion coefficient; IQR, interquartile range; ROI, region of interest; Seg, segment; EHF, early hepatic fibrosis.